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# 1. INTRODUCTION

## 1.1 Title and Contractual Elements of the Project

The preparation of the study entitled: *"PRELIMINARY STUDY – FINAL STUDY OF THE MINAGIOTIKO DAM & FINAL STUDY OF THE IRRIGATION NETWORK OF THE MUNICIPALITY OF PYLOS-METHONI, PREFECTURE OF MESSINIA"*, under the contract signed on 14-01-2015, was assigned by the Directorate of Technical Studies, Constructions and Topography of the Ministry of Rural Development and Food (Project No. 2009ΣΜ08180000/ ΣΑΜ081/8) to the following cooperating offices:

1. A.D.K. ARONIS–DRETTAS–KARLAFTIS CONSULTING ENGINEERS S.A.
2. KASTOR LTD – HELLENIC SUBSURFACE RESEARCH COMPANY, DISTINGUISHED AS KASTOR LTD
3. THEODOROS ILIOPOULOS
4. GEORGIOS EMMANOUILIDIS
5. MICHAIL LEVOYIANNIS

The contractual scope of the project concerns:

- drafting of a preliminary study, final study, and tender documents for the construction of the Minagiotiko Dam, which will be built in the Pylia region of Messinia Prefecture, on the homonymous stream, at a location approximately 5.5 km in a straight line from its estuary and about 2 km west of the village of Vlasaika
- drafting of the final study and tender documents for the rigation networks covering an area of 35,000 stremmas, with irrigation pumping stations, irrigation reservoirs, and the appropriate safety–operation instruments and irrigation intakes, through which the distribution networks will be supplied.

The study will include the investigation of the construction conditions of the dam and the network by carrying out the required exploratory works and preparing the corresponding supporting studies, such as topographical, geological, geotechnical, and Environmental Impact Assessment studies, with the ultimate aim of delivering a unified and functional set of works.

| A.D.K. Consulting Engineers S.A. | | Approval For the Supervising Authority | |
|---|---|---|---|
| For drafting | For the Contractor | Supervision Team | |
| D. Ziogas<br>Study Team Coordinator | M. Aronis<br>Legal Representative of the Consortium | A. Avgenaki<br>Supervisor | S. Gerodimitrou<br>Coordinator of the Supervisors |

## 1.2 Type and Scale of the Project

As mentioned above, the examined works concern complex hydraulic projects of an irrigation nature and include a reservoir and an integrated irrigation network system, so as to constitute a unified functional set of works that will be both techno-economically advantageous and environmentally acceptable.

The planned irrigation networks are expected to cover an area of approximately 35,000 stremmas and will also include water intake facilities, pumping stations, regulation reservoirs with the appropriate safety–operation instruments, and irrigation distribution networks.

## 1.3 Geographical Location and Administrative Jurisdiction of the Project

### 1.3.1 Location

The proposed location of the dam under study is within the boundaries of the Municipalities of Pylos–Nestor and Messini, north of the settlement of Finikounta. It is situated at a straight-line distance of 5.5 km from the estuary of the Minagiotiko stream and approximately 1.6 km west of the settlement of Vlasaika.

The Minagiotiko stream is located in the southern part of the Pylia region, runs from north to south, and discharges into the sea about 800 m west of Finikounta.

The wider area is bounded to the west by the Delimichalis torrent, to the east by the Velika torrent, while to the south it is bordered by the Messinian Gulf.

### 1.3.2 Administrative Jurisdiction of the Project

The works examined in this study—the Minagiotiko stream dam and the irrigation network—are located in the southwestern part of the Peloponnese Region, within the Regional Unit of Messinia, in the Municipalities of Pylos–Nestor and Messini.

The study area is currently under the administrative jurisdiction of four (4) Municipal Units and concerns cultivable lands of the respective former Municipal Districts, as follows:

1. Municipal Unit of Methoni and the former Municipal Districts of Evangelismos, Finikounta, Lahanada, and Finiki.
2. Municipal Unit of Pylos and the former Municipal Districts of Pidassos, Chomatada, Kallithea, and Ambelakia.
3. Municipal Unit of Aipeia and the former Municipal District of Militsa.
4. Municipal Unit of Koroni and the former Municipal Districts of Exochiko and Kaplanio.

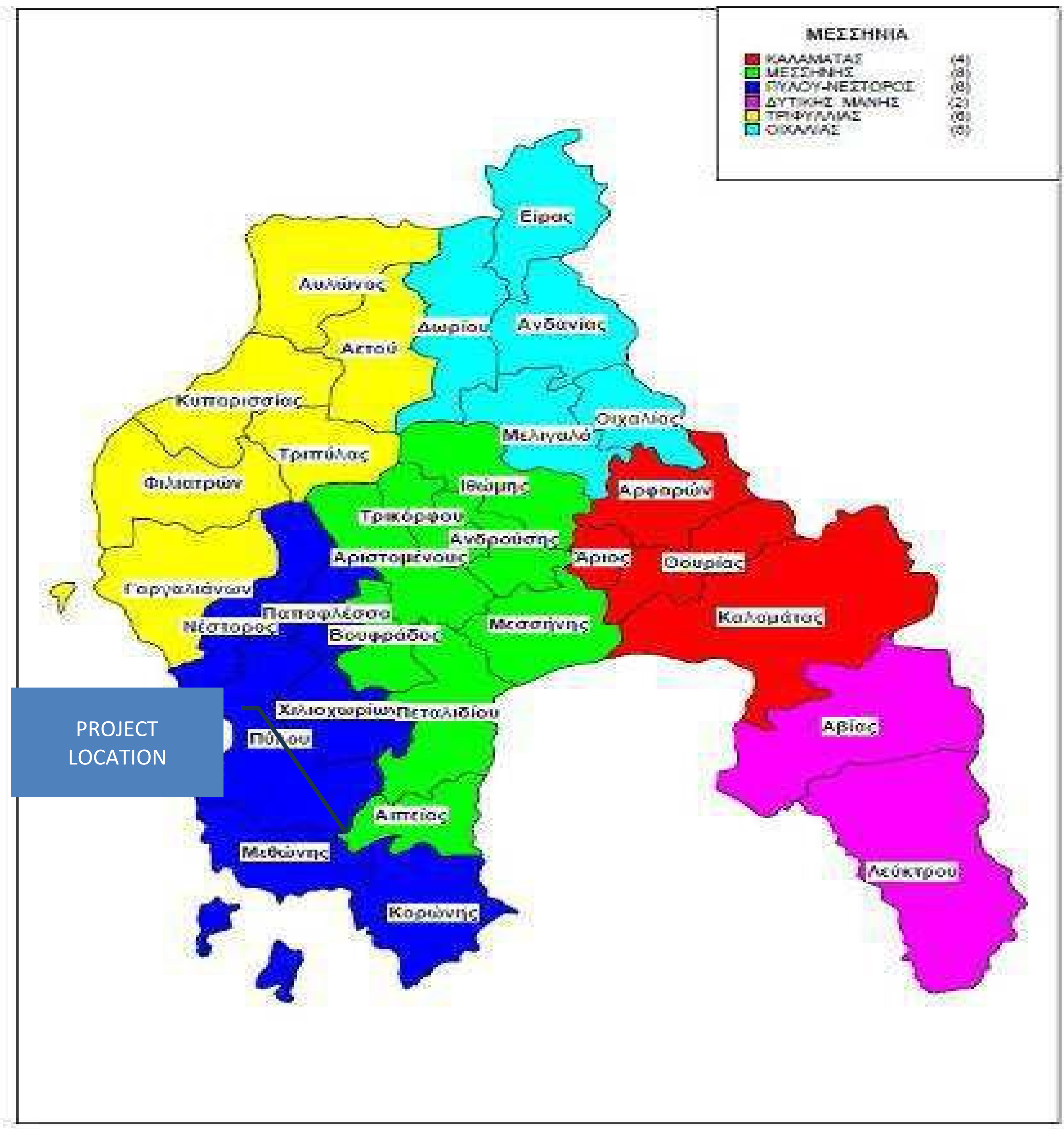



**Figure 1.1: Map of the Regional Unit of Messenia and its Municipalities, after the implementation of the 'Kallikratis' plan**

### 1.3.3. Geographic coordinates of the project or activity

The most important of the works under consideration is the dam body. The coordinates of the beginning and end of the dam axis are given below.

In the Hellenic Geodetic Reference System 1987 (EGSA ’87)¨

- X = 304492.405  Y = 4080952.431
- X = 304540.318  Y = 4080793.770

The coordinates of the dam axis in WGS84:

- X = 572083.707  Y = 4079304.299
- X = 572136.558  Y = 4079147.286

Corresponding coordinates of the beginning and end of the main water conveyance pipelines and the regulation reservoirs follow, in accordance with Figure 6.4 of Chapter 6.1.2.3.

| **START OF PIPELINE** | **Coordinates EGSA** | | **END OF PIPELINE** | **Coordinates EGSA** | |
|---|---|---|---|---|---|
| **Point** | **X** | **Y** | **Point** | **X** | **Y** |
| Reservoir D3 | 301847.64 | 4079029.89 | J-1 | 303672.08 | 4081030.40 |
| J-1 | 303672.08 | 4081030.40 | J-2 | 303536.74 | 4084562.62 |
| J-2 | 303536.74 | 4084562.62 | Reservoir D1 | 303513.38 | 4084574.94 |
| J-2 | 303536.74 | 4084562.62 | Reservoir D2 | 304362.31 | 4085613.51 |
| J-1 | 303672.08 | 4081030.40 | Pumping Station A1 | 304117.61 | 4080726.59 |
| Pumping Station A1 | 304117.61 | 4080726.59 | Reservoir D4 | 307799.05 | 4078996.60 |

## 1.4 Project Classification

The examined works, according to the classification of categories defined by Ministerial Decision 1958/13.01.2012 (FEK-21/B/12), as amended by Decision DIPA 37674/27-07-2016, are included in Group 2, Hydraulic Works. More specifically, the classification by type of works is as follows:

- The dam is classified under works with serial number 1, in subcategory A2, as its height is 49 meters.
- The irrigation network is classified under works with serial number 9, in subcategory A2, since the irrigated area is 35,000 stremmas, greater than the 5,000 stremmas minimum required for inclusion in subcategory A2.
- The reservoir is classified under works with serial number 2, "Water storage works, with a gross storage volume at spillway level V > 10,000,000 $m^3$", in subcategory A1, as the total storage volume amounts to 10,959,007 $m^3$.

Due to the classification of the reservoir in subcategory A1, the other works (dam and network) are consequently also included, and the entire project will be studied under this subcategory.

The Environmental Impact Assessment Study, according to the contract, is prepared in a single stage, that of the EIA.

### 1.5 Project Owner or Activity Authority

The owner of the project is the:

Ministry of Rural Development and Food
General Secretariat for Agricultural Policy & Management of Community Resources
General Directorate of Sustainable Rural Development
Directorate of Technical Studies, Constructions and Topography
Department of Studies and Constructions of Rural Infrastructure Works (ST1) (as the Supervising Authority of the Study).
Postal Address: Detouni 2 & Acharnon 381,
111 43 Athens
Tel.: +30 210-8399789, Fax: +30 210-8399721, E-mail: li93u009@minagric.gr

By decision 429/10287/28-01-2015 of the Ministry of Rural Development and Food, the following supervisors were appointed:

- Mrs. Sofia Gerodimitrou, Civil Engineer (Grade D), as Coordinator of the Supervisors
- Mr. Athanasios Petroyiannis, Electrical Engineer (Grade B)
- Mrs. Mirsini Simou, Agronomist (Grade D)
- Mrs. Stavroula Drakopoulou, Agronomist (Grade E)
- Mr. Vasileios Tsarmpo, Geologist (Grade D)
-

The Supervisor of the Environmental Impact Assessment Study, by Decision 1109/24-03-2017 of the Head of ST1 Department and the Supervising Authority, replacing Mrs.

Stavroula Drakopoulou, is Mrs. Argyri Avgenaki, Agronomist (Grade A), Tel.: +30 210-8205324.

### 1.6 Environmental Consultant of the Project or Activity

The present Environmental Impact Assessment (EIA) was prepared by the company:
ADK Consulting Engineers S.A.
106 Themistokleous Str.
10681, Athens
Tel.: +30 2103894800
**Responsible author: Dimitrios Ziogas, Tel.: +30 2103894924, e-mail**:
d.ziogas@adk.net

In the preparation of this Environmental Impact Assessment for the “Minagiotiko Dam & Irrigation Network of the Municipality of Pylos–Methoni, Prefecture of Messinia”, the following experts participated:

- Dimitrios Ziogas, Geographer–Environmental Scientist, MSc, Team Coordinator
- Christos Nik. Dretta s, Civil Engineer, Environmental Engineer
- Gianna Zalachori, Civil Engineer
- Petros Karapetsas, Civil Engineer
- Maria Mizaki, Civil Engineer
- Eleni Kehagia, Environmental Scientist
- Giorgos Makris, Agronomist, Environmental Engineer
- Dr. Eleftherios Chatzis, Agronomist
- Georgia Christodoulou, Design Support
- Polina Kolokytha, Administrative Support

The present EIA has been prepared in accordance with:

1. Law 1650/86 (FEK 160/A/16.10.86) *“For the Protection of the Environment”*, as amended and in force.
2. Law 3010/2002 (FEK 91/A/25.04.2002) *“Harmonisation of Law 1650/1986 with EU Directives 97/11 and 96/61, procedure for delimitation and regulation of issues related to watercourses and other provisions”*, as amended and in force.
3. Law 4014/2011 (FEK 209/A/21.09.2011) *“Environmental permitting of projects and activities, regulation of unauthorized constructions in connection with the creation of an environmental balance and other provisions under the competence of the Ministry of Environment”*, as amended and in force.
4. Ministerial Decision 1958/13.01.2012 (FEK 21/B/13.01.2012) on *“Classification of public and private projects and activities into categories and subcategories*

*in accordance with Article 1, paragraph 4 of Law 4014/2011 (FEK A' 209/2011)"*, as amended and in force.

5. Ministerial Decision 170225/27.01.2014 (FEK 135/B/27.01.2014) on *"Specification of the contents of environmental permitting files for Category A projects and activities of the Ministerial Decision 1958/2012 (B' 21) as in force, in accordance with Article 11 of Law 4014/2011 (A' 209), as well as any other relevant detail."*

# 2. NON-TECHNICAL SUMMARY

This section summarises the basic characteristics of the projects, basic data on the study area, their expected impacts and measures to address them, and an assessment of the alternative solutions that were examined.

## 2.1. Project location and basic characteristics

The projects under examination in the present study, the Minagiotikos stream dam and the irrigation network, are located in the southwestern part of the Peloponnese Region.

The study area currently falls under the administrative jurisdiction of the Regional Unit of Messinia, in the municipalities of Pylos-Nestoras and Messini.

The cultivated areas to which it refers belong to the Municipal Units and former Municipal Districts, as follows:

1. Municipal Unit of Mekonthos and former Municipal Districts of Evangelismos, Finikodas, Lachanada, and Finikis,
2. Municipal Unit of Pylos and former Municipal Districts of Pithas, Chomatada, Kallikaza, and Ampelakia
3. Municipal Unit of Aipeia and former Municipal District of Militsa.
4. Municipal Unit of Korinthos and former Municipal District of Exochiko and Kaplanio.

The subject of this EIA concerns the construction of

- the dam on the Minayiotiko stream and
- the water transport infrastructure (pumping stations, reservoirs, water transport pipes, etc.).

The irrigated agricultural areas cover approximately 35,000 stremmas and extend from the coastal plain west of Finikounda, Kamaria, and Finikies, north to Kallithea and Militsa.
The estimated annual water consumption from the reservoir is expected to be 8,633,410 $m^3$.

### 2.1.1. Dam

Based on the data of the Preliminary Study, which are presented in detail in Chapter 6 of this Environmental Impact Assessment (EIA), the main dimensions of the dam and the reservoir are summarized as follows:

**Catchment Basin**

- Catchment area: 28,9 $km^2$
- Mean elevation of the catchment: +249
- Elevation of the natural streambed axis at the dam site: ~+78
- Mean annual rainfall: 760 mm
- Mean annual runoff: 8.747.000 $m^3$
- Specific sediment yield: 468.902 $m^3$

**Reservoir**

- Maximum Water Level (crest of spillway): +122,0
- Minimum Water Level (intake threshold): +95,0
- Usable water head: 23,5 m
- Total reservoir volume: 10.959.007 $m^3$
- Useful reservoir volume: 10.490.105 $m^3$
- Reservoir surface area at spillway crest: 886.733 $m^2$

**Dam**

- Dam type: Gravity Dam from Hardfill (Lean RCC)
- Total embankment volume: 196.000 $m^3$
- Maximum height: 49 m from foundation
- Crest length: 177 m
- Crest elevation: +127,00
- Crest width: 10 m
- Slope gradients: Horizontal 0.80 – Vertical 1.0
- Upstream face sealing surface: approx. 4.400 $m^2$
- Plinth base length of sealing face: approx. 180 m

**Spillway**

- Spillway type: Integrated free overflow
- Spillway crest length: 24 m
- Maximum overflow discharge: 265,50 $m^3/s$
- Reservoir level at maximum overflow discharge: +124,50

- Still basin level: +75.30
- Still basin length: 23,95 m
- Still basin width: 24,0 m

**Temporary Diversion – Bottom Outlet – Intake**

- Work type: Conduit
- Length of temporary diversion conduit: 450,00 m
- Slope of temporary diversion conduit: 0,0214
- Cross-section of temporary diversion conduit: Rectangular 5.00 × 4.00m
- Maximum discharge of temporary diversion: 53,7 $m^3/s$
- Minimum intake/outlet level: +95,00
- Cross-section of bottom outlet/intake conduit: Steel pipe D900
- Maximum discharge of bottom outlet: 4,42 $m^3/s$
- Cross-section of intake conduit: Steel pipe D900

### 2.1.2. Irrigation Network

Based on the data of the Supporting Report as well as the analysis carried out for the present EIA, which are presented in detail in Chapter 6.1.2 of this document, the main dimensions of the irrigation network and the central water transmission pipelines are summarized below.

The gross area of the irrigated perimeter amounts to approximately 36.250 stremmas (3.625 hectares) and to 35,000 stremmas (3.500 hectares) of net agricultural land. The irrigation zones, the alignment of the central transmission pipelines, and the locations of the reservoirs are shown in the layout plans (Drawings ΓΟ-1 to 8) of this study, while their main characteristics are presented in the following table.

**Table 2.1. Main characteristics of the irrigated perimeter and central pipelines.**

| Pipeline | Start Node | Stop Node | Length L (m) | Irrigated Area |
|---|---|---|---|---|
| Main transmission pipeline | Dam | Pumping Station A1 | 410 | Zones 1,2,3,4,5 |
| Main transmission pipeline | Pumping Station A1 | J-1 | 880 | Zones 1,2,3,4 |
| Main pipeline to Reservoir Δ1 | J-1 | J-2 | 4,440 | Zones 1,2 |
| Main pipeline to Reservoir Δ1 | J-2 | Reservoir Δ1 | 26 | Zone 1 |
| Pressure pipeline to Reservoir Δ2 | J-2 | Reservoir Δ2 | 1,740 | Zone 2 |
| Main pipeline to Reservoir Δ3 | J-1 | Reservoir Δ3 | 2,966 | Zones 3,4 |

| | | | | |
|---|---|---|---|---|
| Main pipeline to Reservoir Δ4 | Pumping Station A1 | Reservoir Δ4 | 6,480 | Zone 5 |

For the control of discharge and piezometric head at the head of the networks for each zone, a regulating reservoir is installed.

For the design of the works, the critical irrigation demand for the month of July was taken into account:

- Specific 24-hour discharge: 0.0268 l/dt/stremma
- Specific 18-hour discharge: 0.0357 l/dt/stremma
- Specific 16-hour discharge: 0.0402 l/dt/stremma

The application of drip irrigation is proposed, with the area of each irrigation unit being equal to 36 stremmas, with 4–5 farmers per unit.

The required pressure at the outlet of the intake and control unit of the irrigation network is considered to be 2,5 bar, taking into account losses in the application pipelines up to the drippers, as well as possible elevation differences within the irrigation unit.

### 2.2. Distances of the project/activity from settlement boundaries and approved urban planning schemes, boundaries of areas of the national system of protected areas under Law 3937/11 (GG 60/A/11).

The Minagiotiko Dam will be constructed on the homonymous stream, which downstream of the dam site flows generally from north to south and discharges into the Bay of Finikounda after approximately 5,5 kilometers.

The location of the dam is situated at a distance of approximately 1.600 meters west of the settlement of Vlassaiika. The most significant settlement, Kalliklea, is located about 3 kilometers northwest of the dam, while at the same distance to the west lies the settlement of Perivolakia.

The streambed at the site of dam construction constitutes the geographical boundary of the Natura 2000 area GR 2550003, designated as a Site of Community Importance. The examined dam is located partially within this area. However, according to the data of the Special Environmental Study conducted, both the dam area and the agricultural area to be irrigated have not been designated as Nature Protection Areas. These are located in the southern part, along the coasts and islands, while the project area has been characterized as part of the Akritas Terrestrial Mainland Eco-Development Zone.

## 2.3. Summary Evaluation of the Main Impacts of the Projects

The identification and evaluation of the project's impacts are presented in detail in Chapter 9 of this EIA. Below follows a summary assessment and estimation of the substantial impacts of moderate and high intensity and extent from the construction and operation of the projects.

**Negative Impacts**

Construction Phase

As already mentioned, the impacts identified during the construction phase are direct and concern:

- The establishment of borrow pits and construction sites, which constitute discontinuous interventions in the landscape and may cause visual disturbance.
- The disruption of parts of the rural and forest road network, which will be inundated as they lie within the inundation basin of the reservoir.
- The disruption of springs and water supply facilities of the communities of Lahanada and Militsa, which will be inundated as they lie within the inundation basin of the reservoir.
- The reduction of surface runoff of the stream due to the operation of the reservoir.

**Operation Phase**

The negative impacts recorded during operation concern only the reduction of the stream's surface runoff, which are of minor intensity, mainly affecting seasonal flood discharges. These are counterbalanced by the secured ecological flow, even during the water-scarce summer months.

The dam will largely allow for the optimal inter-seasonal regulation of flood discharges, though only of the upstream part of the total catchment basin of the stream. The downstream discharges of the basin, supplemented with the ecological flow from the dam (constant for all months of the year), will continue to feed the streambed up to its estuary.

This water management is consistent with all relevant guidelines and policies, both for water use and for their sustainable environmental management.

**Positive Impacts**

Construction Phase

As already mentioned, positive impacts are identified during the construction phase. These are strong, both direct and indirect, on multiple levels and across all sectors of the economy. Furthermore, the projects are purely developmental, and their impacts are positive and supportive for the implementation of spatial and urban planning.

Operation Phase

The positive impacts expected are permanent and strong, and will significantly affect:

- the improvement of agricultural conditions and the economic outcomes of agricultural holdings, as well as the overall economy of the wider area,
- the flood control function of the stream,
- the groundwater, through the cessation of the operation of irrigation boreholes.

### 2.3.1. Overall Impact Assessment

**The negative impacts from** the examined projects essentially concern only the construction phase and are local, small-scale, and of low intensity, while they will be addressed to a significant degree by the proposed measures in the following chapter and by the Environmental Terms.

**The positive impacts** will occur in both phases, construction and operation, will be of high intensity, will affect the overall economy of the area, and will be permanent.

In essence, from the synthesis of impacts for the examined projects, it emerges that:

- these are projects with full institutional compatibility,
- they are by definition developmental and environmentally friendly,
- the significant impacts are only positive and permanent.

In Chapter 9, the overall impacts of the project are presented in the form of a matrix, evaluated and distinguished according to the construction and operation phases.

### 2.3.2. Summary of Conclusions of the Special Ecological Assessment

The protected area GR 2550003 – "Sapientza and Schiza Islands, Cape Akritas" includes a complex of terrestrial areas (Cape Akritas from Methoni up to Vasilitsi) and insular areas (the Oinousses island complex consisting of Schiza, Agia Marianthi, Sapientza, and Venetiko). The terrestrial part of the area includes coastal, lowland,

and semi-mountainous zones in which a mixed agroforestry landscape is found, consisting mainly of olive groves and dense maquis vegetation. This area is used by migratory birds as a resting place. It is also of major importance due to its rich ichthyofauna and the presence of the monk seal *Monachus monachus*. Certain *Limonium* taxa are endemic to its coastal cliffs and rocky shores.

The zoological significance of this site is indicated by the presence of 29 important vertebrate species, apart from birds, five of which are included in Annex II of Directive 92/43/EEC. Two of these species, the Mediterranean monk seal *Monachus monachus* and the loggerhead sea turtle *Caretta caretta*, are priority species (Field 3.2). These two species, as well as the greater horseshoe bat *Rhinolophus ferrumequinum*, are threatened in Greece and are listed in the National Red Data Book as "Endangered" (the first two) and "Vulnerable" (the third). All five species of the Directive are also included in the lists of the Bern Convention, CITES, and Presidential Decree 67/1981.

The remaining species have been evaluated as Other and Nationally Important Species according to the assessment system of Fields 3.3 and 3.4. Among these species, the Ionian slow worm *Anguis cephallonicus*, the Peloponnesian wall lizard *Podarcis peloponnesiaca*, and the fox *Vulpes v. hellenica* are endemic to Greece (all spread in the Peloponnese, the first also on the Ionian Islands of Ithaca, Kefalonia, and Zakynthos). All taxa of Fields 3.3 and 3.4, except for the hedgehog *Erinaceus concolor* and the fox, are protected under the Bern Convention. Furthermore, the majority of the species found in these two fields are referred to in Presidential Decree 67/1981 (exceptions are the species *Rana ridibunda*, *Ophisaurus apodus*, *Ablepharus kitaibelii*, *Typhlops vermicularis*, *Vipera ammodytes*, *Vulpes v. hellenica*, *Martes foina*, and *Meles meles*).

The species *Bufo viridis*, *Hyla arborea*, and *Ablepharus kitaibelii* have been assessed by the CORINE-Biotopes Programme, while the taxa *Triturus vulgaris graecus*, *Podarcis taurica ionica*, and *Coluber gemonensis* are endemic to the Balkans. The Natura protected area is also an Important Bird Area (IBA) of Greece, due to its position on the western migratory route of birds through Greece, and also due to the density and richness of the avifauna found in the area. At least three threatened species of large eagles, which are notable elements of the local avifauna, are found there: *Aquila clanga* and *Aquila heliaca* ("Endangered"), and *Aquila chrysaetos* ("Vulnerable").

Most of the priority habitats for which the area has been declared protected are found in the coastal part of its terrestrial section and on its islands.
In the area where the dam on the Minagiotiko stream and its inundation basin will be constructed, which constitutes in the narrower sense the Project Study Area, only the habitat of "olive and carob groves" is identified. This habitat is widely distributed

across almost the entire Mediterranean region, represents a typical thermo-Mediterranean formation, and ensures the stability and balance of ecosystems. It also serves as a habitat for several fauna species (birds, invertebrates, reptiles, mammals). The largest part of the interior of the protected area consists mainly of cultivable land and olive groves.

The construction of the dam on the bed of the Minagiotiko stream, with the purpose of creating a reservoir for the provision of irrigation water for 35,000 stremmas in the surrounding area, constitutes primarily a developmental project with an eco-friendly character and full institutional compatibility for the region. The construction of the dam as well as the development of the irrigation network will contribute to the intensification of cultivation and the regulation of existing boreholes. It is expected to contribute to the viability of the rural population, the sustainable practice of agriculture in the area, the production of competitive products, and the retention of the rural population in the countryside.

Of course, the construction of the dam, its reservoir, and the irrigation pipelines is expected to have impacts on the natural environment of the area, which will be of low intensity and extent, and which will also be reversible and manageable with the adoption of appropriate measures.

During the construction phase of the projects, changes to the landscape characteristics are usually caused, mainly concerning the excavation sites of the dam, reservoirs, and networks, as well as the locations of borrow pits for materials. The inundation zone of the dam, as well as the locations of the borrow pits and the construction site, will be cleared of their natural vegetation. At the site of dam construction, the completion of the works will produce the final result, which will not require additional restoration; moreover, the presence of a water surface is always a positive element in the environment and the landscape, even if its origin is anthropogenic. Apart from the inundation zone of the dam, where the clearance will be permanent, both the construction sites and the borrow pits are expected to be restored, replanted with species of the local flora, and left to regenerate so as to regain, as far as possible, their pre-disturbance character.

As regards the construction of the pipelines conveying irrigation water to the irrigated areas, these are expected to be built in cuttings along the embankments of the existing rural road network, which will be covered after the placement of the pipelines without causing disturbances to the natural environment of the area.
The intense human presence in the area and the generation of noise during the construction of the projects are expected to cause disturbances to the fauna inhabiting the area. This disturbance is of low intensity and fully reversible, since after

the completion of the construction works noise levels will return to normal for the area, and the fauna species will return to their natural habitats. This disturbance is manageable, since appropriate measures to reduce noise at the construction site and borrow pits are expected to be taken during construction.

Displacement from habitats of fauna species is expected during the construction phase of the dam works. This particular impact is expected to have a permanent character only in the case of the inundation basin of the dam, where the existing habitats of fauna will be permanently flooded and their nature will change. After the completion of the works, the area is expected to change character, with the aquatic element prevailing and attracting aquatic and amphibian species, as well as other species inhabiting the area. Special mention should be made of bird species, which are expected to find refuge in the area.

As for the borrow pits and construction site facilities, these will be fully restored after the completion of the works, with the use of appropriate soil material and local flora, with the aim of returning them as close as possible to their pre-disturbance condition.

Dust from the construction works is expected to affect the flora of the area, an impact of low intensity and extent, not greater than the area surrounding the construction works of the dam and the reservoir, as well as the roads used by vehicles transporting materials from the borrow pits to the dam. These impacts are expected to be manageable and reversible immediately after the completion of the construction works.

Impacts similar to those of dust in the area are those from exhaust gases emitted by the engines of vehicles and machinery that will be used for the construction of the dam. These impacts will be dealt with through the adoption of appropriate measures and are fully reversible after the completion of the works.

The type and scale of the examined projects are not expected to constitute a sufficient factor to cause changes in the climatic and bioclimatic characteristics of the area.

During the operation phase of the dam and its reservoir, the recorded negative impacts concern only the reduction of the stream's surface runoff, which are of low intensity, mainly affecting seasonal flood discharges. These are counterbalanced by the guaranteed ecological flow, ensured even during the water-scarce summer months. The dam will, to a very large extent, allow for the optimal inter-seasonal regulation of flood discharges, though only for the upstream part of the total catchment basin of the stream. The downstream discharges of the basin, supplemented with the ecological flow from the dam (constant throughout the year), will continue to feed the streambed up to its estuary. This water management is consistent with all relevant guidelines and policies, both for water use and for their sustainable environmental management.

The operation of the reservoir is expected to increase the water surface in the area and attract a significant number of fauna species, particularly birdlife. This, however, may have the possible negative result of fostering hunting activity in the area, particularly illegal hunting, an impact that can be managed with the adoption of suitable measures.

The intensification of agriculture is an impact that arises as a direct consequence of the conversion of agricultural land into irrigated land. The intensive use of fertilizers and plant protection products, as well as the increase in productivity, may create problems, particularly for the groundwater of the area. However, given the scale of stored water in the inundation basin of the reservoir and the scale of the irrigated perimeter, the use of irrigation water appears to be of low intensity (only 255 $m^3$/yr/stremma). This fact indicates that intensive use of water for increasing crop yields is not expected.

Finally, no change is expected in the biodiversity of the area, since no areas currently classified as forest areas (according to the prevailing forestry legislation) will be cleared and converted into irrigated agricultural land.

In conclusion, during the operation phase of the dam and its reservoir, positive impacts are expected on the fauna of the area, as a water body will be created, which is expected to attract aquatic and wetland fauna species, as well as aquatic and wetland bird species. Positive impacts are also expected on cultivated land, which will benefit from the advantageous influence of irrigation water. Possible negative consequences may occur in the ecosystems downstream of the dam, where the quantity of water reaching them via flood discharges will be reduced. However, as already mentioned, the downstream ecosystems are adapted to limited water quantities and to temporary, not continuous, water presence, meaning that they will not be irreparably affected by the restriction of water quantities reaching them after the construction of the dam.

Finally, possible negative impacts from the intensification of agriculture in the area are expected to be reversible through the application of good agricultural practices and through the implementation of methods for cleaning and collecting empty containers of plant protection products used in cultivation.

Among the positive impacts from the operation of the dam, the flood control function downstream and the protection of groundwater aquifers, through the cessation of operation of existing boreholes in the area, should also be taken into account.

It should be emphasized that both the construction and operation of the project do not affect areas, habitats, or priority habitats for which the area was designated as protected.

In summary, all negative impacts are of low intensity, local, manageable with the application of appropriate measures, and are outweighed by the positive impacts that the operation of the dam will bring to the area.

## 2.4. Measures, actions, and initiatives proposed for the integration of the environmental dimension into the project design and the protection of the environment.

### 2.4.1. Integration of the environmental dimension into the project design

#### 2.4.1.1. Selection of dam type

As mentioned in Chapter 7.4.2 *Environmental Assessment – Proposed Solution*, after the evaluation of the alternatives based on environmental criteria, the solution of a gravity dam made of hardfill (lean RCC) was selected. This solution presents specific advantages and is more favorable, since:

- Regarding excavations, fewer are required due to the smaller foundation base and ground footprint,
- Regarding the slopes, smaller heights are required,
- Regarding the availability of necessary materials, it is no more difficult than the earthen dam solution in terms of sourcing, but in addition, smaller quantities will be required,
- Regarding construction time, it is also more favorable, since a shorter period is required.

#### 2.4.1.2. Restoration of borrow pits – disposal areas

This issue always constitutes a sensitive point for many reasons and is usually judged by the outcome, which, when perceived, is generally negative due to unsuccessful restoration or poor site selection.
To avoid a negative outcome, it is proposed, from the design stage and through the preparation of special studies (TEPEM, Exploitation and Restoration Study), to apply specific criteria, guidelines, and conditions, such as:

- Careful selection of the exploitation site among the proposed areas with suitable material, based on criteria such as visibility, concealment, etc.,

- Progressive and simultaneous restoration of the borrow pits through the use of inert and other materials,
- Morphological restoration prior to planting, including topographic slopes of the final surface and the dimensions of slopes – terraces,
- Strict adherence to restoration rules and implementation of the studies,
- Application of good exploitation practices.

#### 2.4.1.3. Other measures

Design of regulating reservoirs for the flow of the irrigation network. It is proposed to examine the possibility of their construction in excavation or semi-excavation, with at least partial lateral embankment and planting to the extent possible, in order to reduce visual disturbance and achieve their integration into the landscape.

### 2.4.2. General measures for the protection of the environment

Apart from the aforementioned measures at the level of integration during the design phase, and the usual legislative measures and specifications for construction sites, etc., as well as good practices, the main and more specific measures related to the examined projects concern the restoration due to their inundation by the reservoir of:

- the water supply springs of the settlements of Vlassaiika and Lahanada–Finikounda and their networks,
- the rural road network of the dam area, which provides access both to cultivated land and for movements between settlements on either side of the stream.

Additionally, management measures are proposed for implementation by the body responsible for network management, which concern:

- the quantitative and qualitative adequacy of the dam waters and the ecological flow and riparian vegetation in the downstream part of the stream,
- the proper management of the waters for the inter-seasonal coverage of irrigation needs, which do not occur only in the summer months,
- the application of the requirements and rules of good agricultural practices regarding the management of plant protection products and packaging.

## 2.5. The benefits from the implementation of the project/activity, including the effects on the local and national economy

The area where the implementation of the projects is proposed has an agricultural profile and particular soil and climatic advantages for agriculture. However, the current state of cultivation is undervalued in relation to the real potential and prospects of the area, which constitutes the earliest continental region of Europe.

The degree of exploitation of these favorable parameters and their utilization in agriculture is exhausted at current levels due to the lack of available exploitable water.

According to the proposed Development Plan of the area under irrigation, Chapter 6.5 of the present study, the construction of the dam and the distribution network is estimated to contribute to the conversion of land currently left fallow or cultivated with low-income arable crops into greenhouse crops and vegetable cultivation.

In the study area, the development of cultivation is estimated to follow a mild form of growth and is expected to result in:

- Conversion of dryland crops into irrigated crops,
- Increase in the area occupied by outdoor vegetable crops,
- Increase in the areas covered by greenhouses,
- Increase in orchard cultivation,
- Increase in the cultivation of table grapes.
-

This development model is consistent with the broader national policy for the production of horticultural products. These crops belong to the promoted types.

It is also noted that there are no organizational and/or administrative and/or legislative measures that need to be taken in order to enable the implementation of the development plan.

### 2.5.1. Institutional benefits

As mentioned in Chapter 5 below, the examined project has a particularly strong institutional environmental character, as it is integrated into all the proposals that have been institutionally drafted and approved (water management plans, National Strategic Plan for Rural Development, regional and local plans (SCHOAP)), which concern:

- the improvement of the performance and competitiveness of the primary sector,
- the optimal management of water with priority given to reducing losses, storing and using surface waters with modernized networks and irrigation methods, while simultaneously reducing the use of groundwater,
- optimal and sustainable management of natural resources, protection of the environment,
- upgrading of irrigation infrastructure and implementation of projects.

The examined project is also explicitly foreseen in the Regional Framework Plan (PPCHSAA) of the Peloponnese, revision proposal of 2014.

### 2.5.2. Expected benefits for the national and local economy

According to the data of the Agri-Economic-Technical Study and the Development Plan of the area, which are presented in more detail in Chapter 6.5 of this EIA, with the implementation of the project, the comparison of revenues and expenditures between the current situation and the projected situation is expected to show, among others, the following significant changes:

- Gross Added Value increases by 132.67%, while Gross Added Value without interest increases by 134.29% after project implementation.
- The IRR is estimated at 10.60%.
- The Benefit/Cost Ratio is equal to 1.41.

Beyond these indicators, significant performance is also estimated for other parameters referred to below, relating to the efficiency of the investment and the return of the project:

- It is estimated that by the year 2029, 100% of the increase in Gross Production Value will have been achieved.
- Net Added Value increases by 136.50%.
- Farm income increases by 136.68%.
- Farm profit rises from €135,022.37 to €7,681,520.73 (+5,589.07%).
- Family income increases by 110.27%.
- Total absorbed workdays are expected to almost double (+373,899.65).

The above values of the significant economic parameters prove that <u>the project is efficient from the perspective of the national economy.</u>

## 2.6 Summary Description of Alternatives and the Proposed Solution

The alternative solutions examined in the framework of the studied works are presented in Chapter 6.1 and essentially concern the choice of the dam type.
As described in detail in that chapter, the following options were examined:

- Earthen dam with a clay core
- Gravity dam made of Roller Compacted Concrete (Lean RCC)
- 

From the comparison of the alternatives using the aforementioned criteria, the solution of the gravity dam made of Roller Compacted Concrete (Lean RCC) presents specific advantages and is considered more favorable because:

1. Excavations: fewer are required due to the smaller foundation base and footprint on the ground.
2. Slopes: lower heights are required.
3. Availability of materials: not more difficult than the earthen dam solution in terms of sourcing; additionally, smaller quantities are required.
4. Construction time: also more favorable, since a shorter period is required.

In contrast, the earthen dam with a clay core, with the necessary construction of a spillway on the left abutment, presents specific comparative “disadvantages” and is environmentally less favorable, because:

1. Large-scale foundation excavations are required.
2. Large-scale and steep excavations and concrete works are required for the lateral spillway.
3. The necessary suitable riverbed sand–gravel materials for the construction of filters and drains were not identified in the project area and would have to be sourced from other locations. This, in addition to increasing costs, would cause environmental burdens due to transport and the creation of additional borrow pits outside the inundation basin and the project area.
4. The construction time of a clay-core dam would be longer due to the larger embankment volume, with a corresponding direct environmental cost (operation of construction sites) and indirect cost (delayed delivery of the project and its expected environmental benefits, such as reservoir operation, aquifer recharge, and cessation of irrigation boreholes).

Taking into account the above, the Study Team, for technical, economic, and environmental reasons, concludes that the most suitable option is the gravity dam made of Roller Compacted Concrete (Lean RCC).

# 3. SUMMARY DESCRIPTION OF THE PROJECT

The subject of this EIA concerns the construction of the dam on the Minagiotiko stream and the associated water conveyance infrastructure (pumping stations, networks, etc.). The Minagiotiko Dam will be constructed on the homonymous stream, approximately 2 km west of the settlement of Vlasaika. The stream flows in a north–south direction and discharges into the sea 5.5 km downstream, approximately 800 m west of the settlement of Finikounta.
From this dam, agricultural land of approximately **35.000 stremmas** will be irrigated, extending from the coastal zone west of Finikounta, Kamaria, and Finiki, northwards up to Kallithea and Militsa. In this area, the slopes are generally mild in the south, becoming steeper in the northern part above the settlement of Kallithea.

## 3.1 Project Characteristics

### 3.1.1 Minagiotiko Dam

During the preparation of the Preliminary Study of the Minagiotiko Dam, two alternative solutions concerning the type of dam were examined, based on the findings of the supporting studies (Geological and Geotechnical), which are included in the project contract and whose data were decisive for the choice of dam type.
Based on the data of the Preliminary Study, the main figures of the Gravity Dam made of Roller Compacted Concrete (RCC) and of the reservoir are summarized as follows:

**Catchment Basin**

- Catchment area: 28.9 km$^2$
- Mean altitude of catchment: +249 m
- Elevation of natural stream bed at the dam axis: ~+78 m
- Mean annual rainfall: 760 mm
- Mean annual runoff: 8.747.000 m$^3$
- Specific sediment yield: 468.902 m$^3$

**Reservoir**

- Maximum Water Level (crest of spillway): +122.0 m
- Minimum Operating Level (intake threshold): +95.0 m
- Useful water depth: 23,5 m
- Total storage volume: 10.959.007 m$^3$
- Useful storage volume: 10.490.105 m$^3$
- Reservoir surface area at spillway crest level: 886.733 m$^2$

**Dam**

- Dam type: Gravity Dam made of Roller Compacted Concrete (Lean RCC)
- Total embankment volume: 196.000 m³
- Maximum height: 49 m from foundation
- Crest length: 177 m
- Crest elevation: +127.00 m
- Crest width: 10 m
- Slope inclinations: Horizontal 0.80 – Vertical 1.0
- Upstream sealing mantle surface area: approx. 4.400 m²
- Base plinth length of sealing mantle: approx. 180 m
-

**Spillway**

- Spillway type: Integrated free spillway
- Spillway crest length: 24 m
- Maximum spillway discharge: 265,50 m³/s
- Reservoir elevation at maximum spillway discharge: +124,50 m
- Still basin elevation: +75,30 m
- Still basin length: 23,95 m
- Still basin width: 24,0 m

**Temporary Diversion – Emptying – Intake**

- Type of works: Conduit
- Diversion conduit length: 450,00 m
- Diversion conduit slope: 0,0214
- Diversion conduit cross-section: Rectangular 5.00 × 4.00 m
- Maximum diversion discharge: 53,7 m³/s
- Minimum intake–emptying level: +95,00 m
- Emptying–intake conduit cross-section: Steel pipe D900
- Maximum emptying discharge: 4,42 m³/s
- Intake conduit cross-section: Steel pipe D900

### 3.1.2 Irrigation Network – Main Figures

The gross area of the irrigated perimeter amounts to approximately 36.250 stremmas, while the net area of the Irrigation Network Study amounts to 35.000 stremmas. The project also includes conveyance works, the required reservoirs, and pumping stations.

The sizing of the water conveyance pipeline to the consumption areas corresponds, according to the Hydrological Study, to an annual water withdrawal from the reservoir equal to 8.633.220 m³.

The alignment of the main conveyance pipelines and the locations of the reservoirs are shown in the layout drawings (Plans ΓΟ-1 – 8) of this study, and their main characteristics are presented in Table 3.1 below.

Table 3.1: Main Characteristics of Main Pipelines

| **Pipeline** | **Start Node** | **Stop Node** | **Length L (m)** | **Irrigated Area** |
|---|---|---|---|---|
| Main conveyance pipeline | Dam | Pumping Station A1 | 410 | Zones 1, 2, 3, 4, 5 |
| Main conveyance pipeline | Pumping Station A1 | J-1 | 880 | Zones 1, 2, 3, 4 |
| Main pipeline to Reservoir D1 | J-1 | J-2 | 4,440 | Zones 1, 2 |
| Main pipeline to Reservoir D1 | J-2 | Reservoir D1 | 26 | Zone 1 |
| Pressure pipeline to Reservoir D2 | J-2 | Reservoir D2 | 1,740 | Zone 2 |
| Main pipeline to Reservoir D3 | J-1 | Reservoir D3 | 2,966 | Zones 3, 4 |
| Main pipeline to Reservoir D4 | Pumping Station A1 | Reservoir D4 | 6,480 | Zone 5 |

For the control of discharge and piezometric head at the head of the networks for each Zone, a regulating reservoir is installed. The storage capacities of these reservoirs are as follows:

- Reservoir D1: 17.325 $m^3$
- Reservoir D2: 4.050 $m^3$
- Reservoir D3: 5.400 $m^3$
- Reservoir D4: 6.300 $m^3$

For the design of the works, the critical irrigation demand for the month of July was taken into account:

- Specific 24-hour discharge: 0,0268 l/s/stremma
- Specific 18-hour discharge: 0,0357 l/s/stremma
- Specific 16-hour discharge: 0,0402 l/s/stremma

The application of drip irrigation is proposed, with the irrigation unit area set at 36 stremmas, with the number of farmers per unit ranging from 4 to 5.
The required pressure at the outlet of the intake and control unit of the irrigation network is taken as 2,5 bar, considering losses in the application pipelines up to the drippers and possible elevation differences within the irrigation unit.

### 3.2 Construction and Operation Phases – Project Schedule

According to the data of the Agrotechnical – Agro-Economic Study, it was assumed that the construction of the project would commence in 2019 and would be completed by the third quarter of 2022.
The overall schedule and the sequence of phases are presented in Section 6.4 of this EIA.

### 3.3 Required Quantities of Raw Materials, Water and Energy, Expected Quantities of Waste

The examined works will not require the use of raw materials, nor will they generate waste in the primary sense of the term.

In the broader sense, significant quantities of borrow pit materials will be required, while considerable quantities of surplus excavation materials will also need to be disposed of in suitable locations, in accordance with the relevant permits.

These two issues are analyzed in detail in the corresponding chapters of this study (Chapters 6.2 and 6.4), and no problem is expected in the disposal of surplus excavation materials, since the borrow pits will also be used as disposal areas.

# 4. OBJECTIVE AND RATIONALE OF THE PROJECT IMPLEMENTATION – BROADER CONTEXT

## 4.1 Objective and Rationale

### *4.1.1 Objective and Rationale of the Proposed Project*

As also mentioned in the study's historical background, the effort to utilize the agricultural land in the provinces of Pylia and Trifylia began in the 1960s.
Since then, a series of relevant studies has been conducted, while today the rationale of the project is strongly aligned with the framework of directives and obligations of the country for the optimal management of water resources, environmental protection, and the sustainable agricultural development of the study area.

The construction of the dam and the distribution network will provide a source of irrigation, from which, according to the studies carried out so far, approximately 9 million cubic meters of water can be made available for irrigation. This quantity is sufficient to cover the water needs of both the existing crops and those foreseen in the future according to the proposed development plan.

The impact of the new project concerns the conversion of rainfed crops into irrigated crops, as well as a limited change in areas currently cultivated with low-income crops into others that will yield higher revenues (greenhouses, open-field vegetables, orchards).

Any such changes will have a long-term horizon and will occur within at least 20 years from the commencement of operation of the dam and the network.

As mentioned in Chapter 5 below, the project under examination has a particularly strong environmental character, as it is included in all the proposals that have been institutionally drafted and approved (water management plans, the National Strategic Plan for Rural Development, regional and local plans (SCHOAAP), which concern

- the improvement of the performance and competitiveness of the primary sector
- the optimal management of water resources with priority given to reducing losses, storing and using surface water through modernized networks and irrigation methods, while simultaneously reducing the use of groundwater
- the optimal and sustainable management of natural resources and the protection of the environment
- the upgrading of irrigation infrastructure and the implementation of projects

**In conclusion, for the projects under examination — the dam and the irrigation networks — the feasibility of their implementation is beyond question, as they are fully aligned**

- at the level of sectoral policies and proposals, since they constitute multifaceted interventions with positive impacts on agricultural activity, environmental protection, the optimal management of water resources, and the combatting of desertification
- at the level of the spatial unit, as the broader area for interventions in the relevant sectors has been clearly defined
- at the level of the proposed infrastructures, since the need for their study and implementation in the examined Minagiotiko stream is explicitly stated.

### 4.1.2 Developmental, Environmental, Social and Other Criteria Supporting the Implementation of the Project or Activity

As stated in the Agro-Economic and Technical Study, no particular problems related to demographic and social issues are observed in the study area.

From the perspective of the natural environment, climate, and soil conditions, the situation is particularly favorable and provides excellent prerequisites for the development of agriculture and the primary sector, as it allows for the production of early and very early vegetables. However, the degree of exploitation of these favorable parameters and their utilization in agriculture is limited to current levels due to the lack of water available for use.

The creation of the dam and the accompanying distribution networks will address this specific problem and make possible the full exploitation of the capabilities and comparative advantages of the study area. Specifically, they will contribute to the conversion of land currently lying fallow or cultivated with low-yield arable crops into greenhouse crops and vegetable cultivation.

Although the dominant crop in terms of cultivated area is the olive (for olive oil production), according to statistical data, more than 86% of the area is non-irrigated. The intensification of cultivation in the area, and particularly the increase of greenhouse crops, depends directly on the quantity and quality of available water.

Expansion into high-yield crops (vegetables – greenhouse cultivation) is considered feasible once the limiting factor of water scarcity is removed.

The restructuring of cultivation through the utilization of water resources will improve farmers' income and is expected to reverse the trend of abandoning greenhouse and arable crops.

**From the above, the social and developmental rationale for the implementation of the project is evident, while the rationale based on economic results is presented in the next section.**

### 4.1.3 Expected Benefits of the Project – Revenues and Expenditures

According to the data of the Agro-Economic and Technical Study and the Development Plan of the area, which are presented in more detail in Chapter 6.5 and in Tables IV 13 and V 17 (Appendix 2 of this EIA), the implementation of the project, when comparing revenues and expenditures between the current situation and the future situation, is expected to result in the following significant changes, among others:

- The Gross Added Value increases by 132,67%, while the Gross Added Value excluding interest increases by 134,29% after project implementation.
- The Internal Rate of Return (IRR) is estimated at 10,60%.
- The Benefit/Cost Ratio is estimated at 1.41.

The above values of the key economic parameters demonstrate that the project has sufficient efficiency from the perspective of the national economy.
In addition to these indicators, noteworthy performance has been estimated for other parameters related to investment efficiency and project returns:

- By the year 2029, the full (100%) increase in Gross Production Value is expected to be achieved.
- Net Added Value increases by 136,50%.
- Farm income increases by 136,68%.
- Farm profit rises from €135.022.37 to €7.681.520,73 (+5.589,07%).
- Family income increases by 110,27%.
- The total absorbed wages are expected to nearly double (+373.899,65).

This significant increase is due to the conversion of crops into irrigated ones and the expansion of high-yield cultivation areas (greenhouses and open-field vegetables), as foreseen in the development plan, which is based on the conversion of rainfed crops into irrigated crops and includes:

- Expansion of the area occupied by open-field vegetable crops.
- Increase in the areas covered with greenhouses.
- Increase in orchard cultivation.
- Increase in the cultivation of table grapes.

This development model is consistent with the national policy for the production of horticultural products. These crops are among those promoted.

In the study area, there is sufficient natural soil drainage, and no drainage works are required, which would otherwise demand significant additional funds, extra implementation time, and would render the project much more expensive.

The existence of permanent plantations (mainly olive groves) and greenhouses does not permit land consolidation (reallocation of land parcels). This avoids particularly time-consuming procedures and significant financial costs, while at the same time the project will be immediately functional and efficient upon its completion.

Conversely, if the works are not constructed (zero-solution scenario), the waters of the Minagiotiko stream basin will not be utilized efficiently, the water management plan for the respective basin will not be completed at environmental and sustainable levels (reduction of groundwater extraction, storage of surface waters for annual and multi-annual use, improvement of agricultural water use with modern irrigation systems for water savings and more effective irrigation), nor will the competitiveness of the primary sector be enhanced. Ultimately, the significant benefits to the agricultural economy of the area and the development of agricultural and related activities will not materialize.

In the case of non-implementation of the works, beyond the negative economic consequences, increased pressures are expected on the agricultural environment and the primary sector in general, manifested in the abandonment of additional arable land and the minimization of cultivation care in olive groves, since their low yield will have to compete with income pressures linked to tourism. These pressures are already present and manifest in two ways: in the broader (non-coastal) project area, where workers prefer employment in the tourism sector rather than in the primary sector, and through residential pressures already evident, relating to the demand for land for holiday–tourist housing and other non-agricultural activities.

In Table 4.1 on the next page (Table IV.13 of Appendix IV of the Agro-Economic and Technical Study), a more detailed comparison is presented between the revenues of the Current and Future Situation from Agriculture and Livestock.

**Table 4.1: Comparison of Revenues in Current & Future Situation from Agriculture and Livestock**

| Type of Expenditures and Revenues | Future Situation (€) | % | Current Situation (€) | % | Difference (€) | % |
|---|---|---|---|---|---|---|
| Gross Production Value | 36,395,789.35 | 100.00 | 16,760,291.70 | 100.00 | 19,635,497.65 | 117.15 |
| Variable Expenditures excl. Interest | 5,865,831.98 | 16.12 | 3,638,602.77 | 21.71 | 2,227,229.21 | 61.21 |
| Gross Added Value | 30,529,957.37 | 83.88 | 13,121,688.93 | 78.29 | 17,408,268.44 | 132.67 |
| Capital Circulation Interest | 469,266.56 | 1.29 | 291,088.22 | 1.74 | 178,178.34 | 61.21 |
| Gross Added Value excl. Interest | 30,060,690.82 | 82.59 | 12,830,600.71 | 76.55 | 17,230,090.11 | 134.29 |
| Depreciation excl. Interest | 758,847.51 | 2.08 | 440,866.67 | 2.63 | 317,980.84 | 72.13 |
| Net Added Value | 29,301,843.31 | 80.51 | 12,389,733.84 | 73.92 | 16,912,109.47 | 136.50 |
| Depreciation Interest | 47,690.08 | 0.13 | 29,570.22 | 0.18 | 18,119.86 | 61.28 |
| Net Added Value excl. Interest | 29,254,153.23 | 80.38 | 12,360,163.62 | 73.75 | 16,893,989.61 | 136.68 |
| Taxes | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Farm Income | 29,254,153.23 | 80.38 | 12,360,163.62 | 73.75 | 16,893,989.61 | 136.68 |
| Paid Labor | 13,064,616.50 | 35.90 | 4,660,635.38 | 27.81 | 8,403,981.13 | 180.32 |
| Family Income | 16,189,536.73 | 44.48 | 7,699,528.24 | 45.94 | 8,490,008.49 | 110.27 |
| Family Labor | 8,508,016.09 | 23.38 | 7,564,505.88 | 45.13 | 943,510.13 | 12.47 |
| Farm Profit | 7,681,520.73 | 21.11 | 135,022.37 | 0.81 | 7,546,498.36 | 5,589.07 |
| Wages Paid | 521,162.62 | – | 185,003.38 | – | 336,159.25 | – |
| Family Agricultural Wages | 328,252.78 | – | 290,512.38 | – | 37,740.41 | – |
| Total Absorbed Wages | 849,415.40 | – | 475,515.75 | – | 373,899.65 | 78.63 |
| Area (stremmas) | 35,000.00 | – | 35,000.00 | – | 0.00 | – |
| Wage per € | 25.00 | – | 25.00 | – | 0.00 | – |

## 4.2. Historical Development of the Project or Activity

The effort to utilize agricultural land in the provinces of Pylia and Trifylia began in the 1960s. For this reason, the following studies have been conducted, relating to the management of water resources and the agricultural development of the study area:

- *"Reconnaissance Soil Report of the Areas of Kyparissia – Filiatra – Pylia,"* prepared by the Land Reclamation Service of the Ministry of Agriculture in 1964.
- *"Study of Reservoirs in the Provinces of Pylia and Trifylia, Prefecture of Messinia"* (Study No. 9481731) – Reconnaissance Study, carried out in 1998 for the Ministry of Agriculture by the consultants: YDROTEK Hydraulic Studies Ltd., P. Manousos & G. Aranitis. The study concerned the identification of sites for the construction of small reservoirs and dams to cover irrigation and water supply needs in the western part of the Prefecture of Messinia (provinces of Pylia and Trifylia). Various dam and reservoir locations were examined for the wider region.
- Studies prepared by the Prefectural Authority of Messinia in 2002: *"Study for the Construction of Minagiotiko Dam,"* including a topographic survey (Ref. No. 686/473, Technical Services Department of the Prefecture) and a geotechnical investigation (Ref. No. 2981/7-8-2002, Technical Services Department of the Prefecture) of the Minagiotiko dam. Within this framework, four boreholes were drilled at the left and right abutments and in the streambed, evaluated accordingly, and the reservoir inundation basin of the dam was mapped.

## 4.3. Economic Data of the Project or Activity

The assessment of the project's profitability is conducted at the level of the national economy, taking into account the increase in gross added value, i.e., after deducting from the gross production value all variable expenses.
The estimation is based on the data available at the time of preparation of this study. Consequently, the construction cost used is the one specified in the project tender. More detailed determinations will be made during the drafting of the Final Design (M.O.S.) once the remaining technical studies have been finalized.

### *4.3.1. Estimation of Total Budget and Project Financing*

According to the data of the Agro-Economic and Technical Study prepared for the examined project (Chapter 11: *Investigation of the Economic Results of the Proposed Plan*), the total investment expenditures — presented in Table V.2 of Appendix VI of the Agro-Economic and Technical Study and reproduced below in Table 4.2 of the present document — concern the studies, the cost of network construction, and the installation of equipment.
The project cost, as specified in the tender for the study and taken into account in the calculations of the Agro-Economic and Technical Study, amounts to **€120.000.000,00**, of which **€90.000.000,00** corresponds to the dam and **€30.000.000,00** to the networks. The figures that follow are derived from this study.

The precise cost will result from the corresponding technical studies at later stages, which are currently under preparation, and will be specified in the Final Design (M.O.S.) covering the entire project, following the completion of all studies.
According to these data, and for a total net agricultural area of **35.000.00 stremmata** (which is included within the project perimeter and will be covered by the irrigation network), the **total construction cost of the project amounts to €101.575.000,00**.

**Table 4.2: Total Investment Expenditures for the Entire Area and Financing Plan (Prices Excluding VAT)**

*(Euros, Constant Prices)*

| **No.** | **Category and Type of Investments** | **Cost / stremma (€)** | **Area (stremmata)** | **Total Investments (€)** | **State Budget (€)** | **Private Loans 6.5% (€)** |
|---|---|---|---|---|---|---|
| 1 | Studies & Programming | - | - | 1,274,740.00 | 1,274,740.00 | - |
| 2 | Public Investments | - | - | 101,575,000.00 | 101,575,000.02 | - |
| 2.1 | Dam & Networks Works (incl. F.E., O.E., Depreciation) | 3,000.00 | 35,000.00 | 105,000,000.00 | - | - |
| 2.2 | Electromechanical Works | 414.29 | 35,000.00 | 14,500,000.03 | - | - |
| 2.3 | Discount (15%) | - | - | 17,925,000.00 | - | - |
| 3 | Private Investments | - | - | 20,900,000.00 | - | 20,900,000.00 |
| 3.1 | Local Irrigation Networks | 420.00 | 35,000.00 | 14,700,000.00 | - | 14,700,000.00 |
| 3.2 | Greenhouse Construction | 22,000.00 | 150.00 | 3,300,000.00 | - | 3,300,000.00 |
| 3.3 | Other Constructions | 4,000.00 | 250.00 | 1,000,000.00 | - | 1,000,000.00 |
| 3.4 | Increase of Working Capital | - | - | 1,900,000.00 | - | 1,900,000.00 |
| 4 | Payment Provision | - | - | 11,250,674.94 | 7,937,242.98 | 3,313,431.96 |
| 5 | **Final Project Cost (1+2+3+4)** | - | - | **135,000,414.97** | **110,786,983.00** | **24,213,431.96** |

In addition to the construction cost of the irrigation network, the total expenditures also include the costs for the implementation of private works.

These expenditures cover the installation of local irrigation networks (per agricultural plot), the construction of greenhouses for the area foreseen in the development plan, as well as the construction of special structures, which include net-houses and high tunnels, intended to support the expansion of open-field vegetable cultivation as projected in the development plan.

The area corresponding to each of these parameters is in accordance with the development plan, while the prices used reflect representative market values. The cost of private investments also includes the expenses related to the increase in working capital, which will be required following the implementation of the investment. The total cost of private investments is estimated at €20,900,000.00.

Including inflation-related provisions, the total investment cost is expected to reach €135,000,414.97. Out of this, €110,786,983.00 is estimated to be covered by the special state budget, while €24,213,431.96 is expected to come from private investments. For the purpose of this study, it is assumed that private investments will be financed through loans, with the interest rate set at 6.5%.

These figures are summarized in the previous Table 4.2 (Table V.2 of the Agroeconomic-Technical Study).

#### *4.3.2. Estimated Partial Indicative Budget of the Proposed Environmental Measures and Actions*

The costing of certain environmental measures is presented in detail at the end of Chapter 10 and mainly concerns:

- the study for the restoration of water supply facilities,
- the provision for restoring damages to the existing road network caused by the circulation of heavy vehicles, and
- the preparation of a Hydraulic Study for the calculation of the total hydraulic discharge and sediment yield in the downstream section of the stream below the dam.

The total indicative cost of environmental measures, excluding VAT, amounts to **€5,057,000**.

### *4.3.3. Project Financing Method*

The project under consideration, entitled: *"Preliminary and Final Design of the Minagiotiko Dam & Final Design of the Irrigation Network of the Municipality of Pylos-Methoni, Prefecture of Messinia"*, was included by decision of the Ministry of Rural Development and Food (ΥΠ.Α.Α.Τ.) No. 4509-26-5-2009 in **Measure 125A.1 of the RDP 2007–2013**, with Code No. 2009ΣΜ08180000.
By continuation decision No. 4375/07-06-2016, the project was included as an assumed obligation under **Measure 4, Action 4.3.1 "Land Improvement Infrastructure"** of the **Rural Development Program 2014–2020 (RDP 2014–2020)**, with Code No. 2016ΣΕ8210041.

### *4.4. Relation of the Project with Other Projects*

The project under consideration is not related to any other existing or under-construction projects in the area in terms of complementarity, compatibility or incompatibility, cumulativeness, etc.
However, as mentioned in Section 4.2 *Historical Development of the Project*, it is connected at the level of studies, since from the 1960s onwards, relevant studies have been conducted in the provinces of Pylia and Trifylia, which concern the management of water resources and the agricultural development of the study area.

# 5. COMPATIBILITY OF THE PROJECT WITH ESTABLISHED SPATIAL AND URBAN PLANNING COMMITMENTS OF THE AREA

## 5.1. Location of the Project in Relation to Areas of the Natural and Human-Made Environment of the Region

### *5.1.1. Established Settlement Boundaries and Approved Urban Planning Schemes*

The boundaries of the settlements within the study area are presented in drawings GO-1 to GO-8, AP-1 and AP-2 of the present study, with a detailed reference made in Chapter 5.2.3 *Institutional Framework*, according to the Local Spatial and Urban Plans (ΣΧΟΟΑΠ). These drawings illustrate the settlement boundaries along with their proposed expansions, the zones of environmental or agricultural land protection, the zones of special regulations, as well as the boundary of the NATURA 2000 area.
As stated in Chapter 5.2.3, apart from the areas of the Municipal Units for which Local Spatial and Urban Plans (ΣΧΟΟΑΠ) have been developed (Methoni, Aipeia, and Koroni), significant areas of the Local Communities of Pidassos, Chomatada, and Kallithea—which are relevant to the present study since they fall within the irrigated perimeters—are not covered by any specific urban planning framework.

### *5.1.2. Boundaries of Areas of the National System of Protected Areas According to Law 3937/11 (FEK-60/A/11)*

As mentioned in Chapter 2.2, the streambed at the site of dam construction constitutes the northern geographical boundary of the Natura 2000 area GR 2550003, designated as a *Site of Community Importance (SCI)*, and the proposed dam is located partially within this area. However, according to the data of the Special Environmental Study conducted, both the dam site and the irrigated agricultural land have not been designated as *Nature Protection Areas*, which are located in the southern part, along the coasts and islands, but rather as the *Mainland Development Zone of Akritas*.
The objectives of protection and other key elements of the aforementioned Special Environmental Study are presented below. The SES was prepared in accordance with the specifications of the Department of Natural Environment Management of the Ministry of Environment, Physical Planning and Public Works (Υ.ΠΕ.ΧΩ.ΔΕ.) and concerns the areas included in the *List of Sites of Community Importance of the European Ecological Network Natura 2000*, with codes:

- GR 2550003: “Sapientza and Schiza Islands, Cape Akritas”
- GR 2550007: “Marine Area of Methoni Strait”

### 5.1.2.1. Justification of the Value of the Protected Object

These areas are of particular importance for the specific reasons outlined below for each of them:
The area **GR 2550003 – Sapientza and Schiza Islands, Cape Akritas** includes a complex of terrestrial and insular ecosystems with significant botanical, zoological, and cultural interest.

Within the area are included:

- **1 Biogenetic Reserve**: *"Sapienza forest of evergreen broadleaves"*, with an area of 24 hectares. (UNEP-WCMC Reference)
- **1 Declared Natural Monument**: *"The forest of evergreen broadleaves on Sapientza Island"*, with an area of 240 stremmata (Decision No. 105497/6459/11-8-86, FEK 656/B/86).
- **1 Controlled Hunting Area**: *"Sapientza"*, with an area of 850 hectares (Decision of the Ministry of Agriculture No. 235228/5821/1977, FEK 1041/B/20-10-77 "regarding the designation and establishment of the Controlled Hunting Area of Sapientza Island").
- Numerous declared monuments, mainly Byzantine and Post-Byzantine.
- The settlements of Methoni and Koroni have been designated as historical preserved monuments by decisions published in FEK 1289/B/20-10-76 and FEK 527/B/31-5-59 respectively.

The area **GR 2550007 – Marine Area of Methoni Strait** includes the marine area of the Methoni Strait, between the coasts from Cape "Kolivri" to "Chondro Kavo" and the northern coasts of Sapientza Island. It constitutes an extensive marine area with high biological diversity and ecological value and a low degree of disturbance from human activities.

The importance of the area is based on the recording of significant species (three mammals and one reptile) included in the Annexes of Directive 92/43/EEC, the presence of seagrass meadows, the priority habitat type (1120 – *Posidonia oceanica* beds), and the existence of numerous declared underwater archaeological sites.

### 5.1.2.2. Protection Objectives

At a general level, the aim of protection is the preservation of the natural and human-made environment and the support of local development.
This overall direction also derives from the fundamental guidelines adopted at both national and EU level.

In particular, the main guiding principles of national and EU policy concern the need for the protection of both the natural and the human-made environment, through:

- Sustainable management of natural resources (sustainable development),
- Urban restructuring and settlement planning,
- Application of environmental planning beyond the urban network.

#### 5.1.2.3. Proposal for Delimitation and Protection Terms

From the evaluation of the characteristics of these areas, the activities of the residents, and the possibilities of classification into protection categories based on Law 1650/86, and in accordance with Article 19, paragraph 5 of this law, the area was designated as a *Zone of Eco-Development*.
Zones of eco-development are defined as extensive areas that may include villages or settlements, provided that they exhibit particular value and interest due to the quality of their natural and cultural characteristics, while at the same time offering significant potential for the development of activities that are compatible with the protection of nature and the landscape.
Within these areas, the following are pursued:

a) The protection and enhancement of their particular natural and cultural features.

b) The strengthening of traditional occupations and activities, which can also be achieved through the renewal and modernization of methods and conditions of the local economy. In eco-development zones, small-scale productive activities may be practiced, adapted to the natural environment and local architecture. The development of agrotourism is particularly encouraged, utilizing rural residences, guesthouses, camping facilities, and other constructions. Industrial activities may be permitted, provided they support the economic revitalization of rural areas and do not cause environmental degradation incompatible with the character of these areas.

c) The education and familiarization of the public with ways and methods of harmoniously combining human activities and natural processes.

d) Public rest and recreation.

**The above objectives are implemented on the basis of specific development and management plans.**
Given the particularity of the area, which consists of a complex of inland, marine and insular terrestrial ecosystems, differing both in terms of the ecological characteristics of the biotic and abiotic environment, as well as in terms of human presence and activity, and consequently in terms of management and conservation objectives, it

was deemed appropriate to divide the eco-development area into three sub-zones. These are characterized, according to their specific features, by distinct approaches regarding protection, enhancement, and the proposed special management measures:

- **O1**: "Marine Eco-Development Zone of the Methoni Strait"
- **O2**: "Continental Eco-Development Zone of Akritas," which includes the area where the projects examined in this EIA will be implemented
- **O3**: "Insular Eco-Development Zone of the Oinousses Islands"

The boundaries of the three eco-development sub-zones, which together form the entire Eco-Development Area "Akritas, Marine Area of the Methoni Strait and Oinousses Islands," are shown on Map EPM-X17_1 – *Protection Zones Delimitation Map*, scale 1:50,000, of the present study.

#### 5.1.2.4. Determination of Protection Zones

Within these zones, a more detailed distinction was made between *Nature Protection Areas* and *Protected Landscapes*, in order to ensure, through institutional arrangements, the safeguarding of the distinctive elements of the natural environment.

**A) Nature Protection Areas of the "Eco-Development Zone of Akritas, Marine Area of the Methoni Strait and Oinousses Islands"**

The following areas, of particular biological and ecological value at national and international level, are proposed for designation as Nature Protection Areas:

- **NP-1 "Methoni Marine Park"**: encompasses the entire marine area with code GR 2550007 – *Marine area of the Methoni Strait*, and includes the marine zone between the coasts stretching from Cape "Kolivri" to "Chondro Kavo" and the northern coasts of Sapienza Island.
- **NP-2 "Kamarion Beach"**: located in the coastal zone approximately 9 km west of Methoni. It has a length of approximately 900 m, a gentle slope, and southern orientation.
- **NP-3 "Faneromeni Beach"**: a coastal site on the eastern boundary of the study area, approximately 8 km south of Koroni. It has a length of about 500 m and includes small-scale dune areas.

**In the "Insular Eco-Development Zone of the Oinousses Islands,"** the following *Nature Protection Areas* are proposed for designation:

- **NP-4 "Agia Mariani (or Agia Marina) Islet"**: a small island of approximately 52 hectares (520 stremmas) and a perimeter of about 3 km, located east of Sapienza Island and west of Schiza Island, at a short distance from the latter.
- **NP-5 "Islets Dyo Adelfia, Bomba, Avgo, and Nisopoulia"**: includes the two rocky islets *Dyo Adelfia* located at the southernmost point of Sapienza Island, the rocky islet *Bomba*, the rocky islets *Avgo* (also known as *Petrokaravo*)

located about 1.5 km south of Venetiko, and the rocky islets *Megalo (Upper) Nisopouli* and *Mikro (Lower) Nisopouli*, situated in the marine area of the site "Limni Papa" north of Methoni.

**B) Protected Landscapes of the "Eco-Development Zone of Akritas, Marine Area of the Methoni Strait and Oinousses Islands"**

The following areas are proposed for designation as *Protected Landscapes*. These are areas of high aesthetic or cultural value, lands particularly suitable for public recreation, or areas that contribute to the protection or efficiency of natural resources due to their distinctive natural or anthropogenic features:

- **PL-1 "Schiza Island"**
- **PL-2 "Venetiko Island"**

**C) "Peripheral Marine Zone" of the Eco-Development Area**

It is proposed that the marine area extending up to the boundary of the continental shelf (200 m isobath) be designated as the *Peripheral Marine Zone* of the Eco-Development Area.

**D) Other Areas of High Natural Value**

Beyond the aforementioned zones, additional ecological units may be considered for future inclusion under special protection status. These areas require particular monitoring against threats such as disturbance, destruction, or alteration of their character, and include:

- The Arbutus (*Arbutus unedo*) forest on Sapienza Island
- *Spartolakka* on Sapienza Island
- The Aleppo pine (*Pinus halepensis*) at Cape Akritas
- Rocky habitats with chasmophytic vegetation
- Submerged or partially submerged marine caves (habitat type 8330)

All the proposed Nature Protection Areas, Landscapes, and the Peripheral Marine Zone are located outside the **Continental Eco-Development Zone**, where the examined projects are situated. In this zone, due to its prevailing agricultural character, no nature protection areas are identified, and the proposed projects are fully compatible with the corresponding protection and management proposals of the Special Environmental Study (SES).

### 5.1.3. Forests, Forest Lands, and Reforestable Areas

In the study area and the project sites, no significant productive or non-productive forests, forest lands, or pastures are identified; on the contrary, agricultural activity dominates. This fact is substantiated by the maps of the SES and those of the Special Ecological Assessment, which are attached in the annexes of this report.
Recently, the Forest Maps of the area have also been posted, in which small areas are shown as reforestable, as well as areas characterized as **DA** (forest in 1945 and agricultural today), where olive groves with trees of significant age, several decades old, are present.
At a previous stage of the project, the following documents were issued for the execution of exploratory drillings at the project construction site:

- Certificate No. 112264/10695 of 4 January 2016 regarding the existence of definitive and irrevocable characterization of land (ADA: ΩΩΓΝΟΡ1Φ-ΤΕΖ).
- Intervention Permit No. 45552/1252 of 31 May 2016 (ADA: 7ΚΞ1ΟΡ1Φ-ΣΗΒ).

These documents are attached in the annex of this report.

### 5.1.4. Social Infrastructure, Public Utility Installations, etc.

In the project area (mainly at the dam site), no social infrastructure or public utility facilities are identified, as the project will be implemented in an area outside the urban plan and settlements, or other planned infrastructures.
Nevertheless, within the area of dam and reservoir construction, inside the inundation basin, the following springs and related water supply facilities are identified:

- For the settlement of Lachanada: at location **YDR-P1**, springs, a reservoir, and an aqueduct are found.
- For the settlements of Vlassaiika and Militsa: at location **YDR-P2**, the Kryovrysi or Kryorema stream hosts a pumping station, which draws water from springs and supplies these settlements with drinking water.

These elements are presented in more detail in Chapter 8.8.3 of the present study (plans GO-4, AP-1, XE-1) and do not constitute a factor of incompatibility with the examined projects, provided that the water supply to these settlements is restored, as described in detail in the chapter on the proposed mitigation measures.

### 5.1.5. Archaeological Sites of Interest

The main project under consideration, namely the dam and reservoir, does not interfere with any known monument and/or archaeological site, as referred to in Chapter 8.6.3 of the present study.

The pipeline network for the transport and distribution of water may possibly pass near a known monument, as its alignment will follow the existing road network, except for very small sections of it. These elements do not constitute a factor of incompatibility with the examined projects.

## 5.2. Existing Spatial and Urban Planning Regulations in the Project Area

### *5.2.1. Provisions and Guidelines of the National Strategic Plan for Rural Development (N.S.P.R.D.) 2007–2013*

#### 5.2.1.1. National Strategic Plan for Rural Development (N.S.P.R.D.) 2007–2013

The new programming period 2007–2013 provides a significant opportunity for development, employment, and sustainability of the rural sector through the support offered by the new European Agricultural Fund for Rural Development (EAFRD).

The National Strategic Plan for Rural Development (N.S.P.R.D.) sets out Greece's priorities for the period 2007–2013, in accordance with Article 11 of the Rural Development Regulation, which stipulates that the National Rural Development Strategy shall be implemented through the Rural Development Programme (RDP).

In drafting the N.S.P.R.D. 2007–2013, a strategy was adopted that was adapted to the new directions of the recent reform of the CAP, which introduced major changes that may have serious impacts on the economy of overall agricultural production, while also incorporating modern environmental requirements.

At the same time, the N.S.P.R.D. was shaped in line with the national policy for Rural Development, as expressed in the National Strategic Reference Framework (NSRF) 2007–2013, as well as with the priorities of the National Reform Programme for Development and Employment 2005–2008, in the context of implementing the Lisbon Strategy. In addition, the N.S.P.R.D. has incorporated the strategy for disaster response and the reconstruction of affected rural areas.

The future rural development policy 2007–2013 for Greece will focus on three main axes:

- improvement of the competitiveness of agriculture–forestry–agri-food sector,
- improvement of the environment and the landscape,
- improvement of the quality of life and diversification of the rural economy,

supported by a fourth horizontal axis (Leader), which will build upon the experience gained from the Community Initiative Leader and will provide the possibility for the application of bottom-up, locally-driven rural development approaches.

Beyond the above, at the Council meeting of December 2008, important decisions were made both within the framework of the "New Challenges" and for addressing the economic crisis. Within the framework of the "New Challenges," the options of the N.S.P.R.D. include the implementation of measures:

- for the restructuring of the dairy sector, within the framework of Measure 123A,
- b) for water management within the framework of Measure 121,
- c) for the use of Renewable Energy Sources (RES) within the framework of Measure 121,
- d) for climate change within the framework of Measure 226, Action 1 and Action 3.

The two aforementioned and underlined observations are directly related to the nature of the examined project and constitute central parameters, further specified in the following sections into axes, actions, measures, etc.

In the following, in Chapter 1 of the N.S.P.R.D., the basic economic, social, and environmental situation is analyzed across the main components:

1. **Competitiveness of the primary sector**

The basic socio-economic condition is documented, along with the (low) level of competitiveness of the primary sector. The limited natural resources are recorded, given that the utilized agricultural area (UAA) of the country in 2003 amounted to 3,967,770 ha, representing 30.1% of the total area, while the corresponding rate in the EU-25 was 42%. Of this area, it should be noted that 82.7% lies in disadvantaged areas.
In conclusion, regarding the Development Perspective, it is stated that: "…for addressing the problems and weaknesses mainly related to … low competitiveness and low Gross Production Value and Added Value, … the priorities for the development of the sector focus on the following: …Development of agricultural and forestry infrastructures to improve competitiveness and reverse the trend of decreasing investments…"

2. **Environmental situation in relation to water resources and climate change**

With regard to this section, the following are substantiated:

- The high percentage of use of Water Resources in Agriculture (87%), where the efficiency of their use is low.

- The low percentage of irrigated land (32.8%) of the utilized agricultural area (UAA).
- In 92% of the irrigated land of the country, irrigation is carried out with systems and techniques that do not ensure rational and sustainable management of water resources.
- 

On the basis of the above, the need for funding essential infrastructures is demonstrated (for the modernization of irrigation networks and exploitation of surface runoff), actions which will contribute to reducing water losses and limiting pressures on groundwater aquifers.

In conclusion, regarding the *Development Perspective*, it is stated that: "…for addressing the problems and weaknesses mainly related to … the degradation of groundwater from human activities and the development of the primary sector … the uneven distribution of water demand in relation to supply across time (irrigation and tourism in summer months) and space (increased consumption in densely populated areas)… the priorities for the preservation and improvement of the environment focus, among others, on: …the application of production methods in the primary sector aimed at rational management and improvement of the quality of water resources…"

Subsequently, in Chapter 2 of the N.S.P.R.D., the *Definition of the Overall Strategy* is presented, along with the transfer of Community priorities into the overall strategy and the determination of national priorities, as follows:

***Overall Strategy***

The overall strategy for Rural Development in Greece during the 4th Programming Period is defined by a broader institutional and political framework. It is aligned with the directions of the WTO, the Kyoto Protocol, the EU's political priorities as described in the Lisbon and Gothenburg strategies, the revision of the Common Agricultural Policy (CAP), and the Community Strategic Guidelines (CSG) for rural development. At the national level, it incorporates the National Strategy for the development of the country (National Strategic Reference Framework – NSRF & National Reform Programme – NRP), the experiences from the implementation of previous programming periods and Rural Development Programmes, and the analysis of the existing situation.
According to the above, the overall strategy for Rural Development in Greece, which is integrated into the NSRF's overall strategy, focuses on sustainable Rural Development through improving the competitiveness of the primary and agri-food sectors, as well as enhancing the environment, within a sustainable countryside. The

overall strategy of the National Strategic Plan for Rural Development in Greece will be implemented through **Four General Strategic Objectives (priorities)**, namely:

- **ΓΣΣ 1**: Maintaining and improving the competitiveness of agriculture, forestry, and the agri-food sector.
- **ΓΣΣ 2**: Protecting the environment and ensuring the sustainable management of natural resources.
- **ΓΣΣ 3**: Improving the quality of life in rural areas and encouraging the diversification of the rural economy.
- **ΓΣΣ 4**: Creating local capacities for employment and diversification in rural areas through the Leader approach.

The achievement of the above general strategic objectives will be pursued through the following specific objectives (sub-priorities):

- Within the framework of achieving the overall strategic objective of maintaining and improving the competitiveness of agriculture, forestry, and the agri-food sector through the upgrading and enhancement of primary sector infrastructures.
- Within the framework of achieving the overall strategic objective of environmental protection and sustainable management of natural resources, through the protection of soil and water resources.

Within the framework of the Strategy for addressing the **"New Challenges"**, one of the key priorities identified in the NSRDP <u>is **"Water Management"**, where it is explicitly stated:</u> "Given that water management will increasingly play a central role in the adaptation strategy to address the already inevitable climate change, in order to mitigate the extreme weather events of droughts and heavy rainfall, <u>projects are scheduled for water storage and for the upgrading and improvement of irrigation networks</u> within agricultural holdings, which contribute to water savings."

Subsequently, under the NSRDP, **Chapter 3** — during the determination of the strategy by axis — **Axis 1 (Improving the competitiveness of agriculture and forestry)** includes targeted actions, as follows:

> "The strategic framework of Axis 1, related to the competitiveness of agriculture and forestry, indicatively includes the implementation of the following actions: … serving the specific objective of upgrading and improving the infrastructures of the primary sector, by promoting infrastructure measures (e.g., land improvement works, utilization and storage of surface waters that contribute to the rational use of water resources, implementation of measures for the utilization of reservoirs

through the construction and modernization of existing irrigation networks, and the improvement of irrigation systems …).

Within the framework of land improvement projects, actions will be supported regarding water storage, groundwater recharge, and the improvement of irrigation systems, with the aim of tackling, to some extent, the problem of water scarcity and the impending drought caused by adverse climate change conditions. Actions will also be financed for the construction of water storage projects and for the upgrading of primary, secondary, and tertiary irrigation, drainage, and road networks. These projects will contribute directly to the objectives set under Directive 2000/60/EC."

**Based on the above, it is evident that the examined projects are in full compatibility and alignment with the provisions of the National Strategic Rural Development Plan (NSRDP) 2007–2013, both at the level of strategic choices and at the level of specialized actions.**

By decision 4509 / 26-5-2009 of the Special Service of the Rural Development Programme, the action entitled *"Preliminary and Final Study of the Minagiotiko Dam & Final Study of the Irrigation Network of the Municipality of Pylos – Methoni, Prefecture of Messinia"* was included in Measure 125A1 of the programme *"Rural Development of Greece 2007–2013."*

#### 5.2.1.2. National Strategic Rural Development Plan (NSRDP) 2014–2020

As already mentioned in Chapter 4.3.3, the examined projects, by virtue of continuation decision 4375/07-06-2016, <u>were included as a contractual obligation</u> under Measure 4, Action 4.3.1. "Land Improvement Infrastructures" of the Rural Development Programme (RDP) 2014–2020, with code 2016ΣΕ8210041.

The projects are fully compatible with the priorities and objectives of the rural development policy, which focus on:

- the protection and strengthening of the environment and ecosystems,
- the improvement of water resources management,
- and the increase of efficiency and effectiveness in agricultural water use.

In addition, as complementary measures within the River Basin Management Plans (RBMPs), these projects constitute a priority under Sub-measure 4.3.1. Furthermore, Priority 5.A, in which the projects are classified, represents a key focus area of this sub-measure, since *"the improvement of the efficiency of water use in agriculture (5A)* *requires a holistic approach to the operation and management of the system: water intake – conveyance – distribution – application at the plant.”*

### *5.2.2. Provisions and Guidelines of the Regional Spatial Planning and Sustainable Development Framework (RSP-SDF) for the Peloponnese (Government Gazette 1485/B/10-10-2003)*

The Regional Spatial Planning and Sustainable Development Framework of the Peloponnese Region was approved by Government Gazette 1485/B/10-10-2003 and established the necessary directions and development priorities.

Subsequently, its revision and public consultation phase was completed at the end of 2014, and its publication in the Government Gazette is pending.

The projects examined in this study are not in conflict with the proposals of the approved RSP-SDF. While they are not directly linked to its specific provisions, they nevertheless fall within the broader framework of the fundamental development guidelines, both of the approved plan and of the proposed revision, as further elaborated below.

**A. Proposals of the RSP-SDF (2003) for the Peloponnese Region**

Specifically, the following references are recorded among the proposals of the RSP-SDF (2003):

In Section C. Proposal of the RSP-SDF, paragraph “1. Spatial Development Model – map D.1.1”, among the Strategic Development Choices, points (h) and (θ) state the following:

- **(η)** “Restructuring, prioritisation, and promotion of the necessary technical and social infrastructure network.”
- **(θ)** “Control of land uses for the protection and sustainable development of natural resources, through existing institutions and mechanisms of spatial/urban planning and environmental protection (legislative framework: Law 1337/83, Law 1650/86, Law 2508/97, Law 2742/99).”

In Section 2. Development Framework, it is specified that: *“The general medium-term Development Objective for the Region, within the framework of the Regional Development Plan 2000–2006 (RDP), consists in reducing the developmental lag of the hinterland, through the utilisation of its natural and cultural assets, and in the sustainable management of resources in already developed areas.”*

Furthermore, the strengthening of the competitiveness of the Primary Sector, particularly agriculture, is recorded as a Strategic Development Choice.

Also, as a specific Strategic Choice for the Primary Sector, it is stated: *"…The strengthening of the competitiveness of dynamic lowland agriculture, not through intensification, but through upgrading the quality of production and improving marketing and processing structures."*

In the same section, paragraph 3. Spatial Organisation,
**subsection 3.2. Protection and Management of Natural and Cultural Heritage – Directions/Axes**, the following requirements are defined for the protection of natural resources and the preservation of their reserves (Forests, Soil, Water, Flora, Fauna):

- «…..
- Adoption of the principle of sustainability in all public and private activities (construction of public and private works, utilisation programmes, etc.).
- …….
- Rational use and management of both groundwater and surface water to avoid over-extraction and waste.
- Control and protection of coastal aquifers.
- Prevention of pollution of all water resources from sewage, negligence, accidents, and systematic monitoring of drinking water quality.
- ……»

In **subsection 3.3. Anthropogeographical Units**, a direction for the development of **Mountainous Areas** is defined as: *"…the development of the primary sector (agriculture, livestock, forestry) and the strengthening of infrastructures to encourage the creation of model agricultural holdings."*

In **Section D. Action Programme – Long-term Action Axes for the Primary Sector**, the following basic infrastructure projects are identified:

- Studies and works to address salinisation in the **Argolic plain**, the **Lower Eurotas valley**, and the **western Messinia area (Filiatra–Kyparissia)**.
- Strengthening of the aquifer and support of soil resources through the study and construction of small mountain dams or reservoirs in problematic areas of the Region.
- Utilisation of existing dams (e.g. Doxa Dam, Corinthia) and planning for the study and construction of other dams of regional importance (e.g. Asopos Dam).

**B. Directions of the Proposed 2014 Revision and Specialisation of the RSP-SDF for the Peloponnese Region**

In the **Evaluation Report of the RSP-SDF (09–2013)** for the Peloponnese Region, the following references are recorded:

**In Section B.4. Productive Activities, the particularly significant contribution of the Primary Sector of the Peloponnese Region to the Gross Added Value** of the national primary sector is highlighted, amounting to approximately 6.3% of the total Regional Gross Added Value.

The contribution of the Peloponnese Region to national agricultural figures is also significant, since, according to ELSTAT data (2007), the Region accounts for 12.6% of the country's agricultural and livestock holdings, ranking it second nationwide after the Region of Central Macedonia, which holds 14.4%.

A particularly important reference is found in Section 9. Other Technical Infrastructure, Water Supply – Irrigation, where it is noted:

*"…**Irrigation**. In the Region, 68 collectively organised networks are in operation. The water originates from boreholes and surface abstractions.*
*The numerous private boreholes operating in the Region, combined with the increased irrigation needs and the overexploitation of the soil for agricultural crops, have led to the degradation of the aquifer, reduced water availability for irrigation, and increased problems of pollution and salinisation of the groundwater."*

**The most essential and specific record related to the nature of the projects under consideration follows in the same section:**

*"…With regard to the implementation of hydraulic infrastructure projects foreseen by the approved RSP-SDF, the following are noted:*
*– Studies and works to address salinisation in the **Argolic plain**, the **Lower Eurotas Valley**, and the **western Messinia area (Filiatra–Kyparissia)**.*
*– In the western Messinia area, the construction of the **Filiatrinos irrigation dam** is under way, while the study of the **Minagiotiko irrigation dam** and the **Langouvardos water supply dam** is planned. Withdrawals from the reservoirs will replace withdrawals from the aquifers.*
*– Strengthening of the aquifer and support of soil resources through the study and construction of small mountain dams or reservoirs in problematic areas of the Region…"*

Finally, in **Section D. Conclusions of the evaluation of all thematic sections**, within **subsection c. Complementary priority choices**, it is explicitly stated that:

*"…the new RSP-SDF will support and highlight large irrigation projects, due to their decisive importance for the growth of the primary sector in the Region."*

The aforementioned references from the evaluation report were subsequently incorporated into the draft Ministerial Decision (03–2015) of the RSP-SDF for the Peloponnese Region, which includes its final proposals. Additionally, the following proposals are made:

In **Section B.1 Spatial Development Model, Subsection B1.2. Wider Spatial Units, a. Agricultural development and rural development**, the following are declared as directions for the agricultural sector:

*"…The general direction is the protection of agricultural land from uses that are not compatible and degrade agricultural activity. Protection prioritises High Productivity Agricultural Land, but also extends to the entirety of agricultural land. Upgrading irrigation infrastructures (dams, spring waters, irrigation networks), taking into account the directions contained in the approved River Basin Management Plans (Water Districts of Northern, Western, and Eastern Peloponnese)."* In **Section B.1.5. Natural and cultural resources of national and regional scope – Proposed networks of natural and cultural resources**, directions are identified for actions addressing the impacts of climate change, desertification phenomena, and the degradation of soils, water resources, and coastal erosion in the Peloponnese Region.

«The **main challenges** that the Regional planning must address in relation to the consequences of climate change are linked to:
(a) **Reduced water supply / increased water demand** for both drinking water and irrigation.
(b) **Increased salinisation of coastal aquifers** and phenomena of desertification.
(c) Increased pollutant concentrations in water systems.

- It is also stated that the Region should undertake actions for the prevention and mitigation of the impacts of climate change and desertification. In particular, it should ensure the … "…Preparation of action plans focused on flood management…." Within the framework of these plans, river management is also included, with measures such as their delimitation, the implementation of maintenance programs to ensure the flow capacity of the riverbeds, protection of the banks through anti-erosion works, and flow mitigation measures (dams, water retention reservoirs, designation of controlled flooding areas, etc.).
- Preparation of action plans focused on addressing increased drought phenomena. Key elements of these plans should include measures for

controlling boreholes, appropriate irrigation and land improvement works, surface runoff retention projects, and initiatives to enhance the recharge and protect the quality of groundwater aquifers, with the aim of maximizing water resource availability. Additionally, modernization of water networks is required to reduce losses, as well as the reuse of water while complying with the necessary quality standards.

- Preparation of action plans aimed at ensuring the long-term sufficiency of water resources. Key elements of these plans should include the monitoring of both the quality and quantity of available water resources. For this reason, projects for storage, transfer, and resource management are required, which must be taken into account in the planning of the Region.

**In conclusion, the projects under consideration—namely the dam and irrigation networks—are fully aligned with the regional planning.**

- At the level of sectoral policies and proposals, as they constitute multi-faceted interventions with positive impacts on agricultural activity, environmental protection, optimal water resource management, and desertification mitigation.
- At the level of spatial units, since the broader area for interventions in the aforementioned sectors has been defined.
- At the level of the proposed infrastructures, especially since the need for their study and implementation in the examined Minagiotiko stream is explicitly mentioned.

### *5.2.3. Institutional Framework According to the SCHOAP of the Municipalities in the Project Area*

The proposed location of the dam under study and the irrigation network lies within the boundaries of the Municipalities of **Pylos-Nestor** and **Messini** (see Plans AP-1 and AP-2). The study area today mainly comprises cultivable land of the former Municipal Districts, specifically:

1. The Municipal Unit of Methoni and the former Municipal Districts of Evangelismos, Finikounda, Lachanada, and Finiki.
2. The Municipal Unit of Pylos and the former Municipal Districts of Pidasos, Chomatada, Kallithea, and Ambelakia.
3. The Municipal Unit of Aipeia and the former Municipal District of Militsa.
4. The Municipal Unit of Koroni and the former Municipal Districts of Exochiko and Kaplanio.

Among these, **Spatial and Residential Organization Plans of Open Cities (SCHOAP)** have been drafted for the Municipal Units of Methoni, Koroni, and Aipeia. However, only the plans for Koroni and Aipeia have been officially approved. The largest portion

of the project area falls under the **SCHOAP of Methoni**, with smaller parts falling under the **SCHOAP of Aipeia** and **Koroni**.
The area where the dam will be constructed and the reservoir created falls within two "Kallikratis" Municipalities – **Pylos-Nestor** and **Messini** – with the stream bed forming their administrative boundary. These details are presented in Plan AP-3 of the present study.

Furthermore, the necessary aggregate quarries required for dam construction are located in the Municipality of **Pylos-Nestor (L1)** and in the Municipality of **Messini (L2)**.

The following sections outline the relevant references, forecasts, and planning guidelines associated with the projects.

#### 5.2.3.1. SCHOAP of the Municipal Unit of Methoni, Messinia

The final proposal (Phase D, Stage B2) of the respective plan was submitted in November 2009, following the completion of public consultation and the incorporation of comments from competent authorities. It has been received by the monitoring committee but has not yet been approved through publication in the Official Gazette.

In drafting the SCHOAP, the guidelines and findings of the Special Environmental Study (SES) for the Natura 2000 sites GR2550003 "Sapienza and Schiza, Cape Akritas" and GR2550007 "Marine Area of Methoni Strait", Messinia, were taken into account.

<u>Objectives of Spatial and Environmental Planning.</u>

In Section Π2, *Organization of Land Uses and Environmental Protection*, the objectives of spatial and environmental planning were defined through the designation of PEP and PEPD zones, closely aligned with the classification of part of the out-of-plan area of the Municipality as a Zone of Eco-Development, as determined by the aforementioned SES of Natura 2000 sites.

Additionally, the objectives identified include the rational use and protection of water resources (both quantitative and qualitative) and the sustainable development of agriculture and livestock farming.

Within the framework of achieving these objectives, several measures were recorded and proposed, directly related to the projects under consideration:

- Improvement of irrigation networks (renovation and modernization).
- Change in irrigation methods.

- Control of boreholes.

The implementation of the examined projects will provide the essential foundation for achieving these objectives, improving both the qualitative and quantitative performance of the primary sector, and ensuring the optimal management of water resources through better utilization of surface waters and stricter control of borehole use.

**The spatial planning and organization of land uses in the peri-urban areas of the Municipality of Methoni**, particularly with regard to the PEP and PEPD zones, are presented in the subsequent section.

**<u>A. Design of Special Protection Areas (S.P.A.)</u>**

In these areas, restrictive special land uses and other urban planning and environmental constraints are imposed, aiming at the protection and enhancement of the archaeological site of **Methoni Castle**, the internationally protected **Natura areas / Eco-development zones**, the forests and forested lands, grassland areas, riparian and streamside zones, as well as the critical coastal zone. Specifically:

1. **S.P.A. 1: Protection and Enhancement of Archaeological Sites.** Areas of archaeological interest include: Methoni Castle at the southwestern end of the Municipality near the settlement of Methoni, the "Papá Lake" area together with the Nisakouli (Nisopoulia) islet, Agia Marianí island, the Agios Onoufrios area north of Methoni, and the Kryoneri site in the Loutsa area.
2. **S.P.A. 2: Nature Protection Areas (N.P.A.).** These cover specific natural sites such as the **Kamaria beach** and the islets **Dyo Adelfia**, **Bomba**, and **Avgo (Petrokaravo)**.
3. **S.P.A. 3: Protected Landscapes (P.L.).** These include **Schiza Island**.
4. **S.P.A. 4: Eco-Development Area – Sapienza Island (E.D.A.).** Protected eco-development zone relating to **Sapienza Island**.
5. **S.P.A. 5: Protection of Forested Vegetation (F.V.P.).** Forests and forested areas located west of the Municipality's territory, as well as scattered forest pockets across the region.
6. **S.P.A. 6: Protection and Enhancement of Rivers, Streams, and Riparian Areas (R.S.P.).** Significant wetlands running through the Municipality, including the **Methoni Limar torrent**, **Rodias stream**, **Minagiotiko stream**, the stream from **Grizokampos to Loutsa**, along with other streams, and their riparian ecosystems. A protection buffer of **50 meters** on either side of their delineated banks is foreseen.
7. **S.P.A. 7: Protection and Enhancement of the Coastal Zone (C.P.Z.).** A coastal strip within **100 meters** of the shoreline, in selected sections along the Municipality's coast.

Of the above categories, within the project area, **S.P.A. 5** and **S.P.A. 6** are identified, while **S.P.A. 2** lies close to, but not overlapping with, the proposed irrigation perimeter. The environmentally significant areas **S.P.A. 1, 3, and 4** do not intersect with the examined works.

**B. Design of Zones for Restriction of Urban Expansion and Building Control (S.P.C.Z.), Outside the City Plan:**

- For the protection of the peri-urban zone of Methoni and the development of mild residential functions, in the immediate peri-urban area east of the settlement and in connection with the main road network, the zone is designated as "P.E.P.D.1: Protection of the peri-urban area and mild residential development (P.P.C.H.O.A.)".
- For the promotion of mild forms of tourism, recreation, and holiday housing, in the out-of-plan area along the coastal front, adjacent to the coastal protection zone and north of the settlement of Methoni, the zone is designated as "P.E.P.D.2: Development of mild forms of tourism, recreation, and holiday housing (T.A.)".
- For the protection and enhancement of agricultural land and the rural landscape in pockets of farmland scattered throughout the municipality, the zone is designated as "P.E.P.D.3: Protection and enhancement of ordinary agricultural land and rural landscape (G.G.)".
- For the protection and enhancement of priority agricultural land, developed east of the Methoni–Pylos national road, the zone is designated as "P.E.P.D.4: Protection and enhancement of high-yield agricultural land and rural landscape (G.G.Y.P.)".
-

Among these categories, the project area mainly falls within **"P.E.P.D.3: Protection and enhancement of ordinary agricultural land and rural landscape"**, covering most of the irrigated zone, while the irrigated perimeter is also located close, in its southeastern part near the boundaries of Finikounda, to **"**P.E.P.D.1: Protection of the peri-urban area and mild residential development (P.P.C.H.O.A.)" and "P.E.P.D.2: Development of mild forms of tourism, recreation, and holiday housing (T.A.)".

**C. Special Protection Areas (P.E.P.) – Regulatory Provisions**

The following have been designated as Special Protection Areas (P.E.P.) in the out-of-plan and out-of-settlement zones of the Municipality of Methoni:

- the archaeological site of Methoni Castle,
- the Nature Protection Areas: Kamaria Beach, the islands/islets Agia Marianí (or Agia Marina), Dyo Adelfia, Bomba, Avgo, and Nissopoulia,

- the Protected Landscapes of Schiza Island and Venetiko Island,
- the eco-development zone of Sapienza Island,
- the forest vegetation protection areas,
- the river and stream protection areas, as well as their riparian zones,
- and finally, the critical coastal zone, within 100 m of the shoreline, at selected sections along the municipality's coastline.

These zones are depicted in Map P.2 of the S.C.H.O.A.A.P., Plan AP-3 of this study, and are the following:

- P.E.P.1: Protection and enhancement of archaeological sites – referring to Methoni Castle at the southwestern end of the municipality, near the settlement of Methoni, the "Limni Papa" area together with the islet Nissakouli (Nissopoulia), Agia Marianí islet, the Agios Onoufrios area north of Methoni, and the Kryoneri site in the Loutsa area.
- P.E.P.2: Nature Protection Area (P.F.) – referring specifically to Kamaria Beach, and the islets Dyo Adelfia, Bomba, and Avgo (Petrokaravo).
- P.E.P.3: Protected Landscapes (P.T.) – referring specifically to Schiza Island.
- P.E.P.4: Eco-development Zone of Sapienza Island (P.O.S.) – referring to the designated eco-development area of Sapienza Island.
- P.E.P.5: Forest Vegetation Protection (P.D.).
- It concerns the forest and woodland areas in the western part of the Municipality, as well as the scattered patches throughout the rest of the area.
- P.E.P.6: Protection and enhancement of rivers, streams, and riparian areas (P.P.R.)
- This zone concerns important wetlands that traverse the Municipality, such as the Methoni Limar torrent, the Rodia stream, the Minagiotiko stream, the stream from Grizokampos to Loutsa, and other watercourses, as well as the riparian areas that support ecosystems developing along their banks, with a protection buffer of 50 m on either side of their delineated boundaries.
- P.E.P.7: Protection and enhancement of the coastal area (P.A.)
- This zone refers to the coastal strip within a distance of 100 m from the shoreline, in selected parts along the Municipality's coastline.

The examined projects are located within the zones P.E.P. 5.0, P.E.P. 5.1, and P.E.P. 6.

The object of environmental protection for each zone is described in detail below:

**P.E.P.5: Forest Vegetation Protection (P.D.)**

This concerns forest and woodland areas in the western part of the Municipality, as well as the extensive scattered patches throughout the rest of the area.

The proposed regulatory provisions aim at the protection of forest-character areas (forests and woodlands), as defined by forest legislation. These zones cannot, by rule, be defined so as to include only forested lands, but also include simple agricultural plots.

These areas are divided into two categories:

P.E.P.5.0: Here, forest vegetation is dominant. In this zone, stricter building restrictions are proposed. The minimum parcel size and buildability threshold are set at 20 stremmata (2 ha) for non-forest agricultural plots, while subdivision is prohibited for forest lands, with the buildability threshold also set at 20 stremmata.

P.E.P.5.1: Here, there is an intense mixture of agricultural crops with forest vegetation. The minimum parcel size is set at 8 stremmata, with buildability allowed for plots of at least 4 stremmata for non-forest agricultural land. For forest plots, subdivision is prohibited, and the minimum buildability threshold is set at 20 stremmata.

Permitted land uses and construction restrictions are also defined, which, however, do not concern the examined projects.

In the general environmental protection restrictions for zones P.E.P.5.0 and P.E.P.5.1, it is stated that:
"Water abstraction from any aquifer is permitted for drinking and irrigation purposes, provided that it does not degrade the environment and maintains the currently existing local populations of flora and fauna."

This provision is consistent with the purpose and character of the examined projects.

**P.E.P.6: Protection and Enhancement of Rivers, Streams, and Riparian Areas (P.P.R.)**

This zone concerns significant wetlands traversing the Municipality's territory, such as the Methoni Limar torrent, the Rodia stream, the Minagiotiko stream, the stream from Grizokampos to Loutsa, as well as other watercourses, and the riparian areas supporting ecosystems that develop along their banks, within a buffer of 50 m on either side of their delineated boundaries. This distance is extended where clusters of forested areas occur adjacent to the banks.
As a river and stream protection zone, a 50 m buffer on either side of the delineated watercourse boundaries is designated. The demarcation of all rivers and streams—both primary and secondary branches—is required.
In these areas, the minimum plot size and buildability threshold is set at 8 stremmata (0.8 ha) for non-forest agricultural land, while subdivision is prohibited for forest parcels, for which the minimum buildability threshold is 20 stremmata (2 ha).

Permitted land uses and building restrictions are also defined, though they do not concern the examined projects.
Within the general environmental protection restrictions for zone **P.E.P.6**, it is stated that:
"Water abstraction from any aquifer is permitted for drinking and irrigation purposes, provided that it does not degrade the environment and ensures the preservation of the currently existing local populations of flora and fauna."
This provision is consistent with the purpose and character of the examined projects.

**D. Zones of Development Restriction and Control (P.E.P.D.) – Regulatory Provisions**

The **Zones of Development Restriction and Control (P.E.P.D.)** in the non-planned areas of the Municipality of Methoni are defined as follows:

- PEPD 1 areas, excluding the settlements of Methoni and Finikounda
- Eco-tourism and recreational areas – PEPD 2
- Two types of agricultural land protection zones: PEPD 3, for high-productivity land, and PEPD 4, for ordinary agricultural land and the rural landscape.

The object of environmental protection for each zone is described below:

P.E.P.D.1: Protection of Peri-Urban Area and Mild Residential Development (P.P.C.H.O.A.) This refers to the immediate peri-urban area of Methoni, to the north and east of the settlement up to the road leading to the beach, and the area surrounding the settlement of Finikounta. Its purpose is the protection and safeguarding of the peri-urban environment from incompatible uses and the promotion of mild residential functions.

The character of this zone aims at the controlled development of mild urban uses directly linked to the settlements, as well as the creation of a reserve of residential land for future expansion.

In these areas, the minimum parcel size is set at 6 stremmata, with buildability allowed for plots of at least 4 stremmata. Permitted land uses and building restrictions are also defined, though they do not concern the examined projects.

P.E.P.D.2: Development of Mild Forms of Tourism, Recreation and Holiday Housing (T.A.) This zone concerns the development of eco-tourism and recreational activities in non-planned areas and aims at promoting eco-tourism, recreation, culture, environmental education and awareness, hospitality, and sports functions, while ensuring landscape protection.

In these areas, the minimum parcel size is set at 6 stremmata, with buildability at 4 stremmata for non-forest plots. Subdivision is prohibited in forest parcels, for which the minimum buildability threshold is 10 stremmata. Permitted uses and building restrictions are also defined, though they do not concern the examined projects.
**The examined projects (irrigation perimeters) do not fall within this zone. Moreover, an additional buffer has been left for the potential future extension of this zone to the north and west of the settlement of Finikounta.**

<u>P.E.P.D.3: Protection and Enhancement of Simple Agricultural Land and Rural Landscape (G.G.)</u>

This zone refers to clusters of agricultural land scattered throughout the Municipality's territory and aims at the protection and enhancement of agricultural land and the rural landscape.

In these areas, the minimum parcel size and buildability threshold is set at 6 stremmata. Permitted uses and building restrictions are also defined, though they do not concern the examined projects.

**The examined projects (irrigation perimeters) mainly concern these areas, which they will support within the framework of their protection and enhancement.**

<u>P.E.P.D.4: Protection and Enhancement of High-Productivity Agricultural Land and Rural Landscape (G.G.Y.P.)</u>

This zone refers to clusters of high-productivity agricultural land located east of the national road to Pylos. It aims at the protection and rational management of such land and is strictly agricultural.

In this area, the minimum parcel size and buildability threshold is set at 8 stremmata. The subdivision of agricultural plots is prohibited, in accordance with Article 24, par. 37, Law 2945/01 (Amendment of Article 56, Law 2637, par. 6 b', c', d', e').

The examined projects are not directly related to this zone. However, it should be noted that in **P.E.P.D.4**, restrictions are imposed on the number and volume of water abstractions per hydrological basin, following relevant studies, with the aim of preserving the reserves and the levels of groundwater aquifers.

**The examined projects will strongly support this goal, indirectly by enhancing aquifer recharge through infiltration from the reservoir catchment area, and directly by reducing the use of boreholes.**

General regulatory provisions for all non-planned zones stipulate that: "A restriction is imposed on the number and volume of water abstractions per hydrological basin, taking into account the restrictive measures for water resources set by the Water Directorate of the Region of Peloponnese, following relevant studies aimed at preserving groundwater reserves and levels."

**E. Residential Organization**

The boundaries of the settlements of the Municipality, as well as the proposed residential expansions under the S.C.H.O.O.A.P. (Spatial and Residential Organization Plan of Open Cities) for primary housing, based on the programmatic targets for the year 2023, are defined as follows:

- Residential expansion of Methoni, under the provisions for settlements with less than 2,000 inhabitants, covering an area of 13.08 ha.
- Delineation of the settlement of Kamaria, under the same provisions, to meet additional needs, covering an area of 8.4 ha.
- Delineation of the settlement of Evangelismos, with an additional delineated area of 36.50 ha.
- Delineation of the settlement of Varakes, under the same provisions, to meet additional needs, with an additional delineated area of 9.90 ha.
- Delineation of the settlement of Finikounta, to meet additional needs, with an additional delineated area of 29.5 ha.
- Delineation of the settlement of Kainourgio Chorio, to meet additional needs, with an additional delineated area of 7.06 ha.
- Delineation of the settlement of Grizokampos, under the same provisions, with an additional delineated area of 14.6 ha, intended both for the regularization of the pre-1923 settlement boundary and for the accommodation of additional housing needs.

For the remaining settlements of the Municipality, based on the programmatic targets for the year 2023, no land deficit is identified for the future coverage of residential needs concerning primary housing.

### 5.2.3.2. S.C.H.O.O.A.P. of the Municipal Unit of Aipeia, Regional Unit of Messinia

The Spatial and Residential Organization Plan of Open Cities (S.C.H.O.O.A.P.) of the Municipal Unit of Aipeia of the Municipality of Messini, Regional Unit of Messinia, covering the entire area of the former Kapodistrian Municipality, was approved by decision No. 14001/875 (Government Gazette 456/ΤΑΑΚΠΘ/17-12-2013).

The examined projects concern part of the area of the Municipal Unit of Aipeia, specifically a section of the Municipal District (or Local Community) of Militsa. The closest settlement to the location of the dam and the irrigated zone is Vlasaiika.

According to the S.C.H.O.O.A.P., for the area and the settlements of interest in relation to the examined projects, the following provisions are recorded:

- Delineation of the settlement of Vlasaiika, covering a total area of 26 stremmata.
- For the already delineated settlement of Militsa, the area is 522 stremmata, with an average building coefficient (ΣΔ) of 0.8.
- Delineation of Special Protection Areas (P.E.P.).
- Delineation of Control and Building Restriction Areas (P.E.P.D.).
-

**The spatial planning and organization of land uses** in the non-urbanized areas of the Municipality of Aipeia, concerning the P.E.P. and P.E.P.D. zones, are as follows:

## A. Design of Special Protection Areas (P.E.P.)

The Special Protection Areas (P.E.P.), identified as P1, PP1, PARCH1, PARCH2 on map P.2.1, scale 1:25,000 of the S.C.H.O.O.A.P. (Plan AP-3 of this EIA), refer to significant areas of the Municipal Unit, outside the settlements, where restrictions on land use and building conditions are binding, thus having the status of absolute protection or a closely approaching regime. In forested or reforestable areas that fall within P.E.P. zones, the provisions and procedures of the relevant forestry legislation apply.

In the project area, small sections are characterized as P1: Area of Protection of Forest Areas and Agricultural Land in the Mountainous Zone. These areas consist of extensive lands with mountainous features and a high proportion of forested land, while also including spaces of traditional agricultural activities, as evidenced by the dense network of rural roads. In these areas, uses regulated by forestry legislation may be permitted, except for the establishment of Forest Villages, as defined by current law. Certain activities included in the P.E.P.D. categories may also be permitted, but at smaller scales. These areas are considered zones of simple protection.

For these areas, the minimum plot size for subdivision is set at 8,000 m², and the minimum buildable size at 4,000 m². The permitted uses and building restrictions defined do not affect the examined projects.

**The projects (dam, reservoir, irrigation perimeter) concern such lands, which they will support within the framework of protection and enhancement.**

**B. Control and Building Restriction Areas (P.E.P.D.)**

The Control and Building Restriction Areas (P.E.P.D.), identified as AGR, TH, and TA on map P.2.1, scale 1:25,000 of the S.C.H.O.O.A.P. (Plan AP-3 of this EIA), concern areas outside settlements (existing and expansions) and outside the Special Protection Areas (P.E.P.). They represent intermediate transitional zones.

In these areas, restrictions apply both to the possibility of establishing certain land uses permitted under the existing “outside-plan development” framework, and, in some cases, to the allowable building sizes defined by current regulations, in order to achieve the desired spatial pattern for each area.

For the project area, sections are characterized as **AGR – Semi-Mountainous Agricultural Hinterland**. These zones represent the wider surrounding area of hinterland settlements, typically traditional agricultural zones, where a relatively small number of dispersed holiday homes and tourist facilities may be developed. For these areas, the “small-scale unit” is selected – a type not explicitly defined by law but referring to either classical hotels, or rented rooms/apartments with additional services. The concept of **agrotourism accommodation** is also introduced, involving a direct or indirect link to local agricultural production, small-scale operations, and a strong connection to the natural and cultural environment, though not yet formally institutionalized. For these areas, the minimum plot size and buildable size are set at 4,000 $m^2$. The permitted uses and building restrictions defined do not affect the examined projects.

**The projects (irrigation perimeter) concern such lands, particularly in the area around Vlasaiika, which they will support within the framework of protection and enhancement.**

### 5.2.3.3. S.C.H.O.O.A.P. of the Municipal Unit of Koroni, Regional Unit of Messinia

The Spatial and Residential Organization Plan of Open Cities (S.C.H.O.O.A.P.) of the Municipal Unit of Koroni of the Municipality of Pylos–Nestor, Regional Unit of Messinia, covering the entire area of the former Kapodistrian Municipality, was approved by decision No. 14001/876 (Government Gazette 421/ΤΑΑΚΠΘ/28-11-2013). The examined projects concern part of the area of the Municipal Unit of Koroni, specifically a section of the Municipal District of Kaplanio, with the closest settlements being Exochiko and Zizanio.

According to the S.C.H.O.O.A.P., for the area and settlements of interest in relation to the examined projects, the following provisions are recorded:

- Delineation of the settlement of Exochiko, covering an area of 39 stremmata.
- Expansion of the settlement of Zizanio by 49 stremmata, reaching a total area of 90 stremmata, with an average building coefficient (ΣΔ) of 0.8.
- Delineation of Special Protection Areas (P.E.P.).
- Delineation of Control and Building Restriction Areas (P.E.P.D.).

Both P.E.P. and P.E.P.D. categories concern the proposed provisions of the S.C.H.O.O.A.P. for the organization of land uses and environmental protection in areas outside city plans, outside settlement limits, and outside areas designated for urban development.

**A. Special Protection Areas (P.E.P.)**

These areas concern significant sections of the Municipal Unit, outside settlements, where restrictions on land uses and building conditions are binding, thus having the character of absolute protection or a regime closely approaching it. In forested or reforestable areas within P.E.P. zones (see map P2, scale 1:25,000 of the S.C.H.O.O.A.P., Plan AP-3 of this EIA), the provisions and procedures of forestry legislation apply, as they do throughout the Municipality's territory. This means that the S.C.H.O.O.A.P. does not interfere with the competencies and regulations foreseen by forestry law, nor does forestry law "extend" into P.E.P. areas, which often constitute broader spatial units.

**For the project area, no Special Protection Areas (P.E.P.) are identified.**

**B. Control and Building Restriction Areas (P.E.P.D.)**

The Control and Building Restriction Areas (P.E.P.D.), indicated as AGR, TH, and TA on map P.2 (scale 1:25,000) and Plan AP-3 of this EIA, concern areas outside settlements (existing and expanded) and outside the Special Protection Areas (P.E.P.). These constitute intermediate transitional zones.

In these areas, restrictions apply both to the possibility of establishing certain land uses foreseen under the current "outside-plan development" framework and, in some cases, to the permissible building volumes defined by existing regulations, in order to achieve the desired spatial pattern of each area.

**For the project area, lands characterized as AGR – Semi-Mountainous Agricultural Hinterland are encountered.**

These zones represent the wider surrounding environment of hinterland settlements, typically traditional agricultural areas, where a relatively small number of dispersed holiday homes and tourist facilities may be developed. For these areas, the “small-scale unit” is preferred – a type not explicitly defined by law, but referring either to a classical hotel, or to rented rooms/apartments with additional service provisions. The concept of **agrotourism accommodation** has also been introduced, involving at least an indirect connection with local agricultural production, small-scale development, and a general link to the natural and cultural environment, although not yet formally institutionalized.

In these areas, the minimum plot size and buildable size are set at 4,000 m², subject to Article 9, paragraph 2 of Law 3937/11. The permitted uses and building restrictions defined do not affect the examined projects. Additionally, for the areas of the S.C.H.O.O.A.P. regulations that fall within the GR2550003 zone, the minimum plot size and buildable size is set at 10,000 m², but only for the section that lies within this zone.

**The examined projects (irrigation perimeter) concern agricultural lands of this type, in the area of the settlements of Exochiko and Zizanio, which they will support within the framework of protection and enhancement.**

**Quarries – Mines – Extractions**

The operation of mines and extraction-related facilities is permitted and approved through current procedures, including the criterion of landscape preservation. Their environmental licensing also considers their visibility from the main tourist routes of the area, as a significant condition.

#### *5.2.4. Water Management Plan*

According to the Water Resources Management Plan of the Special Secretariat for Water of the Ministry of Environment, Energy and Climate Change (ΥΠΕΚΑ), the *“River Basin Management Plan of the Western Peloponnese Water District (GR01)”* was prepared and approved (Government Gazette 1004/B/24-04-2013). The Western Peloponnese Water District (GR01) is one of the fourteen (14) Water Districts into which the Greek territory was divided by Law 1739/1987 (Government Gazette 201/A/20.11.1987). These correspond to the River Basin Districts of Article 3 of Presidential Decree 51/2007, as determined by Decision No. 706/2010 of the National

Water Committee (Government Gazette 1383/B/02.09.2010), later corrected in Government Gazette 1572/B/2010.

The district is located in the southwestern part of mainland Greece and the Peloponnese, covering an area of 7,235 km². Administratively, this area includes, in whole or in part, the Regional Units of Arcadia, Ilia, Achaia, Messinia, and Laconia.
In terms of natural–geomorphological boundaries, the district is delimited to the north by the mountain ranges of Erymanthos and Aroania, to the east by Mount Artemisio, Mainalo, and Taygetos, to the south by the Messenian Gulf, and to the west by the Ionian Sea and the Kyparissiakos Gulf.

The River Basin District is structured around two main catchments:

- the **Alfeios River Basin (GR29)**, with a total area of 3,810 km², and
- the **Pamisos–Nedon–Neda Basin (GR32)**, with a total area of 3,425 km².

The examined projects are located within the **Pamisos–Nedon–Neda catchment (GR32)**.

The main rivers traversing this basin are the Pamisos and the Neda, both with continuous flow, and the Nedon, which has torrential flow.

In addition to these, there are several smaller rivers and streams, considered significant within the framework of this study, forming distinct riverine water systems.

**Figure 5-1. Western Peloponnese Water District (GR01)**

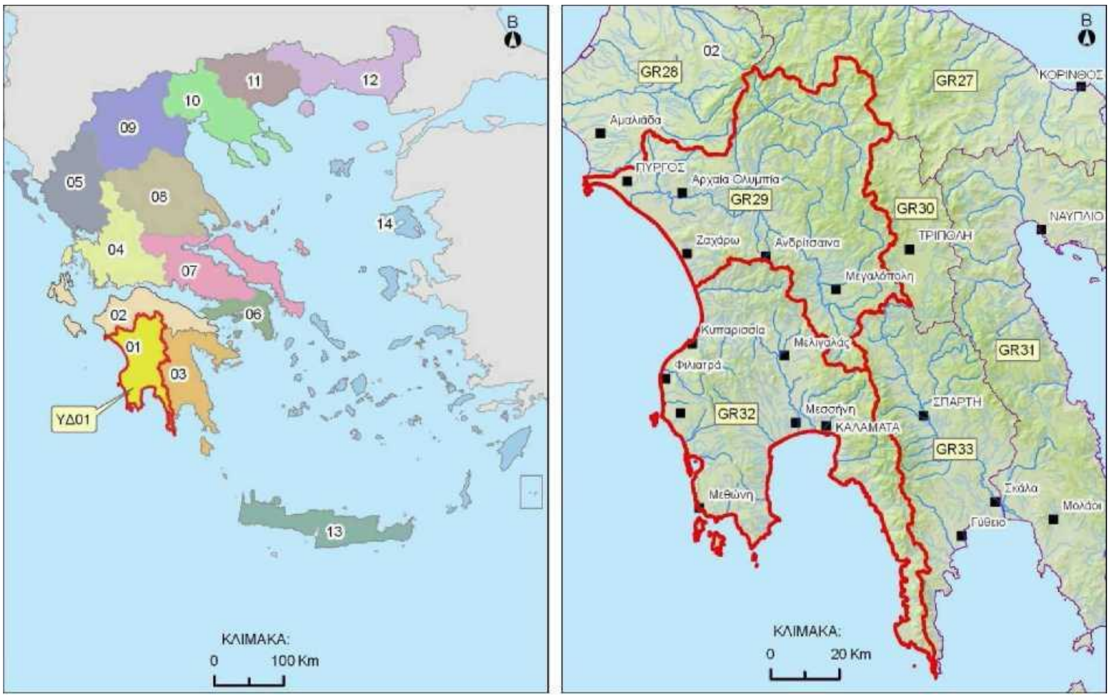


Table 5-1 below lists, for the main rivers and streams of the LAP (GR32), the length of the main channel of each river/stream and the area of its catchment basin.

**Table 5-1. Main rivers in the Pamisos–Neda–Nedon River Basin (GR32)**

| Name | Main Channel Length (km) | River Catchment Area (km²) |
|---|---|---|
| Pamisos | 43,47 | 567,60 |
| Neda P. | 31,44 | 278,55 |
| Aris P. | 15,40 | 203,05 |
| Kalo nero R. | 24,67 | 183,31 |
| Velikar | 32,04 | 149,37 |
| Nedon P. | 22,43 | 146,11 |
| Miloi R. | 19,44 | 134,83 |
| Selas R. | 23,95 | 95,87 |
| Klisoureiko R. | 15,39 | 64,92 |
| Filiatrino R. | 24,43 | 62,90 |
| Panouzagas R. | 13,76 | 48,31 |
| Lagouvardos R. | 8,29 | 48,09 |
| Minagiotiko R. | 13,19 | 43,42 |

In Figure 5-2, the main rivers and streams of the Western Peloponnese Water District (GR01), as well as the most important of their tributaries, are depicted.

**Figure 5-2. Main rivers of the Western Peloponnese Water District (GR01)**

| ΟΝΟΜΑ | ΜΗΚΟΣ ΚΥΡΙΑΣ ΚΟΙΤΗΣ (χλμ) | ΕΚΤΑΣΗ ΛΕΚΑΝΗΣ ΑΠΟΡΡΟΗΣ ΠΟΤΑΜΟΥ (χλμ$^2$) |
|---|---|---|
| ΑΛΦΕΙΟΣ Π. | 127,03 | 3.497,09 |
| ΛΑΔΩΝ Π. | 65,78 | 1.137,19 |
| ΕΡΥΜΑΝΘΟΣ Π. | 51,85 | 359,48 |


The examined projects are planned for implementation at the **Minagiotiko Stream**, which has the smallest catchment area, 43.42 km², and the second shortest riverbed length, 13.19 km.

**Land use in the Pamisos–Nedon–Neda RBD**

Overall, in the Pamisos–Nedon–Neda River Basin District, agricultural land accounts for 44%, forested areas for 37%, and pastures for 16%. Specifically, regarding cultivated land, in the basin there are approximately 1,114,000 stremmata (111,400 ha) of farmland. Within this area, there are 66,000 stremmata of vineyards and currant vineyards, 167,300 stremmata of arable crops, 841,000 stremmata of tree crops, and 40,000 stremmata of vegetables. The above figures are based on the latest available agricultural census of ELSTAT (2007).

**Water use**

In the entire Water District, the total annual water demand for all activities and uses amounts to about 234.5 million m³. Agriculture (irrigated land), being the main user, consumes approximately 77% (about 180 million m³) of this total.
For the Pamisos–Nedon–Neda RBD (GR32), the total annual water demand for all activities and uses amounts to about 114.0 million m³. Agriculture (irrigated land) is again the main user, consuming ~80% (~91.0 million m³) of the total water demand.

**Pressures**

Regarding the identification and recording of activities and pressures in RBD GR32, low-intensity pressures have been recorded, mainly associated with olive mills and livestock units, with the highest values concerning BOD, N, and P. Overall, pollutant levels for the basin are low, while for the Minagiotiko sub-basin they are the lowest recorded.

**Typology**

According to river classification criteria, the Minagiotiko Stream is characterized as a river water body with the code **IsL1**, meaning it belongs to the Ionian eco-region, with low runoff, low altitude, and steep gradient.

**Planned projects**

For all planned, designed, or under-study projects and activities related to water resources, and regarding their potential to affect the achievement of environmental objectives for surface and groundwater bodies, the following parameters are considered:

- Maturity for implementation by 2015.
- Type of project or activity.
- Selection of projects/activities significant in terms of expected socio-economic benefits, such as irrigation works.
- Importance of the project/activity in achieving environmental objectives.

Planned projects and activities, which have been recorded but are not expected to be completed by 2015, or any new projects that may be proposed, must be examined and assessed in terms of their impacts and consequences with respect to the objectives of the Directive, so that they are taken into account in subsequent revisions of the Water Management Plans.

In Table 4.2 of Annex 8 of the WMP, which lists these planned projects, the projects examined in the present study are also recorded as follows:

- Entry No. 106: **Minagiotiko Dam**, on the Minagiotiko Stream. It is planned to irrigate 44,500 stremmata (265 $m^3$/stremma/year). *Reconnaissance study of reservoirs in the provinces of Pylia – Trifylia, Messinia Prefecture, 1998.*
- Entry No. 118: **Irrigation Networks of the Minagiotiko Dam**, estimated at 20,000 stremmata in the Municipal Unit of Pylos and 24,400 stremmata in the Municipal Unit of Methoni. *Study by the Ministry of Development (ΥΠΑΝ).*

**From the above information, no form of incompatibility of the project emerges, since it is already listed in the WMP. On the contrary, due to its positive characteristics, it is consistent with the directions and objectives of the Water Management Plan.**

Furthermore, as noted in Section 5.2.1.2, the examined projects, as **Complementary measures** in the RBMPs, constitute a priority within the framework of the **Rural Development Programme (RDP) 2014–2020, sub-measure 4.3.1.**, while **Priority 5.A**, under which they fall, is a key area of focus of this sub-measure, since *"the improvement of water use efficiency in agriculture (5A) requires a holistic approach to the operation and management of the system: abstraction – transport – distribution – application to the crop."*

# 6. DETAILED DESCRIPTION OF PROPOSED PROJECTS

The proposed projects were briefly presented in Section 3 of this study and, as mentioned, concern the dam and the irrigation networks. The description of the projects is provided below, as examined in the corresponding technical studies, specifically in the Preliminary Dam Study and the Introductory Study of the irrigation networks.

For the dam project, two alternative solutions were examined, concerning the type of dam, based on the data of the supporting studies (Geological and Geotechnical), which are included in the project contract and whose findings are decisive for the choice of dam type.

The comparison of the two solutions (Solution 1: Earth-fill dam with clay core and frontal spillway, and Solution 2: Gravity dam from Roller Compacted Concrete (lean RCC) with integrated spillway in the dam body) is presented in Chapter 7, while the works of the proposed dam solution are described below.

## 6.1 Description of the works of the Minagiotiko Dam

### *6.1.1 Contractual basic parameters of the dam*

The Minagiotiko Dam will be constructed approximately 2 km west of the settlement of Vlasaiika, on the stream of the same name, which flows from north to south, at a distance of 5.5 km from its estuary, located about 800 m west of the settlement of Finikounta.

The **contractual** basic parameters of the dam and reservoir are as follows:

**Catchment Area**

- Catchment area: 28.9 $km^2$
- Average elevation of the catchment: +249
- Elevation of the natural streambed at the dam axis: ~+78
- Average annual rainfall: 775 mm
- Average annual runoff: 9,405,736 $m^3$
- Specific sediment yield: 700,000 $m^3$

**Reservoir**

- Maximum Water Level (MWL) of reservoir (spillway crest elevation): +122.0
- Minimum Water Level (intake threshold elevation): +95.0
- Useful water depth: 27.0 m
- Total reservoir volume: 12,500,000 $m^3$

- Useful reservoir volume: 11,800,000 m³
- Reservoir surface area at spillway crest level: 850,000 m²

**Dam**

- Dam type: Earth-fill
- Total embankment volume: 540,000 m³

Maximum height: 49 m from the foundation

Crest length: 177 m

Crest elevation: +127.00

Crest width**:** 10 m

**Spillway**

- Spillway type: Free frontal
- Spillway crest elevation: +122.00
- Spillway crest length: 20.0 m
- Channel length: 220.0 m
- Maximum spillway discharge: 157.00 m³/s
- Reservoir level at maximum spillway discharge: +125.00

**Temporary diversion – drainage – intake**

- Type of work: Pipeline
- Length of temporary diversion conduit: 450.00 m

According to the applicable Technical Specifications of Studies (P.D. 696/74), the purpose of the Preliminary Study of Earth-fill and Rock-fill Dams (Article 198) is *"the selection of the preferred techno-economic solution regarding the extent and the form of the overall project, and the resolution of the basic construction problems of the works. This selection should result from the synthesis of the findings of the required Special Studies in combination with the investigation of technical and economic issues as well as the fiscal implications."*

During the preparation of the Preliminary Study of the Minagiotiko Dam, the Study Team, taking into account the findings of the supporting investigations, carried out a techno-economic evaluation of the earth-fill dam solution, while also examining alternative dam types.

In the Preliminary Study, the following criteria emerged as critical for the design and the choice of dam type:

- the qualitative suitability and quantitative adequacy of construction materials (support body materials, core materials, sand and gravel for filters and drains, rockfill materials, concrete aggregates, etc.),
- the foundation conditions,
- the existing possibilities for spillway construction, the seismicity of the wider area and its potential impact on the project.

During the Preliminary Study, the results of the geological/geotechnical investigations were taken into consideration. In the course of the Construction Materials Investigation, with the excavation of 17 exploratory boreholes, conducted between October 19–20, 2015 and December 13–22, 2015, sampling was carried out at five quarry sites. From these samples it was found that there are no riverbed sand–gravel materials suitable for fine-grained filters and drains for incorporation into an earth-fill dam with a clay core. Consequently, the Study Team examined the gravity dam solution using Roller Compacted Concrete (RCC), given the sufficiency of aggregate materials from quarries for the construction of the dam body.

The Study Team examined in detail the following solutions:

- **Earth-fill dam with clay core and frontal spillway on the left abutment** (see series of Drawings Nos. 2.1, 2.2 and 2.4.1),
- **Gravity dam from roller-compacted concrete (lean RCC) with integrated spillway** in the dam body (see series of Drawings Nos. 3.1 to 3.16).

### 6.1.1.1. Alternative Solution 1: Earth-fill Dam with Clay Core

This is an earth-fill dam with a central clay core. The general arrangement of the works is shown in Drawing 2.1 of the Preliminary Study. The dam crest is set at elevation +127.00. The works include the dam body, the spillway with the energy dissipation structures, the diversion–drainage–intake works, and the service and access restoration roads.
Alternative Solution 1 is presented in detail in Chapter 7 of this Environmental Impact Assessment and in the corresponding technical drawings.

### 6.1.1.2. Proposed Solution: Alternative 2, Gravity Dam of Roller-Compacted Concrete (lean RCC)

#### 6.1.1.2.1. General

This solution constitutes the proposed option, as derived from the comparison of alternatives, which is presented in detail in Chapter 7 of this Environmental Impact Assessment.

For Solution 2: Gravity Dam of Roller-Compacted Concrete (RCC), the key figures of the dam and the reservoir are as follows:

**Catchment area**

- Catchment area: 28.9 $km^2$
- Mean elevation of catchment: +249
- Elevation of natural streambed at the dam axis: ~+78
- Mean annual rainfall: 760 mm
- Mean annual runoff: 8,747,000 $m^3$
- Specific sediment yield: 468,902 $m^3$

**Reservoir**

- Reservoir MWL (Maximum Water Level – spillway crest level): +122.0
- Reservoir LWL (Lowest Water Level – intake sill): +95.0
- Usable water depth: 23.5 m
- Total reservoir volume: 10,959,007 $m^3$
- Useful reservoir volume: 10,490,105 $m^3$
- Reservoir area at spillway crest level: 886,733 $m^2$

**Dam**

- Dam type: Gravity Dam of Roller-Compacted Concrete (Lean RCC)
- Total embankment volume: 196,000 $m^3$
- Maximum height: 49 m from foundation

Crest length: 177 m
Crest elevation: +127.00
Crest width: 10 m
Slope inclinations: Horizontal 0.80 – Vertical 1.0
Upstream sealing mantle surface area: approx. 4,400 $m^2$
Length of sealing mantle foundation plinth**:** approx. 180 m

**Spillway**

- Spillway type: Integrated free overflow
- Spillway crest length: 24 m
- Maximum spillway discharge: 265.50 $m^3/s$
- Reservoir level for maximum spillway discharge: +124.50
- Still basin level: +75.30
- Still basin length: 23.95 m
- Still basin width: 24.0 m

**Temporary diversion – drainage – intake**

- Type of work: Conduit
- Length of temporary diversion conduit: 450.00 m
- Gradient of temporary diversion conduit: 0.0214
- Cross-section of temporary diversion conduit: Rectangular 5.00 × 4.00 m
- Maximum diversion discharge: 53.7 $m^3/s$
- Minimum intake–drainage level: +95.00

- Cross-section of drainage–intake conduit: Steel pipe D900
- Maximum drainage discharge: 4.42 $m^3/s$
- Cross-section of intake conduit: Steel pipe D900

#### 6.1.1.2.2. Dam Axis & Crest

The dam axis was located approximately 90 m downstream of the confluence of the two branches of the Minagiotiko stream, in order to:

a) capture in the reservoir the flow of both branches, and
b) minimize, as far as possible, the volume of embankment.

The MWL of the reservoir was set at elevation +122. This elevation was chosen on the basis of the results of the sensitivity analysis of the water balance for the operation of the reservoir (Chapter 5, Hydrological Study).
The dam crest was set at elevation +127, taking into account the routing of the maximum flood level through the reservoir (Chapter 2, Hydraulic Calculations).
The dam crest is configured with a total width of 9.60 m. This width includes a 6.5 m wide carriageway with sidewalks and guardrails of a total width of 3.10 m. On the upstream side of the crest, in addition to the safety guardrail, a wave wall of reinforced concrete is also foreseen. It is noted that the crest road of the dam follows the specifications according to OMOE.

Pedestrian circulation on the sidewalk of the crest road is not recommended. This sidewalk serves ONLY the inspection needs of the dam.

#### 6.1.1.2.3. Dam Body

In this case, the dam body is constructed from a mixture of cement, aggregates, and water, while the addition of fly ash to the mix will also be examined. The mixing ratios and construction method will be described in detail in the Final Design and finalized after supplementary sampling and tests to be carried out by the Consultant prior to the commencement of construction. Below are some basic specification elements of the materials.
For the construction of the roller-compacted concrete (RCC) embankment, the following requirements, among others, must be observed:

- The maximum aggregate size shall be less than 60 mm.
- The filler percentage (passing through No. 200 sieve) shall be between 8% and 16%.
- The cement shall be Greek-type Portland 11/35 with the minimum possible ratio, between 50 and 70 kg per $m^3$ of RCC.

- The water ratio shall be as low as possible, in order to achieve the required compaction.

For thermal performance reasons, an increased cement ratio is undesirable. Strength will be achieved by minimizing the moisture content in the mix and by intensive compaction using a vibrating roller. The thickness of the layers is foreseen at 30 cm. Mixing will take place in a suitable central plant, and transport, placement, and compaction must be carried out in the shortest possible time.

Regarding the available materials for the construction of the RCC, the rock materials for the supply of aggregates to be used have been identified in borrow pits L1, L2, and L3. These materials exist in large quantities and have been deemed suitable based on the geological and geotechnical investigations carried out.

The downstream face of the RCC embankment is designed with a slope of 1.0 vertical to 0.80 horizontal (see Drawing 3.2.1). For protection and improved construction, the downstream face of the RCC body is foreseen to be stepped, with the placement during construction of prefabricated C16/20 concrete units of Γ-shape section, 0.82 m high and 0.66 m base width, which will confine the placed and compacted RCC layers. The upstream face of the RCC embankment has a slope of 1.0 vertical to 0.80 horizontal and is shaped with appropriate means, without the use of prefabricated elements, unless tests during construction prove that with the available equipment and applied method, satisfactory construction of the upstream end of the RCC layer cannot be achieved. In this case, the Contractor, without additional compensation, will apply an appropriate confinement system for the RCC layers, subject to the approval of the Authority. In this case, the proper placement of the perforated Φ200 drainage pipes between the sealing mantle and the RCC body must not be impeded.

#### 6.1.1.2.4. Upstream Sealing Mantle

The upstream sealing mantle is constructed from reinforced concrete C20/25 with reinforcement S500. It has a variable thickness between 30 cm and 60 cm and is cast in situ, after the drainage system works described in the following paragraph have been carried out. Casting of the mantle is foreseen using a suitable system of sliding steel forms with an integrated vibration system.
Since the upstream sealing mantle is the waterproofing element of the dam body, thorough sealing of all construction and expansion joints of the mantle is foreseen, as well as contact of the facing with the foundation plinth and with the crest walls of the dam, using sealing tapes, sealing materials, etc.

At the stage of the Final Design, the possibility of using a geomembrane sealing system

will be examined. This system would consist of layers of geosynthetic material ensuring the sealing and drainage of the upstream face of the dam.
For the collection and removal of any possible seepage through the upstream facing, a suitable drainage system is foreseen. This system consists of perforated PVC pipes D200, wrapped in geotextile, placed at 3.0 m intervals on the upstream face of the roller-compacted concrete (RCC) embankment within a suitably excavated channel. These pipes discharge into the lower central collector conduit (PVC D630), which is to be embedded in the foundation plinth of the sealing facing.

#### 6.1.1.2.5. Dam and Plinth Foundation Conditions

According to the Geological Study (G. Emmanouilidis & S. Fotis, October 2016) and the Geotechnical Study (Kastor Ltd., October 2016), for selecting the appropriate foundation depth of the dam body and the plinth, as well as the foundation of the spillway structure, the following criteria are proposed:
a) The foundation of the dam body should be placed on the formations of the flysch substratum, which are slightly to locally moderately weathered and moderately fractured (Engineering-Geological Zone 2 / Layer IV): siltstones, sandstones, alternations, as well as conglomeratic formations of type C1 with a silty matrix and usually weak to slightly strong cementation. These formations have a semi-rocky structure, moderate to locally poor quality characteristics, and are considered suitable for the dam foundation, provided that the thickness of the formations with poor quality is small. The dam will rest on a foundation layer on formations of Layer IV, which underlies at a depth beneath Layers I and II.
b) The foundation of the plinth and the spillway should be placed on formations of the flysch substratum that are sound to slightly weathered and slightly to locally moderately fractured (Engineering-Geological Zone 1 / Layer IV). These formations are usually associated with conglomeratic formations of type C2 with a sandstone–limestone cement and strong cohesion, as well as with sandstone/siltstone formations with generally similar quality characteristics. The formations of Zone 1 have a rocky structure, generally good quality characteristics, and are considered suitable for the foundation of the dam plinth and the spillway.

#### 6.1.1.2.6. Sealing Conditions and Sealing Measures

Furthermore, according to the Geological Study, assessing the data regarding the sealing conditions of the reservoir basin of the Minagiotiko dam, it is concluded that:

- The sealing conditions prevailing in the area of the reservoir basin are good, since the morphology of the area does not favor water leakage, the flow paths towards other basins (at lower elevations) are long, and the hydro-lithological characteristics of the flysch formations composing these paths are favorable.

- The sealing conditions are unfavorable at the most downstream part of the reservoir basin, i.e., in the area where the reservoir will be in contact with the dam abutments. Specifically, the sealing conditions of the geological substratum, beneath the foundation surface of the dam plinth and along the extension of the abutments, are considered moderate to unfavorable, due to: a) the increased permeability of the formations to significant depths (Equal Permeability Zones 3 and 2), (b) the great depth of the groundwater table in the higher parts of the abutments, and (c) the reverse movement/flow of water from the bed of the Minagiotiko stream towards the lower parts of the abutments, as shown on the map of Drawing GM-10 of the Geological Study.

  Therefore, water leakage from the reservoir towards the lower basin/bed of the Minagiotiko, through the abutments of the dam, is considered certain, due to the unfavorable morphology of the abutments and the adverse hydro-lithological characteristics of the flysch formations forming the area.

  For determining the necessary depth and extent of the required sealing, it is proposed to adopt the permeability criterion, which is suggested to be: a) <2 Lugeon for the area of the plinth, and b) <4 Lugeon for the areas extending into the abutments to the north and south.

  Regarding the sealing methodology of the geological substratum, it is assessed that:
- For sealing the flysch substratum beneath the foundation surface of the dam plinth, the method of cement grouting in three (3) rows with a staggered arrangement of boreholes is appropriate, along with the drilling of control boreholes in each independent sealing section.
- For sealing the Pleistocene/Pliocene substratum in the extension of the dam abutments to the north and south, the diaphragm wall method C/B is considered appropriate.

  The geometric characteristics and other details of the sealing shown in the drawings of this preliminary design will be finalized in the framework of the final design of the project.

  To monitor the watertightness of the abutments during the filling and operation of the reservoir, it is proposed to construct control piezometers at a short distance downstream of the sealing axis.

#### 6.1.1.2.7. Abutment Stability Conditions

Based on the Geological Study, the stability conditions of the abutments are considered moderate, since these abutments present landslides/rockfalls of moderate extent and volume. The materials of these instabilities are currently in marginal equilibrium. During the filling and operation of the reservoir, instabilities may develop in the inclined parts of the abutments adjacent to the reservoir, due to fluctuations in the water level and the presence of Pleistocene/Miocene formations which are in marginal equilibrium.

In the excavation slopes for the dam foundation, there is a possibility of developing instability mechanisms of small extent and volume. Such potential instabilities are not expected to cause any problem in these slopes.

For the high excavation slopes that will be created upstream and downstream of the dam and spillway foundation zone, it is proposed to reinforce their stability with the installation of the usual support measures.

Additionally, it is noted that the left/southern abutment, due to the peculiarity of its morphological relief —a low and narrow ridge— is characterized as a problematic area regarding its overall stability under reservoir filling and operating conditions. For this reason, it requires reinforcement by constructing an embankment in the extension of the upstream body of the dam. This embankment can be constructed from the excavation materials of the foundation trench of the dam and the spillway.

#### 6.1.1.2.8. Monitoring Instruments

The main objectives of instrument installation are:

- monitoring the behavior of the project regarding deformations, possible joint openings, and displacements of the roller-compacted concrete (RCC) dam body,
- monitoring piezometry, mainly at the foundation,
- monitoring any potential development of temperatures during the curing of the RCC mix (although this is not considered likely),
- monitoring the seismic behavior of the project.

<u>A. For monitoring the behavior of the project, it is proposed:</u>

- installation of electric crack-meters at selected positions of the plinth–impervious slab joint as well as between sections of the impervious slab. Estimated number: 30.
- installation of pendulums (normal and inverted). Estimated number: 4.
- installation of benchmarks for measuring surface displacement along the crest and on the downstream slope of the dam. Estimated number: 19.
- establishment of triangulation reference points. Estimated number: 6.
- installation of inclinometers to monitor any displacements in the abutments. Estimated total length: 100 m.

B. For monitoring piezometry, it is proposed:

- installation of electric piezometers of vibrating wire type in boreholes to be drilled downstream of the grouting curtain. Estimated number: 3×2=6.
- installation of electric piezometers of vibrating wire type at the dam foundation along the entire length of two control sections for uplift monitoring. Estimated number: 2×5=10.
- construction of observation wells for monitoring groundwater level downstream of the dam at the abutments and in the riverbed. Estimated total length: 200 m.

C. For monitoring any potential development of temperatures during the curing of the RCC mix (although not considered likely):

- instrumentation of a central control section with thermometers placed at three elevation levels. Estimated number: 17.

D. For monitoring the seismic behavior of the project, it is proposed:

- installation of 2 triaxial accelerographs of motion-balancing type (one on the dam crest and one on a rock outcrop downstream of the dam).

#### 6.1.1.2.9. Design of Crest and Spillway

For the design of the spillway, the solution of a frontal spillway integrated into the dam was examined. In Greece to date, the choice of the design flood hydrograph is determined by the magnitude of consequences deemed acceptable in the event of failure due to overtopping of the dam. In general, the type of potential consequences is classified into three categories:

- Loss of life.
- Economic losses:

a) direct, due to material damages (dam body and related structures, houses, crops, industrial facilities, etc. in the downstream area of the dam), and
b) indirect, either due to the loss of the dam in a series of beneficial uses which will be lost along with the project (e.g., water supply, hydroelectric production, flood protection), or due to the degradation of the functionality of public utility networks (water supply, sewerage, energy transmission, communications, transport).

- Environmental consequences and impacts on ecosystems, including the effects of a potential leakage of stored toxic substances.

Recently, the Hellenic Committee on Large Dams (HCLD, 2016) has proposed a categorization of dams for the selection of the Design Flood.

It is noted that this categorization is based on both national and international experience. The choice of the dam category will be made under the assumption of the most adverse type of failure, in terms of potential consequences regarding loss of human life and economic damages.

The determination of consequences is based on field surveys, examination of existing data, and maps. Based on the above, the categories shown in Table 6.1 were proposed.

According to the plan of the Hellenic Committee on Large Dams (HCLD, 2016), the safety check flood is defined as the flood corresponding to an extremely small probability.

For this flood discharge, the spillway, the energy dissipation arrangement, and the crest of the dam are acceptable to function (with marginal safety) at the limit of failure.

Conversely, the spillway design flood is defined as the flood that allows the works to operate with the safety margin resulting from the freeboard. This flood corresponds to the higher probability of occurrence.

It is noted that the distinction between gravity dams and earthfill dams is made taking into account the vulnerability of each dam type to overtopping, since guidelines for determining the freeboard safety allowance do not yet exist.

In the present study, for the determination of the flood on the basis of which the dam crest level is defined and the spillway works are designed, the guidelines of the Hellenic Committee on Large Dams, as well as corresponding foreign guidelines (e.g., ICOLD, 2007; ICE, 1996; FEMA, 2004) are considered.
Based on the above criteria and the proximity of the dam to inhabited areas with significant tourist activity (e.g., Finikounda), the Minagiotiko Dam is classified in Category 1.

**Table 6.1: Categorization of dams for the Design Flood.**

| Category of potential consequences | Consequences | Spillway Design Flood (return period, years) | Safety Check Flood (return period, years) |
|---|---|---|---|
| **Category 1** | Possible loss of animals' life.<br>Major losses in the productive and social fabric.<br>Irreversible environmental damages. | 10.000 | PMF (Probable Maximum Flood) |
| **Category 2** | No loss of life animals' expected.<br>Significant direct and indirect economic losses.<br>Significant reversible environmental impacts. | 1.000 (gravity & RCC)<br><br>5.000 (earthfill) | 5.000 (gravity & RCC)<br><br>10.000 (earthfill) |
| **Category 3** | No loss of life animals' expected.<br>Minor economic losses.<br>No significant environmental impacts. | 200 (gravity & RCC)<br><br>500 (earthfill) | 500 (gravity & RCC)<br><br>10.000 (earthfill) |

From the Hydrological Study carried out within the framework of the present contract, the statistical analysis of extreme storm events and the determination of the design flood are necessary for the sizing of the spillway and the diversion works.

According to the British Institution of Civil Engineers, for dams whose failure endangers human lives in a community, the design flood corresponds to the Probable Maximum Precipitation (PMP) or, at a minimum, to a flood with a return period of 10,000 years.

Within the framework of the Hydrological Study, and for various rainfall durations, the Intensity–Duration–Frequency (IDF) curve was developed for the HNMS (Hellenic National Meteorological Service) station at Methoni, which is the representative station for the catchment area of the dam.

From the analysis of maximum rainfall intensities, the final form of the areal-reduced IDF curve is given by the following equation:

$$i(d,T) = \frac{12.28 * (T^{0.15} - 0.55)}{(1 + d/2.0)^{0.50}}$$

The flood hydrographs corresponding both to the Probable Maximum Precipitation (PMP) and to the return period of T = 10,000 years (24-hour duration) are presented

in Figures 6.1 and 6.2 below. As shown, the peak discharge is 265.5 m³/s and 193.9 m³/s for the PMP and for the return period of T = 10,000 years, respectively.
For the design of the dam crest and the sizing of the spillway, the flood hydrograph corresponding to the PMP was selected.

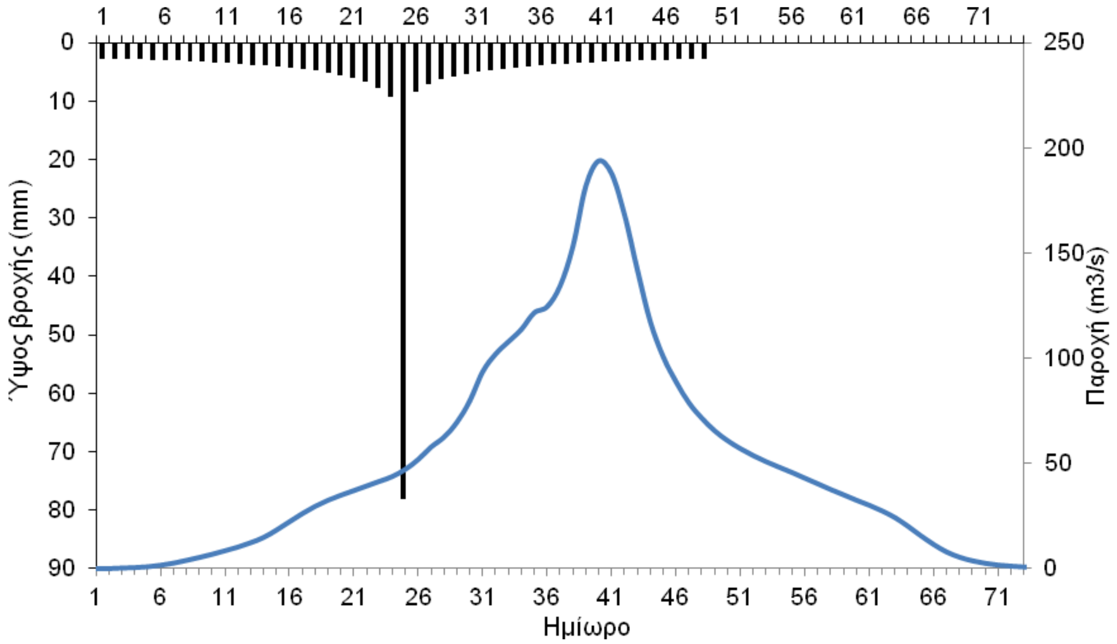



**Figure 6.1: Hyetograph (in black) and design hydrograph (in blue) for a 10,000-year return period of 24-hour duration.**

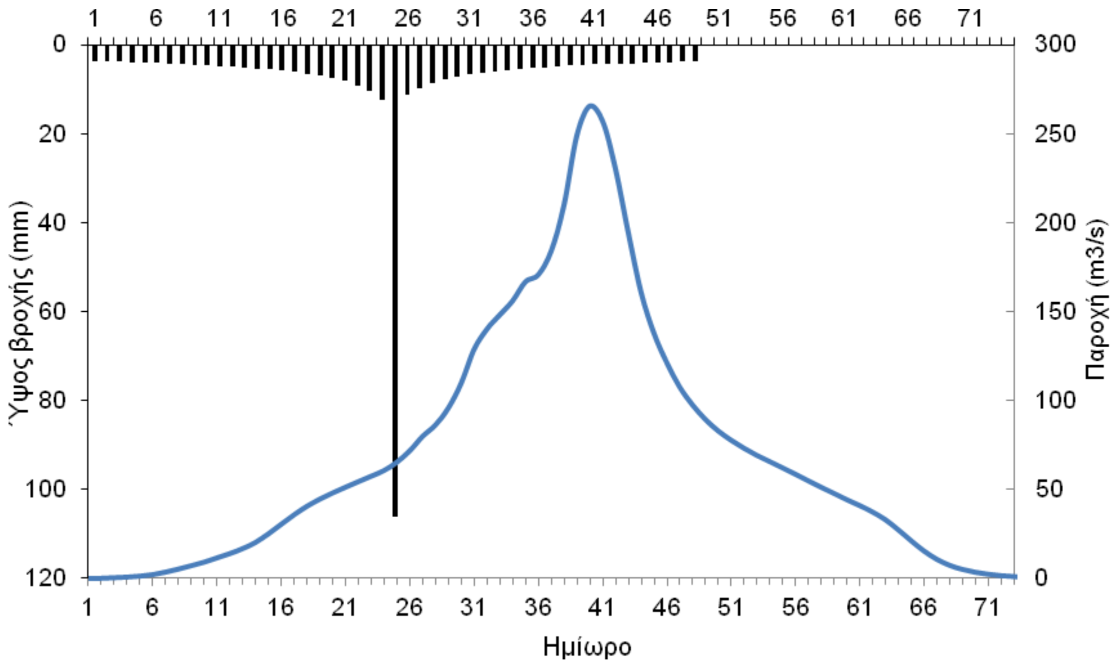
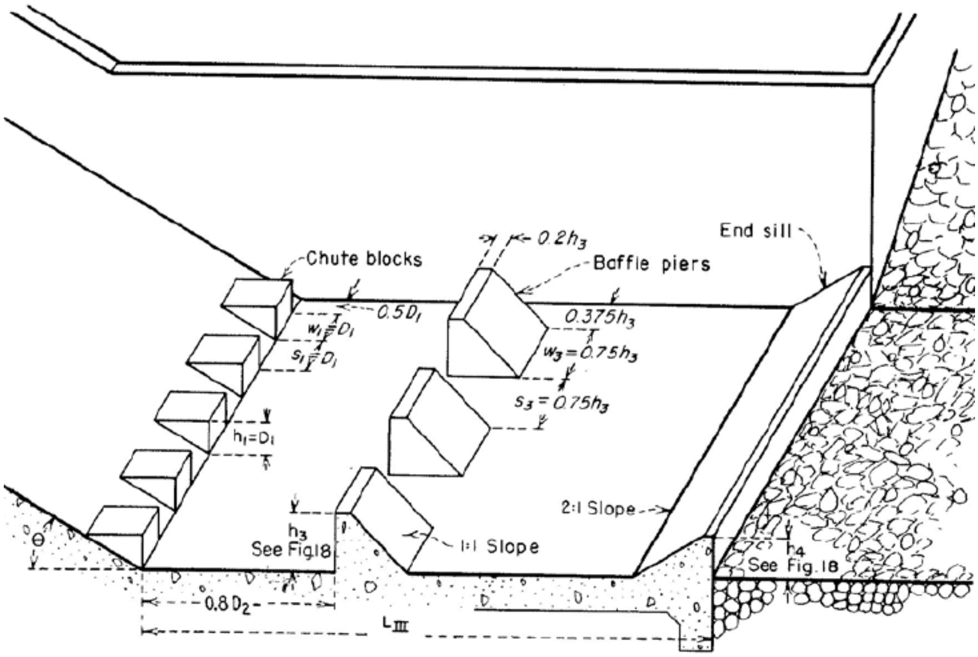



**Figure 6.2: Hyetograph (in black) and design hydrograph (in blue) for the Probable Maximum Precipitation (PMP) of 24-hour duration.**

### 6.1.1.2.10. Σχεδιασμός έργων Καταστροφής Ενέργειας

Τα έργα καταστροφής ενέργειας αποσκοπούν στην ομαλή παροχέτευση των πλημμυρικών παροχών στη φυσική κοίτη του χειμάρρου και συνεπώς δεν συνδέονται άμεσα με τον κίνδυνο υπερπήδησης του φράγματος. Για τον σχεδιασμό των έργων καταστροφής ενέργειας, τα οποία και, είναι συνήθης η επιλογή πλημμύρας μικρότερης από εκείνη που λαμβάνεται για τον καθορισμό της στάθμης στέψης του φράγματος και τον σχεδιασμό του υπερχειλιστή (Mason, 1993). Επιλέγεται η πλημμύρα περιόδου επαναφοράς Τ=10000 έτη. Η ίδια πλημμύρα λαμβάνεται υπόψη για τον υδραυλικό έλεγχο του ρέματος Μιναγιώτικο κατάντη του φράγματος. Όπως προκύπτει, η παροχή αιχμής είναι 193,9 m3/s για περίοδο επαναφοράς Τ=10000 έτη, ενώ το μέγιστο ημιωριαίο ύψος βροχής είναι 281,63mm.

Για τη διαστασιολόγηση της λεκάνης ηρεμίας και με βάση τα υδραυλικά δεδομένα της εισερχόμενης ροής επιλέγεται λεκάνη ηρεμίας Τύπου III σύμφωνα με το United States Bureau of Reclamation (USBR, 2012). Η λεκάνη ηρεμίας Τύπου III προτείνεται για περιπτώσεις όπου το υδραυλικό άλμα είναι καλά διαμορφωμένο (*F1*>4,5) και όπου η ταχύτητα *v1* της εισερχόμενης ροής είναι μικρότερη από 18,3m/s (=60ft/s). Το πλεονέκτημα της λεκάνης ηρεμίας Τύπου III είναι το μικρότερο μήκος της σε σύγκριση με άλλους τύπους λεκανών.




$$L = 5 * (y_2 - y_1)$$

and the resulting stilling basin length is 14.02 m – 14.00 m.
In addition, from the design nomographs, the dimensions of the dentations are also calculated as h1 = 0.65 m, h3 = 0.91 m, h4 = 0.81 m.

### 6.1.1.2.11. Diversion Works Design

For the dimensioning of the temporary diversion works of the stream during construction, flood events with return periods of T = 20 years and T = 50 years are usually considered.
For the selection of the appropriate return period T for the design of diversion works, the probability of occurrence of a flood event (risk – potential failure) is taken into account in relation to the operation period of the works n:

$$J = 1 - (1 - \frac{1}{T})^n$$

The usual operating period of diversion works is 3 to 5 years. Specifically, for a return period equal to T = 20 years and an operating duration of 5 years, the risk is 23%. Regarding diversion works, it is desirable that the risk be less than 25%. Within the framework of the Hydrological Study, both a return period equal to T = 20 years and a return period of T = 50 years (which corresponds to a risk of almost 10%) were examined. Ultimately, the flood hydrograph with a return period of T = 20 years was selected, with a peak discharge of 53.7 $m^3/s$, while the maximum half-hour rainfall depth is 83.68 mm.
Reservoir drawdown is carried out through the D900 steel pipe, which is also used for water intake. Elevation +95.0 constitutes the threshold of the drawdown and intake pipe and, therefore, the lowest operating level of the reservoir. The pipe operates under pressure from the maximum reservoir level of +122.00 down to the level of +95.00. The intake of the pipe and its initial section are placed on the right abutment of the reservoir. The pipe then, after forming a 60° angle, is positioned within the diversion conduit up to the valve house.

### 6.1.1.2.12. Water Intake Works Design

The intake pipe branches off from the drawdown pipe inside the valve house. The downstream section of the pipe from the valve house will be analyzed in detail during the Final Design of the dam and irrigation network of this contract. The dimensioning of the pipe is based on the maximum total required discharge, which according to Chapter 5 of the Hydrological Study "Sensitivity Analysis of the Water Balance" corresponds to the month of July and is calculated as follows:

- Total discharge in July: 2,559,239 $m^3$ (= irrigation 2,512,303 $m^3$ + water supply 27,331 $m^3$ + ecological discharge 19,604 $m^3$)

- Intake pipe discharge in August for 16-hour irrigation: 1.40 $m^3/s$.

A diameter of D900 is selected, corresponding to a flow velocity of 2.20 m/s. For the ecological discharge, a diameter of D300 is selected.

### 6.1.1.2.13. Hydraulic Control of the Stream Downstream of the Dam

The discharge for the hydraulic control of the Minagiotiko stream downstream of the dam is that considered for the design of the stilling basin, i.e. the flood discharge with a return period of 1:10,000, Q = 193.9 $m^3/s$. The control concerns the section of the Minagiotiko stream from the outfall of the flood spillway channel of the dam to approximately 400 m downstream, for which topographic data are available.
The calculation of the non-uniform flow is carried out using the standard step method, with the hydraulic mathematical model HEC-RAS of the U.S. Army Corps of Engineers. The results of the calculations are presented in Tables 12 and 13 of the Annex of the Preliminary Study.

### 6.1.1.2.14. Erosion Conditions

The lithological formations that compose the catchment area exhibit varying degrees of resistance to erosion phenomena, depending on their structure and qualitative characteristics.
According to the Geological Study, it is estimated that:
the largest proportion of the formations that compose or cover the area are formations with low to medium resistance to erosion, and

- the erosion products are mainly fine-grained clastic materials and, to a lesser extent, coarse-grained clastic materials.

To reduce the volume of sediments that will be transported/deposited in the Minagiotiko reservoir area, the construction of sediment retention terraces is proposed at selected locations upstream of the inundation limit. This issue will be examined in detail within the framework of the Final Design of the dam, which will follow in the next study phase of the project.

### 6.1.1.2.15. Stability Analysis

Within the framework of the Preliminary Design of the Dam, a stability check of the embankment was carried out, and the following conditions were examined:

1. Operation (without earthquake)
2. Operation (with earthquake)
3. Operation with surcharge (without earthquake)

4. Operation with surcharge (with earthquake)
5. Flood

During the analysis, the following loadings were applied:

- Self-weight
- Uplift
- Hydrostatic pressure (upstream)
- Earth fill thrust
- Earthquake

Based on the above loadings, the safety factors against sliding and overturning, as well as the ground stresses at the foundation of the dam, are determined in the following pages. As shown in the summary of Table 6.2 below, the safety factors are satisfied under all examined conditions.

**Table 6.2: Calculation Results**

| Condition | Analysis Method DA-3: Rd/Ed (> 1.0) | | |
|---|---|---|---|
| | **Sliding** | **Overturning** | **σmax (kPa)** |
| 1. Operation (without earthquake) | 1.20 | 1.67 | 701 |
| 2. Operation (with earthquake) | 1.25 | 1.65 | 815 |
| 3. Operation with surcharge (without earthquake) | 1.18 | 1.76 | 670 |
| 4. Operation with surcharge (with earthquake) | 1.20 | 1.73 | 790 |
| 5. Flood | 1.44 | 1.95 | 630 |

According to EN 1997-1:§6.5.3(12)R, if it is possible for water to infiltrate at the interface between the foundation and a non-drained clay subsoil, it must be verified that: **Rd ≤ 0.4Vd**.
Therefore, for the calculations, it is assumed that there will be a foundation improvement layer beneath the dam.

According to EN 1997-1:§6.5.3(10), the value of the friction angle (δ) at the foundation base interface may be taken equal to the value of the angle of internal friction at the critical state (ϕ′cv) in the case of foundation with cast-in-situ concrete, while any cohesion shall be disregarded. Since cohesion is disregarded and the foundation concerns rock formations, the angle of internal friction derived from the relevant assessments is considered to represent the estimate of the critical state friction angle.

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### 6.1.1.2.16. Occupation Zones – Road Works

#### 6.1.1.2.16.1. General

The occupation zones of the works include:

- the occupation zones of the dam body with the safety works, operating works, and access road works: namely, the dam body, spillway with stilling basin, gatehouse, outlet–water intake pipeline, road works, and the occupation zone of the reservoir area.

The occupation zones will be finalized after the definitive dimensioning of the works during the Final Design stage. The works mentioned above are shown schematically in Drawings 1.2, 2.1, and 3.1 of the Preliminary Design.

#### 6.1.1.2.16.2. Road Network of Dam Works

Local access to the dam, its ancillary works, and the reservoir will be provided through the construction of the following road works:

- Access road from the intake to the dam crest: width 8.50 m, length 460 m.
- Access road to the gatehouse: width 8.50 m, length 300 m.
- Access roads to the dam crest from the left and right abutments: width 8.50 m, total length 706 m.
- Crest road of the dam: width 6.50 m, length 165 m.

The horizontal alignments, longitudinal profiles, and cross-sections of these roads are presented in Drawings 2-1, 3-1 to 3.16.

The pavements will be constructed with gravel sub-base in two layers. In the case of surplus excavation products from pipeline trenches, rural roads may be constructed on low embankments in order to avoid the transportation of excavation products.

Specifically, for the crest road of the dam, it will follow the specifications of OMOE. It is recommended that pedestrian traffic on the sidewalk of the crest road be avoided. This sidewalk serves **only** for dam inspection purposes.

Additionally, during the Final Design of the networks, the proposed irrigation works will need to be complemented with rural roads that will ensure year-round access to all agricultural parcels, facilitate the movement of agricultural machinery, the transportation of products, and the operation and maintenance of the works. These rural roads will provide access and service to each irrigation unit.

#### 6.1.1.2.16.3. Proposed Supplementary Works

Within the framework of the Final Design of the dam, the following studies will also be carried out:

- Seismicity and seismic hazard study.
- Dam break analysis and flood wave propagation study.
- Study of road network restoration around the reservoir area.
- Further investigation of the foundation and sealing conditions upstream of the dam toe (plinth location)

### *6.1.2. Irrigation Network*

#### 6.1.2.1. Basic Principles of Irrigation Network Layout

The following data are based on the information of the preliminary report. For the purposes of the Environmental Impact Assessment (EIA), these were supplemented with further investigation regarding the main water transmission pipeline, the re-regulation tanks, and the irrigated zones. The irrigation network will be studied in the next phase according to the contract. The elements of this section concerning the irrigation network are therefore not final.

Within the framework of the Irrigation Networks Study, the areas to be irrigated and the irrigated zones are examined based on hydraulic criteria (elevations), land uses as they emerge from existing SCHOAP (Spatial and Urban Plans for Open Cities), and guidelines of the relevant regional and municipal services concerning the trends and development choices of the examined areas (tourism, secondary housing, etc.).
It should also be noted that when determining the irrigated areas, the proposed Delimichalis Dam was taken into account. This dam is located 2 km northwest of the settlement of Foiniki, on the homonymous stream. Using this information, the proposed irrigation zones were determined at this stage of the technical studies. These zones were presented in a joint meeting of the competent services of the Regional Unit of Messinia and the Ministry of Rural Development and Food (ΥΠΑΑΤ), and were approved. These zones are shown in Drawings GO_1 to GO-8 of this study.

In addition, the basic elements of the irrigation network were identified, namely the alignments of the main water transmission pipelines, pumping stations, and tanks. The rest of the irrigation network will be examined in detail at a later stage, during the Final Design of the networks.

In **Table 6.3** below, the areas of the zones and the total irrigated surface of the project are presented.

**Table 6.3: Irrigated Zone Areas**

| Zone | Area (stremmas) | Excluded Areas – Roads (stremmas) | Excluded Areas – Forests/Streams (stremmas) | Net Irrigated Area (stremmas) |
|---|---|---|---|---|
| Zone 1 | 19,600 | 290 | 500 | 18,810 |
| Zone 2 | 4,200 | 60 | 35 | 4,105 |
| Zone 3 | 2,700 | 40 | 0 | 2,660 |
| Zone 4 | 3,050 | 50 | 15 | 2,985 |
| Zone 5 | 6,700 | 100 | 160 | 6,440 |
| **Total** | **36,250** | **540** | **710** | **35,000** |

The total gross area within the perimeter of the irrigation networks under study is 36,250 stremmas, divided into the following categories:

- Roads: 540 stremmas
- Forests–Streams: 710 stremmas
- Net irrigated area: 35,000 stremmas

The irrigation networks serving the project area will be supplied with water from the reservoir of the Minagiotiko Dam through the main conveyance pipelines transporting irrigation water from the dam.

The main branch of the pipeline, made of steel pipe DN800, begins at the end of the dam's intake pipeline, has a length of approximately 410 m, and terminates at Pumping Station A1.

The sizing of the above irrigation water conveyance pipeline by gravity, according to the Dam's Preliminary Design, was carried out for an annual water withdrawal from the reservoir equal to 8,633,220 $m^3$.

The minimum intake level of the Minagiotiko reservoir is +95.00. Given that the study area extends up to the +240 contour line and the required pressure upstream of the intake is 35 m, it is not possible to supply the entire irrigation network by gravity.

Regarding the layout of the irrigation network, pumping stations will be provided for the supply of regulating tanks, from which the irrigation networks will be fed, while every effort will be made to supply the largest possible area by gravity.
In the selection of the routes for the irrigation network conveyance pipelines, the following criteria are taken into account:

- Alignment as much as possible beneath existing roads.
- Shorter route length.
- Alignment outside residential areas and through regions offering space for the deposition and storage of pipes and equipment.
- Route facilitating future maintenance and operational works.
- Avoidance of frequent crossings of national or other significant roads.
- Avoidance of natural obstacles (e.g., streams).
- Avoidance of unstable soils and steep slopes.

The study's provisions include the improvement of existing rural roads or the construction of new ones where required for the implementation of the proposed pipeline alignments.

In dividing the area into irrigation units, the following will be sought:
- Irrigation units shall include within their boundaries entire landholdings, and not parts thereof, to the extent feasible and where property boundaries are known.

The area of the irrigation units will be approximately 36 stremmas each. This criterion may be relaxed in certain cases where dictated by property boundaries, the morphology of the area, or natural/technical obstacles (streams, major transport works). Elevation differences within an irrigation unit will not exceed 4.0 m.

The water intakes for supplying each irrigation unit are generally designed as single inlets. Double inlets will only be required in exceptional cases. The positions of the intakes shall be defined to meet the following conditions:

- Located on a road or public right of way.
- Situated approximately in the center of the irrigation unit or at a point ensuring common access from the entire unit.

#### 6.1.2.2. Layout of Irrigation Water Conveyance Pipelines

The configuration of the conveyance pipelines and irrigation networks developed within the framework of this study provides for the creation of five independent irrigation zones as follows:

- **Zone 1 (northern):** Covers the section of the study area between the settlements of Pidasos and Kallithea. Its upper boundary to the north, east, and west is defined by the +180 contour line. Zone 1 extends southwards to the +152 contour line southeast of the settlement of Evangelismos. The irrigation network of this zone will be supplied by the regulating reservoir D1 by gravity.
- **Zone 2 (northeastern):** Covers the section of the study area east and southeast of the settlement of Kallithea. The eastern and upper boundary is defined by the +240 contour line, while the southern and lower boundary is the +180 contour line. The irrigation network of this zone will be supplied by the regulating reservoir D2 by gravity.
- **Zone 3 (central):** Covers the section of the study area with ground elevation higher than +180 of Zone 1, southeast of the settlement of Perivolakia and northeast of Evangelismos. The irrigation network of this zone will be supplied by the regulating reservoir D3 through a booster pumping station (booster 2).
- **Zone 4 (western):** Covers the section of the study area west of Zone 1, from the settlement of Perivolakia in the north to the settlement of Phoiniki in the south. The eastern and upper boundary is defined by the +152 contour line. The irrigation network of this zone will be supplied by the regulating reservoir D3 by gravity.
- **Zone 5 (southeastern):** Covers the section of the study area between the settlements of Vlasaiika, Exochi, and Giannoukakaika, as well as the area south of the Minagiotiko Dam reservoir up to the settlements of Lahanada and Foinikounta. The upper boundary of Zone 5 is defined by the +204 contour line. The irrigation network of this zone will be supplied by the regulating reservoir D4 by gravity. For the southern part of Zone 5, where ground elevations are higher at lower elevations (<+100), a pressure–flow control tank is foreseen to ensure the desired hydraulic head.

The regulating reservoirs D1, D3, and D4 will be supplied by pumping from Pumping Station A1 through main pressurized transmission pipelines. Reservoir D2 is supplied from Reservoir D1 via Booster Pumping Station 1. Detailed characteristics of the regulating reservoirs are presented in Table 6.4 below.

The main pressurized transmission pipeline from Pumping Station A1, constructed from steel pipes DN700 and approximately 880 m long, branches into two sections (at point J-1) that supply the three planned regulating reservoirs of the irrigation network zones.

The first branch (from J-1 to J-2) supplies regulating reservoirs D1 and D2 of Zones 1 and 2 and will be constructed with DN700 steel pipes of approximately 4,440 m total length. Reservoir D2 is fed via Booster Pumping Station 1. The pressurized pipeline (from J-2 to Reservoir D2) will be constructed with DN350 steel pipes of approximately 1,740 m total length.

The second branch (from J-1 to D3) supplies Regulating Reservoir D3 of Zones 3 and 4. This branch is approximately 2,966 m long and will be constructed with DN400 steel pipes. The irrigation network of Zone 3 is supplied from Reservoir D3 via Booster Pumping Station 2.

For supplying Regulating Reservoir D4 of Zone 5, a branch pressurized pipeline of DN450 steel pipes with a total length of approximately 6,480 m is foreseen, starting from the suction tank of Pumping Station A1 and ending at Reservoir D4.

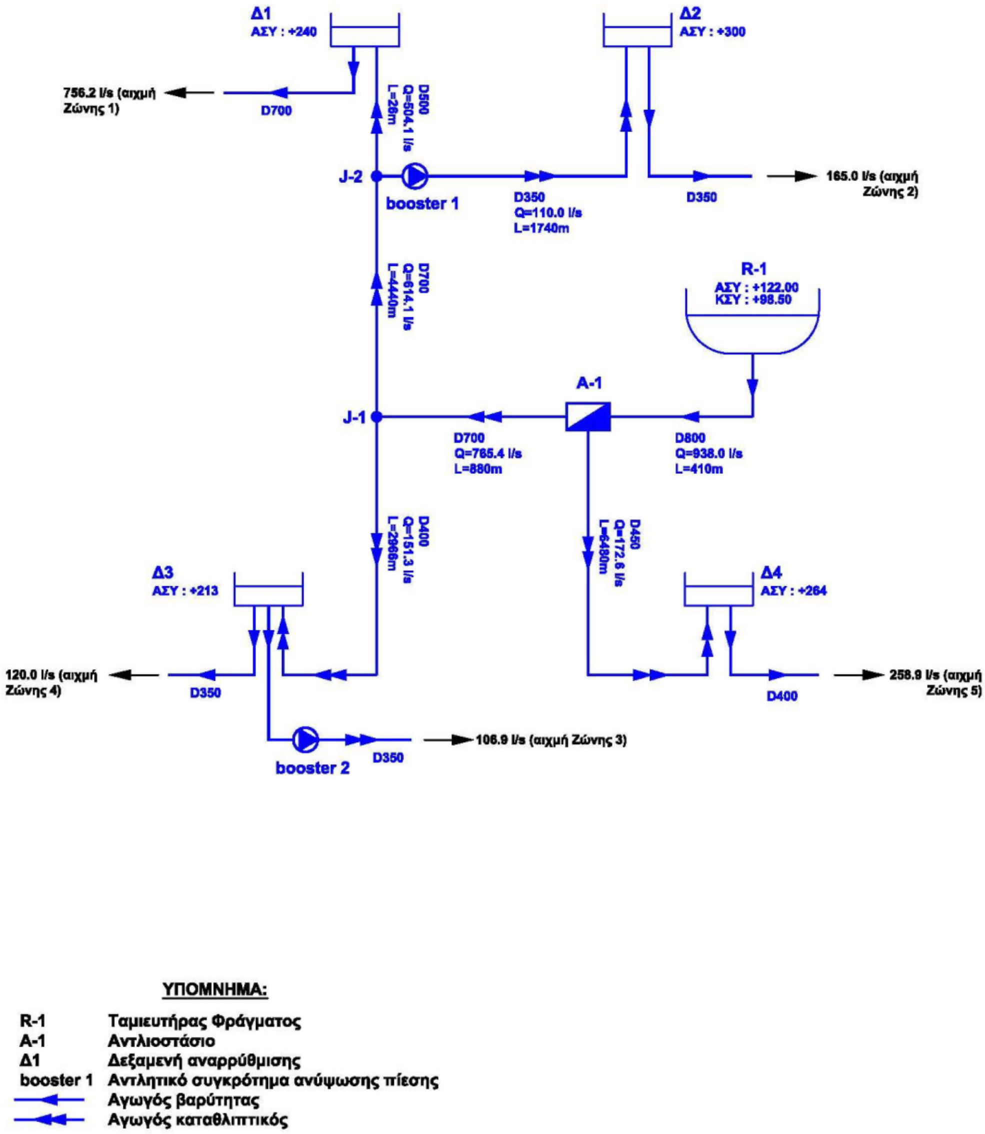
The schematic layout of the main pressurized transmission pipelines, with corresponding lengths and design discharges, as well as the basic characteristics of the regulating reservoirs, is presented in Figure 6.4 on the following page. The discharges of the transmission pipelines and the sizing of the regulating reservoirs correspond to the irrigation requirements of July.

The alignment of the main transmission pipelines is shown in the layout drawings (Plans GO-1 to GO-8) of the present study, and their main characteristics are presented in Chapter 3.1.2, Table 3.1, page 21, of this EIA.

#### 6.1.2.3. Pipe material and class

For the selection of the pipe material, an economic evaluation was carried out among four standard types of pipes: high-density polyethylene (HDPE), glass-reinforced polymer (GRP), steel, and ductile cast iron. In the comparison of the examined pipe materials, based on the Unified Price Lists (Circular 7-Δ11γ/ο/5/08-12/02/2013 – Ministry of Development, Competitiveness, Infrastructure, Transport and Networks), all installation costs were included, using February 2013 prices. For GRP pipes, an additional cost was applied to account for the manufacture and installation of special fittings and anchors, while for steel pipes, additional costs for the manufacture and welding of special fittings (bends, tees, etc.) were also considered.

**Figure 6.4: Schematic layout of main pipelines and reservoirs**




The investigation concluded that the most economical solution is to use:

- **PE pipes (PN12.5 and PN16)** for small diameters **110 ≤ DN ≤ 315**, and
- **Steel pipes** for diameters **350 ≤ DN ≤ 1000**.

The nominal pressure Pnom., i.e., the pipe class, must satisfy the condition: **Pnom. > P0**, where P0 is the maximum hydrostatic pressure at the examined pipe positions.

The difference Pnom.–P0 must provide a sufficient margin for the management of hydraulic transients.
The pressure class of the polyethylene pipes selected is **16 bar or 12.5 bar**, as imposed by the network topography.

### 6.1.2.4. Assumptions for Pipe Dimensioning

For the calculation of linear head losses in pipes, the **Darcy–Weissbach equation** is applied, with roughness coefficients according to **Colebrook**.
For maximum and minimum flow velocities and the absolute roughness of the internal pipe surface, the following guidelines are considered: Circulars Δ.22200/30-7-1977 and BM3/21417/17-8-1984 of the Ministry of Public Works.

- Absolute roughness: **0.1 mm** for polyethylene pipes, **1.0 mm** for steel pipes.
- Maximum permissible velocities range from **1.55 m/s to 2.50 m/s**, depending on the material and pipe diameter.

Additional assumptions:

- Kinematic viscosity of water at 10°C: **0.0131 $cm^2/s$**
- Increase of linear losses due to local losses: **+10%**
- Minimum required pressure immediately upstream of the irrigation intakes: **35 m $H_2O$**

### 6.1.2.5. Irrigation Network Pipes

The general layout of the irrigation networks follows the definition of the zones. As previously mentioned, the irrigation network is divided into five zones.

- For internal diameters **D ≥ 350 mm**, the pipes are constructed from **steel pipes St 37.2 according to DIN 17100**.
- For smaller diameters, the pipes are constructed from **3rd generation high-density polyethylene pipes (PE 100)**.
- The choice of pipe pressure class is determined by the network topography and will be **16 bar or 12.5 bar**.
- Fittings will be of **16 bar class**.

**Pipe installation:**

- Pipes of the irrigation networks will be installed under existing asphalt and dirt roads, in improved dirt roads, as well as in new rural roads.
- Minimum total cover of the pipes: **1.10 m**.
- **Steel pipes**: bedded on a sand layer of 15 cm for diameters up to D550, and 20 cm for larger diameters. Embedded to a height of 0.30 m above the crown with crushed quarry material. The remainder of the trench is filled with suitable excavation products, well compacted.

- **PE pipes**: bedded on a 15 cm sand layer and embedded in sand up to 0.30 m above the crown. The remainder of the trench is filled with suitable excavation products, well compacted.
- Surplus excavation products will be used as embankments in roadworks or transported to approved spoil disposal areas, or as otherwise specified in the Environmental Terms.

**Depth of installation:** as shallow as possible, in combination with respecting the minimum longitudinal slopes and minimizing the number of high and low points where air release valves and drain valves are placed.
Other factors affecting the pipe installation depth are crossings under or over obstacles, which may include existing ditches, roads, bridges, streams, public utility pipelines (ΟΚΩ), etc.

The minimum depth at which the pipes are proposed to be installed has been determined so that they have at least **1.10 m cover** from the top outer surface of the pipe; otherwise, their resistance to deformation, rupture, and uplift must be checked in relation to the expected mobile and permanent loads. In cases of small covers or crossings under a structure, the pipes will be embedded in concrete.

The pipe trench will have vertical slopes, and up to a depth of **1.25 m** it will not require support. Otherwise, the portion of the slope above 1.25 m from the excavation bottom will be sloped. If the excavation depth exceeds **1.75 m**, safety measures are required, such as trench wall support and possible groundwater pumping. For trenches deeper than 1.75 m, slope support is mandatory. In all cases, before starting the works, the Contractor must carry out trial excavations to assess the necessary safety measures.

Air must be removed from inside the pipe during operation. This is ensured by directing the flow toward higher points, where automatic removal through air valves will occur. Therefore, the installation of horizontal pipe sections is prohibited. The pipelines should have a minimum longitudinal slope of **2‰** for ascending branches (in the direction of flow) and **4‰** for descending branches (when the movement of air bubbles is opposite to the water flow). At high points of the pipeline route, air valves will be installed to remove accumulated air.

For the emptying of pipeline sections for repair, maintenance, or complete drainage during the winter, drain valves will be provided mainly at low local points of the longitudinal profiles of the pipelines. Pipe drainage is usually directed into adjacent streams, or wherever topographically feasible. Otherwise, drainage manholes will be provided.

#### 6.1.2.6. Regulation Reservoirs

To control the discharge and hydraulic head at the network heads of each Zone, a regulation reservoir is installed. Each reservoir is constructed in an excavation with vertical walls and a foundation slab of reinforced concrete **C20/25**. At the reservoir inlet, a manhole with a motorized butterfly valve is provided to control the operation of the supply pipeline.

Each reservoir also includes an **overflow pipeline** made of steel pipe and a **drain pipeline** of steel pipe **D200**. The operation of the drain pipeline is controlled by a butterfly valve installed in the intake-drain manhole.

The manholes are constructed of reinforced concrete **C20/25** and form an integral structure with the main reservoir. The drain pipeline meets the overflow pipeline downstream, through which both drainage and overflow discharges are conveyed to a suitable recipient. The intake-drain manhole also includes a motorized butterfly valve to control the operation of the intake pipeline. Inside the reservoir, a sump for drainage-intake is created to position the drain and intake pipelines at the appropriate level.

The reservoir areas will be fenced, and access to them will be provided via existing roads. The locations of the reservoirs are shown in the layout drawings **GO-1 to GO-8**, and their design parameters are presented in **Table 6.4** below.

#### 6.1.2.7. Control Devices and Safety Equipment

To ensure the possibility of isolating sections of the network for repair and maintenance purposes, control valves are provided at suitable locations. The control valves will be of the butterfly type and will be motor-operated for diameters D600 or larger, and manually operated for diameters smaller than D600. The typical valve chambers, depending on the diameters, will be made of C20/25 concrete, allowing inspection, maintenance, and easy replacement.

At the low points of the pipeline routes, drain valves are to be installed. Pipeline drainage will be directed into adjacent streams where feasible. Otherwise, combined drainage/overflow manholes will be provided. At the high points of the pipeline routes, air valves will be installed to remove accumulated air. All air valves will be placed within concrete chambers, allowing inspection and easy replacement.

It is also necessary to provide, at appropriate locations, surge relief valves to protect the network from the risk of pipeline rupture or disturbance of joints and fittings due to overpressures and/or underpressures. Furthermore, the installation of a flow meter on the intake pipeline in the dam area is recommended.

#### 6.1.2.8. Rural Road Network

The study area is crossed by a network of national, provincial, and municipal roads, which ensures satisfactory movement between the settlements. The existing **rural road network** covers basic needs for access to crops and the transport of agricultural products.

The proposed irrigation works must be complemented with rural roads that will ensure, throughout the year:

- access to all agricultural plots,
- movement of agricultural machinery,
- transportation of products, and
- operation and maintenance of the works.

The layout of the rural road network will be coordinated with the layout of the underground irrigation pipelines in order to facilitate the construction and maintenance of the pipelines, as well as access to intake points.

The proposed rural road network, where required, will include the **reconstruction of existing inadequate rural roads** and, locally, the construction of new ones. Roads with a **carriageway width of 5.0 m** will be ensured for the main transmission pipelines and for steel pipelines of the irrigation networks (diameter ≥ 350 mm). For smaller-diameter polyethylene pipelines, roads with a **carriageway width of 4.0 m** will be provided.

The road pavements will be constructed of **gravel base course in three layers** (one sub-base layer and two base layers). In cases where there are surplus suitable excavation materials from the pipeline trenches, rural roads can be constructed on **low embankments** to avoid transportation of excavation products.

#### 6.1.2.9. Borrow Pits and Disposal Sites

The construction of the irrigation networks includes the creation of trenches, generally of shallow depth, and the placement within them of the irrigation network pipes with appropriate bedding and embedding. It also includes rural road works and concrete structures (tanks and manholes).

The required aggregates for the implementation of the above works will be obtained from the areas of borrow pits L1 and L2, which have been identified and are proposed for licensing (see Chapter 6.2.1 of the present study), to cover the needs of the examined works (dam and networks), and in any case from existing legally operating quarries and sand-and-gravel extraction facilities.
The excavation products, which will mainly come from the trenches for the placement of the irrigation network pipes, will primarily be used for the backfilling of these trenches. The quantities that remain surplus will be used, provided they are deemed suitable, for the construction of rural roadworks.

Unsuitable or surplus excavation products will be disposed of as follows:

- in the rural roadworks of the project,
- in the surfacing of existing roads,
- for the restoration of the project's borrow pits,
- for the restoration of idle quarries or depleted quarry sections in the wider project area, and
- in legally authorized disposal sites for waste or inert materials, as well as for the restoration of former waste disposal areas.

### 6.1.2.10. Basic Agro-Technical Design Criteria of the Works

#### 6.1.2.10.1. Specific Irrigation Flows

The critical irrigation flows for the month of July, which are derived and taken into account for the design of the works, are as follows:

- **Specific flow (24-hour):** 0.0268 l/dl/str.
- **Specific flow (18-hour):** 0.0357 l/dl/str.
- **Specific flow (16-hour):** 0.0402 l/dl/str.

The maximum daily irrigation duration for the operation of the network is set at **16 hours**.

#### 6.1.2.10.2. Proposed Irrigation System

The application of **drip irrigation** is proposed. Drip irrigation applies water to a part of the soil, specifically to the root zone of the plant. The water flow from the drippers is very low, 2–4 liters per hour, resulting in all the water being absorbed by the soil without surface runoff.
The advantages of drip irrigation include:

- energy savings,
- water savings (25% compared to sprinkler irrigation and 50% compared to surface irrigation methods),
- reduction of weeds, and

- reduction of the risk of disease occurrence as a result of not wetting the crop foliage.

The efficiency of drip irrigation ranges between **85% and 95%**. Other advantages of drip irrigation include its suitability for irregular topography and sloping land, as well as its compatibility with automation systems.

A disadvantage of drip irrigation is the **increased initial installation cost** and the need for frequent inspection of filters and drippers to ensure proper operation of the system.

It is also noted that in the study area, drip irrigation is already a widespread irrigation method, and given the advantages mentioned, it is considered that there is no reason to change it.

**Table 6.4: Dimensioning of Regulatory Reservoirs**

| Irrigation Zone | Reservoir | Net Irrigated Area (stremmas) | July 24h Flow (l/s) | July 16h Flow (l/s) | Required Regulatory Volume (m³) | Reservoir Dimensions (m) | Reservoir Volume (m³) |
|---|---|---|---|---|---|---|---|
| Zone 1 (green) +180 | Δ1 | 18,810 | 504.1 | 756.2 | 14,518 | 70×45×5.5 | 17,325.00 |
| Zone 2 (orange) +240 | Δ2 | 4,105 | 110.0 | 165.0 | 3,168 | 45×30×3 | 4,050.00 |
| Zone 3 (turquoise) +213 | Δ3 | 5,645 | 151.3 | 226.9 | 4,357 | 45×30×4 | 5,400.00 |
| Zone 4 (purple) +153 | Δ3 | – | – | – | – | – | – |
| Zone 5 (pink) +204 | Δ4 | 6,440 | 172.6 | 258.9 | 4,971 | 45×35×4 | 6,300.00 |
| **Total** | – | **35,000** | **938.0** | **1,407.0** | – | – | – |

### 6.1.2.10.3 Size of Irrigation Unit – Intake Flow per Outlet

In the farms included in the study area, there is no uniform size of land parcels. Depending on the type of cultivation, the average parcel size ranges from 6 to 10 stremmas. Apart from the size of the parcels, the selection of the irrigation unit also took into account the differences in water requirements between crops, as well as the lack of homogeneity in crop composition across the different parts of the area.

It is proposed that the area of each irrigation unit be set at 36 stremmas. With the choice of an irrigation unit of 36 stremmas, the number of farmers per unit will not exceed 4–5. This number is considered satisfactory for the proper operation of the

network without conflicts between users. It is further proposed that the system be designed and operated with alternating outlet operation (every other one).
The intakes will be of a single outlet, with a flow rate of 6.0 l/s. This capacity can comfortably cover the water needs of the irrigation unit. The required specific irrigation demand for the critical month of July is calculated at 0.0402 l/s/stremma for 16-hour irrigation.

#### 6.1.2.10.4 Operating Pressure at the Outlet

The pressure required for the operation of drip irrigation emitters is 1.0–1.5 bar. The required pressure at the outlet of the intake and control unit of the irrigation network is taken as 2.5 bar, considering losses in the application pipelines up to the emitters and possible elevation differences within the irrigation unit.
The pressure at the intake entrance is taken as 3.5 bar, considering losses in the intake and control unit.

#### 6.1.2.10.5 Irrigation Intakes

Water distribution to the irrigation units is foreseen through single-outlet intakes, each with a nominal flow of 6.0 l/s. Double-outlet intakes will be required only in isolated cases.
The positions of the intakes shall be defined to meet the following conditions:

- Location on a road or common access path.
- Location approximately at the center of the irrigation unit or at a point ensuring communal access from the entire unit.

Each intake outlet will operate with an electronic pre-paid card system. The card will open the flow valve, and units will be deducted based on consumption. Card charging will be carried out at the Project Management Authority, with the consumer paying the corresponding fee. The card reader at the intake will include a screen displaying the remaining units. The cards will be unique to each intake, corresponding to a single irrigation unit.
The pressure required for the operation of drip irrigation emitters is 1.0–1.5 bar. The required pressure at the outlet of the intake and control unit of the irrigation network is taken as 2.5 bar, considering pipeline losses up to the emitters and possible elevation differences within the irrigation unit. The intake entrance pressure is set at 3.5 bar, considering losses in the intake and control unit. Permanent pressure reducers are therefore foreseen.
The irrigation intakes will include:

- A main body with diameter DN 100 mm, of suitable length so that the outlet is located approximately 0.30 m above ground level.
- A pressure reducer.

- Flow limiter of 6.0 l/s or 12 l/s (single or double outlet).
- Anti-frost protection with automatic safety valve.
- Flow meter (analog, for total volumetric consumption).
- Automatic electronic valve with pre-paid card system at each intake.
- Quick coupling socket at the end of each outlet.
- Opening–closing control (handwheel) with such a step that full opening or closing is achieved in more than 6 seconds.

The intake will be protected by a cylindrical manhole of internal diameter 1.20 m, made of reinforced concrete. The intakes are generally placed approximately in the middle of the side of the irrigation unit if the terrain and agricultural road network allow; otherwise, for network economy, they are placed at the edge. Each intake corresponds to one irrigation unit. The final definition of the unit boundaries will be made by the Managing Authority in consultation with the farmers.

#### 6.1.2.11. Expropriations, Permanent and Temporary Land Occupations of Works

In areas where common-use zones are insufficient for the construction of the proposed works (irrigation network with manholes, reservoirs, and rural road network), zones of permanent occupation of the works are required.

In the pipeline installation zones, an additional strip of temporary occupation 10 m wide is required for the lateral temporary storage of excavation materials.

Before the construction of the works, the Supervising Authority or other competent body will undertake the necessary procedures for expropriation and implementation on the ground of the public-use zones for roads, pipelines, and reservoirs. Also, prior to construction, the necessary procedures will be carried out to make available to the Contractor the zones of temporary occupation for pipe laying and storage of excavation materials adjacent to the trench. For temporary occupations, the cost of compensation for “standing crops” will also be foreseen.

For this reason, and because such procedures are generally time-consuming, the Contractor shall expedite the studies that will determine the areas to be expropriated for the construction of the works. These procedures will be taken into account in the construction schedule.

The boundaries of the areas to be expropriated shall be marked on the ground, before the start of works, with permanent stakes visible from a distance. Where required, following approval by the Authority, the permanent expropriations will be fenced with wire mesh.

### *6.1.3. Land Consolidation (Reallocation of Land Parcels)*

In general, in the case of land reclamation projects, mandatory land consolidation is foreseen under Legislative Decree 674/77. During the consultation meetings held with local authorities and the supervising authority of the study (Ministry of Rural Development and Food) regarding the projects under consideration, the issue of land consolidation was examined and excluded due to the widespread presence of perennial crops (olive groves, etc.). This decision is further supported by the fact that no other drainage or flood protection works will be carried out, which would otherwise make the application of land consolidation imperative.

#### *6.1.4. Arrangement for Ensuring Ecological Flow*

The determination of ecological flow is a critical parameter involved in the calculation of the water balance of the hydrological basin and in the design of the works of the Minagiotiko dam. The calculation of the required flow is provided in Chapter 6.6.2.7 below. The proposed arrangement for the continuous and unobstructed flow of the ecological discharge is presented in the previous Chapter 6.1.1.2, within the section *Design of Intake Works* and in drawings 3.1.1., 3.9, and 3.10. With the proposed arrangement, the ecological flow is ensured with a steady discharge for all months of the year, including the traditionally “dry” months of July, August, and September.

## 6.2. Supporting Construction Facilities, Borrow Pits, Spoil Disposal Areas

### *6.2.1. Borrow Pits*

#### 6.2.1.1. Research Background – Requirements for Borrow Materials

During the preparation of the Preliminary Design of the Minagiotiko dam, and taking into account the elements of the supporting works, the Design Team investigated technically and economically the solution of an earth dam, while also examining alternative dam types. Within the present Preliminary Design, the following criteria were highlighted as critical for the design and selection of the dam type:

- the qualitative suitability and quantitative adequacy of construction materials for the dam (support body materials, core materials, filter and drainage gravel, rockfill, concrete aggregates, etc.),
- the foundation conditions,
- the existing possibilities for the construction of the spillway,
- the seismicity of the wider area and its possible impact on the project.

Based on this consideration, the geological investigation was oriented towards identifying possible borrow pits for the production of the materials required for the construction of either:

- an earth dam with a central clay core, or
- a gravity dam of roller-compacted concrete (lean RCC).

**i) Dam Type: Earth Dam with Central Clay Core**

For the construction of this type of dam, according to initial estimates of the hydraulic study (*Volume of Preliminary Measurements – Preliminary Design Budget*), the following are required:

- Clayey materials for the construction of the core: Estimated volume approx. 92,100 $m^3$.
- Sand-gravel materials for the construction of filters and drains: Estimated volume approx. 39,350 $m^3$ and 29,400 $m^3$, respectively.
- Granular or rocky materials for the construction of support bodies and external protection zones: Estimated volume approx. 530,000 $m^3$ and 24,000 $m^3$, respectively.

The required materials from borrow pits for the construction of the earth dam total **898,125 $m^3$ = (39,350 + 29,400 + 530,000 + 24,000) × 1.5**.

**ii) Dam Type: Gravity Dam of Roller-Compacted Concrete (lean RCC)**

For the construction of this type of dam, according to initial estimates of the hydraulic study, the following are required:

- Rocky materials for the construction of the dam embankment: Estimated volume approx. **196,000 × 1.5 = 294,000 $m^3$**.

It is noted that the *macroscopically estimated* qualitative characteristics of the rock materials, which can be used for the construction of the supporting embankments of an earth dam as well as for a “hardfill” type dam, are common. For this reason, the geological investigation focused on:
a) identifying borrow pits for soil materials and borrow pits for rock materials, and
b) attempting to assess—using macroscopic criteria—the qualitative suitability and adequacy of these materials for each intended use.

The geological investigation for locating the required construction materials for the dam was carried out within the reservoir basin area and extended to the wider surrounding area around the project site. Within this scope, ten (10) sites with soil formations inside the reservoir basin were delineated (borrow pits coded D-1 to D-10, drawing GM-12), as well as four (4) sites with rock formations in the wider project area (borrow pits coded L-1 to L-4, drawing GM-11).

Specifically:

a) In the reservoir basin area, the following soil materials were investigated:

- **Recent and older fluvial deposits**, as encountered along the wider bed of the Minagiotiko stream and its tributaries. Within these deposits, borrow pits D-1 to D-7 were delineated and subsequently investigated.

- **Colluvial deposits / scree and landslide materials**, occurring as strips at the base of the reservoir basin abutments. Within these materials, borrow pits D-8 and D-9 were delineated and subsequently investigated.
- **Pliocene deposits**, which cover the largest part of the reservoir basin. Based on geological mapping and macroscopic descriptions of the materials, borrow pit D-10 was delineated and subsequently investigated.

b) In the wider area, within the catchment basin or its periphery, the following formations were investigated: **limestone formations, Messinian conglomerates, and flysch formations where the sandstone/conglomeratic phase predominates**, since the argillaceous flysch formations are not suitable as construction materials for a rockfill dam or a "hardfill" type dam.

#### 6.2.1.2. Borrow Pits of Soil Formations

The soil formations covering the wider area of the reservoir basin include: Pliocene deposits and their colluvium, recent and older alluvial deposits, and colluvial and landslide materials of the flysch formations.

Based on visual observation of the above formations and the relatively short transport distance of the eroded materials, it is estimated that the soil formations have a silty composition and a low plasticity index. For the detailed assessment of the qualitative suitability and quantitative adequacy of these materials, borrow pits D-1 to D-10 were delineated.

A brief description of these borrow pits follows, taking into account the results of the geotechnical investigation:

**i) Borrow Pit D-1a**

Borrow pit D-1a is located in the wider bed of the stream immediately upstream of the dam and has a total area of 5,000 m².

**ii) Borrow Pit D-1**

Borrow pit D-1 is located in the wider bed of the stream immediately upstream of borrow pit D-1a and has a total area of 68,000 m².

**iii) Borrow Pit D-2**

Borrow pit D-2 is located along the bed of the main branch immediately after its confluence with a secondary branch coming from the east. Its total area is 23,500 m².

**iv) Borrow Pit D-3**

Borrow pit D-3 is located in the wider bed of the NE branch of the Minagiotiko stream up to the end of the reservoir basin. Its total area is 174,000 m².

**v) Borrow Pit D-4**

Borrow pit D-4 is located in the uppermost part of the NW branch of the Minagiotiko stream, in the section where the flow direction is from W to E. Its total area is 53,000 $m^2$.

**vi) Borrow Pit D-5**

Borrow pit D-5 is located in the central part of the NW branch of the Minagiotiko stream. Its total area is 20,000 $m^2$.

**vii) Borrow Pit D-6**

Borrow pit D-6 is located in the wider area of the eastern branch of the Minagiotiko stream. Its total area amounts to 70,000 $m^2$.

**viii) Borrow Pit D-7**

Borrow pit D-7 is located in the wider bed of the eastern branch of the Minagiotiko stream and, more specifically, in the wider bed of the easternmost branch. Its area amounts to 20,000 $m^2$.

**ix) Borrow Pit D-8**

Borrow pit D-8, located at the lowest part of the left abutment of the most downstream section of the reservoir, is composed of mixed-phase materials, i.e. colluvium and alluvial deposits. Its area amounts to 42,000 $m^2$.

**x) Borrow Pit D-9**

Borrow pit D-9, located on the left slope of the eastern branch of the Minagiotiko stream, consists of colluvial materials of the Pliocene formations. It is noted that borrow pit D-9, according to verbal information, had been previously investigated for its suitability as a borrow pit for brick production. It was abandoned due to its high content of gravel and rock fragments. Its area is about 22,000 $m^2$.

**xi) Borrow Pit D-10**

Borrow pit D-10 was excavated in Pliocene formations, which macroscopically consist of clayey silts with few gravels. Its area is about 52,000 $m^2$.

6.2.1.3. Borrow Pits of Rock Formations

**General Consideration**

This group includes the Borrow Pits coded L1, L2, L3, and L4, which are located in the wider area, around the project site.

From the macroscopic/visual inspection carried out during the geological mapping and delineation of these Borrow Pits, the qualitative characteristics of the rock formations in these areas were assessed. Specifically:

**i) Borrow Pit L1**

The area of Borrow Pit L1, located at a straight-line distance of approximately 6.0 km NW of the project site, in particular near the settlement of Arapolakko, is composed of limestone formations of the Gavrovo–Pylos geotectonic zone.

According to the IGME geological map, these formations are of Eocene–Paleocene age, are thick-bedded, gray to whitish-gray, exhibit a bituminous odor upon fracture, and alternate with dolomitic layers.

The exact location of the borrow pit on the ridge of the aforementioned formations has not yet been determined and will be finalized within the framework of the TEPEM (Environmental Impact Technical Study). Borrow Pit L1 is proposed for further geotechnical investigation, in order to determine the qualitative suitability of the limestone formations as materials for the construction of the dam's supporting embankments and protection zones, as well as for use as concrete aggregates.

Within this investigation, special attention is required for the study of the mineralogical composition of these formations, since the presence of bituminous material and dolomites results in a degradation of the qualitative properties of the limestone. The volume of limestone formations in this area is very large and, therefore, there is no issue of quantitative adequacy.

**ii) Borrow Pit L2**

The area of Borrow Pit L2, located at a straight-line distance of approximately 1.0 km SSE of the project site, specifically between the settlements of Vlassaiika and Lahanada, is composed of the conglomerates of Messinia.

According to the IGME geological map, these formations belong to the Gavrovo–Pylos geotectonic zone, are of Eocene–Oligocene age, are strongly cemented, polymictic, with pebbles/cobbles derived from rocks of the Olonos–Pindos zone. In more recent publications, they are referred to as the Messinia conglomerates.

The exact location of the borrow pit on the ridge of the above-mentioned formations has not been determined and will be finalized within the TEPEM framework. Borrow Pit L2 is proposed for further geotechnical investigation, in order to determine the qualitative suitability of the conglomerate formations as materials for the construction of the dam's supporting embankments and potentially for the protection zones. The volume of conglomerate formations in this area is very large and, therefore, there is no issue of quantitative adequacy.

**iii) Borrow Pit L3**

The area of Borrow Pit L3, located at a straight-line distance of approximately 5.0 km NNE of the project site, specifically in the area of the settlement of Kato Ampelokipoi, is also composed of the Messinia conglomerates.

These formations have the same characteristics as the conglomerates of Borrow Pit L2. Borrow Pit L3 is proposed for further geotechnical investigation, in order to determine the qualitative suitability of the conglomerate formations as materials for the construction of the supporting embankments and potentially for the protection zones of the dam.The volume of conglomerate formations in this area is also very large and, therefore, there is no issue of quantitative adequacy.

**iv) Borrow Pit L4**

The area of Borrow Pit L4, located at a straight-line distance of 0.4 km WSW of the project site, specifically on the right abutment of the Minagiotiko downstream of the dam site, is composed of flysch formations.

According to the IGME geological map, this formation belongs to the Gavrovo–Pylos geotectonic zone, is of Eocene–Oligocene age, and consists of alternations of sandstones and shales.

Borrow Pit L4 is not proposed for further geotechnical investigation, since there is a risk of instabilities occurring during the excavation of these formations.

#### 6.2.1.4. Criteria for the Selection of Borrow Pits

The selection of the most suitable/appropriate Borrow Pits will be made after a comparative evaluation, based on certain criteria, such as:

- the qualitative suitability of the materials, following the execution of the required laboratory tests,
- the distance from the Project area,
- access conditions,
- ease of transport,
- construction scheduling (simultaneous or not implementation) of the dam works and the irrigation network, taking into account their rehabilitation,

- potential problems that may arise during the development and exploitation of the borrow pit and/or quarry, and
- the optimal restoration of the environment.

### *6.2.2. Disposal Areas*

#### 6.2.2.1. Required Disposal Sites – Volume of Materials

The estimated excavation volume for the construction of a dam of the "lean roller-compacted concrete" type is approximately **196,000 m³**, plus **15,400 m³** from the excavations of roadworks.

These materials may be used—partly—for the construction of the stability-enhancing embankment of the dam's left abutment. Since the design of this embankment will be carried out within the framework of the Final Design of the Project, the exact volume of surplus materials to be transferred to the disposal area is not yet known. In total, the disposal volume of materials is estimated at approximately **260,000 m³**.

#### 6.2.2.2. Criteria for the Selection of Disposal Areas

The main criterion for selecting the disposal sites of excavation products resulting from the construction of the Project is the **environmental restoration** of the areas that will be chosen as rock quarries for the construction of the dam's supporting bodies and other zones.
This choice has the disadvantage of requiring double loading–unloading of the materials, since the excavation for the dam foundation will precede the quarry excavation.
Based on this reasoning, it is considered that the selection of Disposal Areas will be made after the completion of the geotechnical/laboratory investigations and the selection of the most suitable/appropriate rock quarrying areas.

It should be noted that, from the investigation conducted to identify other suitable locations on the abutments surrounding the reservoir basin, no suitable site was found for the disposal of these materials, since the entire area consists of a large continuous olive grove or is covered by forest/shrub vegetation.
The criteria used in this investigation include:

- morphology,
- land use,
- distance/access conditions/ease of transport, and

- potential stability problems that might be caused by the disposal of these materials.

Part of the excavation products may be used for the construction of the proposed embankment to reinforce the left abutment of the dam. This issue will be further examined within the framework of the Final Design of the Project.

### *6.2.3. Summary*

Within the framework of the geological investigation (Drawings GM-11, GM-12.1, and GM-12.2), the Borrow Pits of soil formations (D1 to D10) and rock formations (L1 to L4) were identified and delineated.
The following elements summarize the selection of Borrow Pits/Quarries and Disposal Areas.

#### 6.2.3.1. Borrow Pits

For the investigation of soil materials for the construction of the impermeable core and the filters/drains of the earth dam, the following were selected:

- Borrow Pits D1 to D7, located within the reservoir basin and specifically in the river terraces of the Minagiotiko torrent and its other major tributaries/streams, as well as
- Borrow Pits D8, D9, and D10, located on the abutments of the reservoir basin and specifically in the formations of the mixed phase (Pliocene colluvial deposits – weathered material and older fluvial deposits).

From the evaluation of the data and the results of the geotechnical investigation carried out on these borrow pits, the following conclusions were drawn:

- There is a surplus of fine-grained materials suitable for the construction of the dam core. These materials can be obtained—preferably—from Borrow Pits D-6, D-7, D-9, and D-4 (total volume: **457,000 m$^3$**), and subsequently from the other borrow pits, except Borrow Pit D-10. The priority selection is due to the fact that the materials of these borrow pits present better qualitative characteristics.
- There are no materials of known volume and satisfactory granulometric grading for the production of filters and drains. The materials identified in the reservoir basin have a local character, as they were not found in all locations. It is also noted that, where such materials were found, they constituted the deeper horizon, and therefore excavation of the overlying layers would be required. The identified materials are clayey/silty (since the passing material through No200 sieve is between 21% and 41%), meaning processing such as screening or washing would be required, and their thickness is unknown.

For the investigation of rock materials for the construction of the supporting bodies and the protection zones of the rockfill dam, as well as aggregate materials for the construction of the “lean roller-compacted concrete” dam, the following were selected:

- Borrow Pit L1, located approximately 6.0 km NW of the Project site, in the area of the settlement of Arapolakka. This area consists of limestones with a thick-bedded structure, bituminous odor upon fracture, and alternations with dolomites.
- Borrow Pit L2, located approximately 1.0 km SSE of the Project site, between the settlements of Vlasaiika and Lachanada. This area consists of strongly cemented, polymictic conglomerates of the flysch formation.
- Borrow Pit L3, located approximately 5.0 km NNE of the Project site, in the area of the settlement of Kato Ambelokipoi. This area also consists of conglomerates, with characteristics similar to those of Borrow Pit L2.
- Borrow Pit L4, located in flysch formations (alternations of sandstones/siltstones) at a distance of approximately 0.4 km WSW of the Project site, specifically at the right abutment of the Minagiotiko downstream of the dam location.

The materials that can be obtained from the above borrow pits show **quantitative sufficiency for each intended use** in both types of dam construction.

It is proposed that both sites L1 and L2 be accepted and licensed for reasons of construction flexibility and functionality, since the valley of the stream lies between the dam and the irrigation network, and without an appropriate bridging structure, the transport of materials from these sites to the project area would not be possible. From site L1, it is not easy to transport materials to the dam site, but it is possible to supply the needs of the irrigation network. Conversely, from site L2, it is not easy to transport materials to the network construction areas north and west of the dam site and the valley, without significant detour; however, it is deemed appropriate for the supply of materials for dam construction, as it is located at one-sixth of the distance of L1. Furthermore, if the irrigation networks and the dam are not constructed simultaneously, the same borrow pit cannot be used as a disposal site with simultaneous restoration, as mentioned above.

#### 6.2.3.2. Disposal Areas

The main criterion for the final selection of disposal areas is the environmental restoration of the regions selected as rock quarries.

Although this option has the disadvantage of double loading/unloading of excavation materials, it is considered necessary.
Consequently, the restoration of the borrow pits, in combination with what was mentioned in the previous section, will be carried out primarily with surplus excavation materials, while the remaining quantities will be used for the surfacing of the rural road network of the entire irrigated area.
It is also noted that part of the excavated materials may be used for the construction of the berm/embankment to reinforce the stability of the left abutment of the dam.

## 6.3. Connections with the Road Network and Infrastructure Networks

The examined works will be implemented in a rural area outside major infrastructures, and no significant interference is identified.
Specifically, the dam will be constructed near the settlement of Vlasaika, on the stream. Existing roads, mainly rural or forest roads, will be used for access to the construction sites. In some areas, new access roads will be added, leading to the construction site. (Drawing 1.2 and Drawing 3.1.1.)
At the end of the project, full restoration of the road accesses will be carried out in all locations where interruptions occur due to the works and the reservoir of the dam.
As for the network of main water transmission pipelines, from the dam to the irrigation zones, it will follow, as far as possible, the existing road network and will be installed beneath it, while in certain areas where a different route must be followed, new road sections will be created at the surface and handed over for use by the local community.

## 6.4. Construction Phase

### *6.4.1. Dam*

#### 6.4.1.1. Construction of the Minagiotiko Dam (Proposed Solution)

After the contractor's installation, the construction works of the Dam will begin with the clearing of the foundation surface of the works, which will include shrub removal, cutting and uprooting of trees in the reservoir basin, general excavations, and the necessary earthworks shaping in the dam area. The total quantities of earthworks are presented in detail in the table on the following page, for the two dam types and for the construction of the main water transmission pipelines.

<u>IRRIGATION NETWORK – EARTHWORKS BALANCE ($m^3$)</u>

| DESCRIPTION OF WORK | EARTH EXCAVATIONS | ROCK EXCAVATIONS | EMBANKMENTS WITH EXCAVATION PRODUCTS | SURPLUS MATERIALS |
|---|---|---|---|---|
| | Dam Type | Dam Type | Dam Type | Dam Type |
| | Earthfill | RCC | Earthfill | RCC |
| DAM | 147,030 | 64,700 | 311,900 | 149,900 |
| ROADWORKS | 16,050 | 15,900 | 5,300 | 5,300 |

IRRIGATION NETWORK – EARTHWORKS BALANCE ($m^3$)

| | SOIL EXCAVATIONS 90% | ROCK EXCAVATIONS 10% | EMBANKMENTS WITH EXCAVATION PRODUCTS | SURPLUS MATERIALS |
|---|---|---|---|---|
| **IRRIGATION NETWORK (zone area 35,000)** | 315,000 | 35,000 | 182,700 | 167,300 |

REQUIREMENTS OF SANDY-GRAVEL MATERIALS AND AGGREGATES FROM QUARRIES ($m^3$)

| DESCRIPTION OF WORK | ROCKFILL FROM BORROW PITS FOR EMBANKMENTS | AGGREGATE MATERIAL FROM BORROW PITS FOR EMBANKMENTS | AGGREGATE MATERIAL FROM BORROW PITS FOR CONCRETE | TOTAL MATERIAL FROM BORROW PITS |
|---|---|---|---|---|
| | Dam Type | Dam Type | Dam Type | Dam Type |
| | Earthfill | RCC | Earthfill | RCC |
| DAM | 25,740 | 1,740 | 898,125 | 294,000 |
| ROADWORKS | - | - | 18,200 | 18,200 |
| NETWORK | - | - | - | - |

The construction works will commence with the erection of the cofferdam/embankment upstream of the dam site. For the construction of the cofferdam/embankment, excavation works and other earthworks will precede (excavation, loading/unloading, foundation preparation, transport and placement of excavation products), followed by embankment construction using suitable materials in accordance with the provisions of the Final Design.

Excavation works, according to the data of the Geological and Geotechnical investigations presented in Chapter 8.4.5, are expected to proceed smoothly and be carried out using conventional mechanical equipment (bulldozers D6, D7, or D8 and hammer use for prior loosening of harder formations – ripping), as confirmed in practice during excavations performed for access to the exploratory drilling sites.

The construction of the diversion conduit will follow. For the diversion conduit, excavation works and other earthworks will precede (rock foundation preparation, loading/unloading, transport of excavation products, trench backfilling, etc.). This will be followed by pipe installation, concreting of the relevant structures, the required embankments, and the installation of intake pipelines.

Next will be the excavation of the plinth, with excavation works and other earthworks (excavation, loading/unloading, foundation preparation, transport and placement of excavation products). Simultaneously, construction of the intake structure will begin, including the relevant earthworks and associated concrete works.

Subsequently, construction of the plinth will take place, which may begin before completion of its excavation, with part of it executed in parallel with the construction of the dam body. The plinth construction works will be performed according to the provisions of the Final Design. Prior to completion of these works, installation of intake pipelines may also be carried out.

Grouting works for sealing the plinth will partly be carried out in parallel with the dam body construction and may begin before the plinth construction is finalized. These works will include drilling of holes, grout injection tests, and grout injection.

Construction of the dam body will follow. Subsequently, the upstream sealing works of the dam body will be executed. A detailed topographical survey of the upstream surface will precede, followed by shaping of the final surface. The works will be completed with concreting and final shaping of the crest wall.

In parallel, construction of the spillway and the bridge over it will be completed, including shaping and concreting works. Finally, dam roadworks, crest safety features (guardrails, lighting, etc.), and other remaining works will be completed. With the completion of the dam body construction, monitoring instruments will be installed in accordance with the Final Design provisions.

The construction of the control building and the connection of the intake and drainage pipelines can be carried out in parallel with the plinth grouting works. These works will include excavation and other earthworks (excavation, loading/unloading, foundation preparation, transport and placement of excavation products), construction of concrete structures, and building works of the superstructure. The construction will be completed with the interconnection of the intake and drainage pipelines and the installation of operating and control devices.

The sequence of the above works is indicative and will be finalized during the preparation of the Tender Documents, depending on the provisions of the Final Design.

#### 6.4.1.2. Project Timeline

For the purposes of this study, the construction of the project is estimated to have commenced in 2019 and to be completed by the third quarter of 2022. The sequence of phases is included in Table V.1 of the Appendices of the Geo-Technical Report, while the detailed schedule is attached in Figures 6.5 and 6.6 on the following pages.

The project will comprise the construction of the dam, installation of the main pipelines, construction of the network, construction of reservoirs, pumping stations, manholes, etc., and the installation of the electromechanical equipment required for the project's operation.

In parallel with the implementation of the project, starting in 2021, the phase of adaptation of agricultural holdings is also expected to begin, along with the establishment of the Service that will be responsible for the operation of the irrigation network.

Both the adaptation of agricultural holdings and the operation of the network will continue throughout the amortization period of the dam.

#### 6.4.1.3. Proposed Scheduling of Irrigation Network Construction

The precise determination of the project execution schedule naturally falls under the Contractor’s scope. The indicative sequence of works presented below may be modified depending on the provisions of the Final Design.

It is, however, considered appropriate to provide some useful guidelines for selecting the order of priority for construction. For the smooth progress of the works, it is preferable to tender the dam and the irrigation network as a single contract.

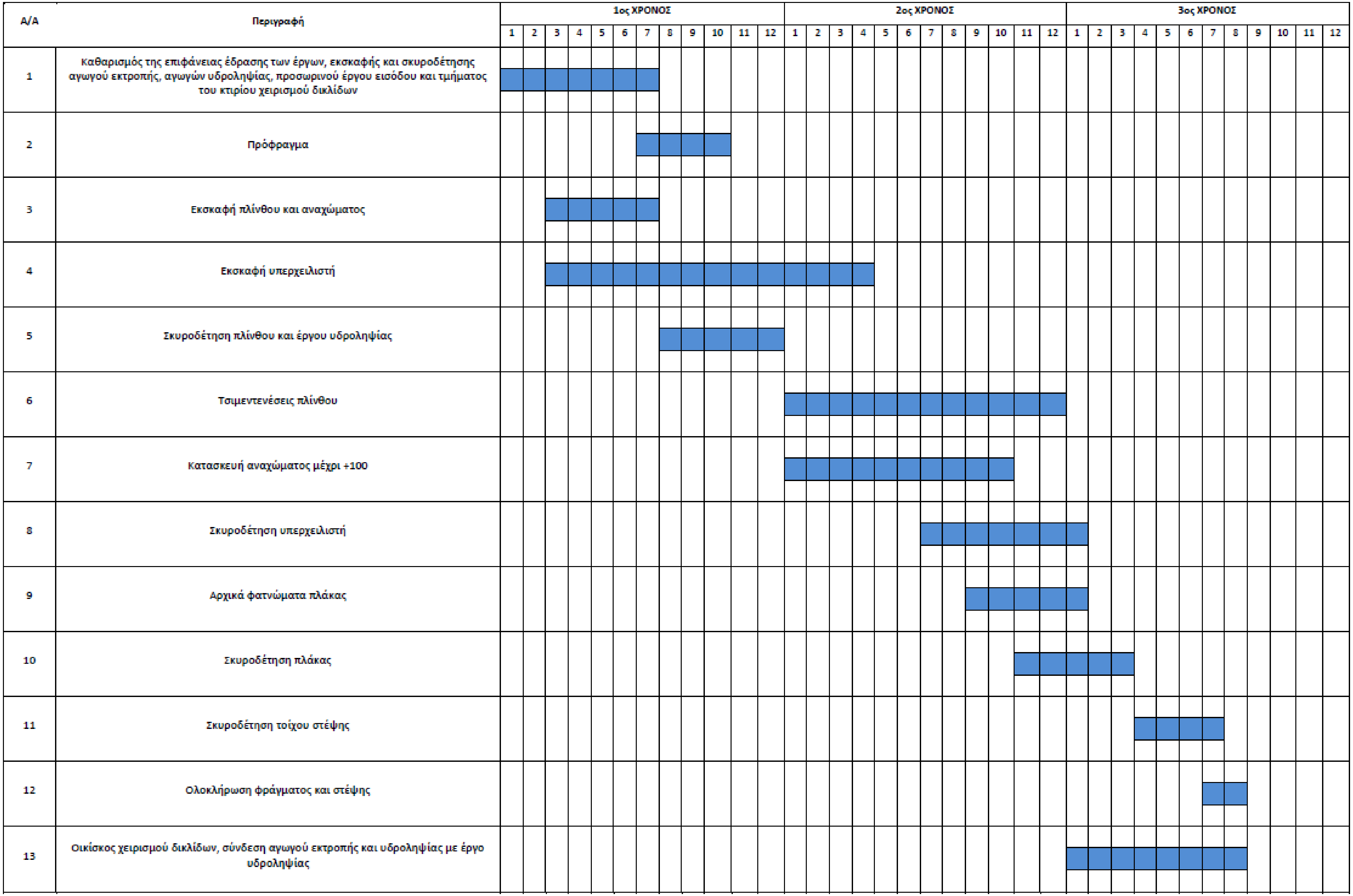
Since land consolidation (land redistribution) is not proposed in the study area, the immediate construction of works is feasible. Therefore, it is proposed that the irrigation networks in Zones 1 through 4 be constructed simultaneously.

The crossings of the main transmission pipelines towards the irrigation zones will be secured through expropriations or easements.

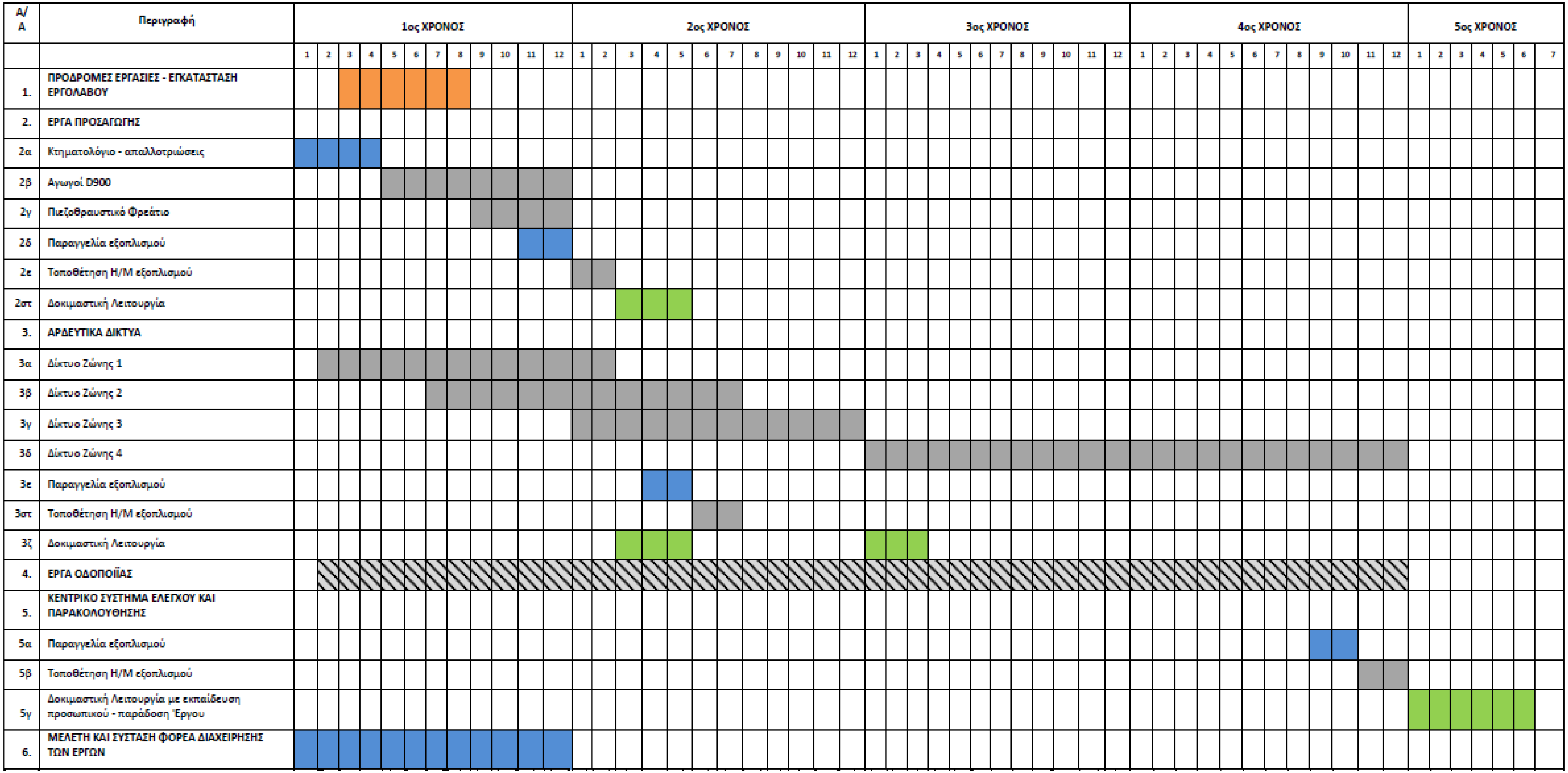
Construction of the main transmission pipelines will follow, preceded by excavation works and other earthworks (rock foundation preparation, loading/unloading, transportation of excavation materials, trench backfilling, etc.). Subsequently, the construction of the secondary and tertiary pipelines will take place, again preceded by the corresponding earthworks.

For the phased construction and operation of the networks, the water conveyance works must first be carried out, following the expropriation of the required areas.

Σχήμα 6.5.: ΕΝΔΕΙΚΤΙΚΟ ΧΡΟΝΟΔΙΑΓΡΑΜΜΑ ΚΑΤΑΣΚΕΥΗΣ ΚΑΙ ΛΕΙΤΟΥΡΓΙΑΣ ΤΟΥ ΦΡΑΓΜΑΤΟΣ ΜΙΝΑΓΙΩΤΙΚΟΥ



Σχήμα 6.6.: ΕΝΔΕΙΚΤΙΚΟ ΧΡΟΝΟΔΙΑΓΡΑΜΜΑ ΚΑΤΑΣΚΕΥΗΣ ΚΑΙ ΛΕΙΤΟΥΡΓΙΑΣ ΤΟΥ <u>ΑΡΔΕΥΤΙΚΟΥ ΔΙΚΤΥΟΥ</u> ΜΙΝΑΓΙΩΤΙΚΟΥ




**ΠΑΡΑΤΗΡΗΣΕΙΣ**

ΠΡΟΔΡΟΜΕΣ ΕΡΓΑΣΙΕΣ (ΔΙΑΣΦΑΛΙΣΗ ΕΛΕΥΘΕΡΩΝ ΧΩΡΩΝ, ΑΔΕΙΟΔΟΤΗΣΕΙΣ ΚΛΠ ΔΙΑΔΙΚΑΣΙΕΣ) - ΟΛΟΚΛΗΡΩΣΗ ΕΡΓΟΤΑΞΙΑΚΗΣ ΑΝΑΠΤΥΞΗΣ

ΣΥΝΤΑΞΗ ΜΕΛΕΤΗΣ ΚΑΙ ΥΠΟΒΟΛΗΣ ΟΛΟΚΛΗΡΩΜΕΝΗΣ (ΠΛΗΡΟΥΣ) ΜΕΛΕΤΗΣ

ΕΚΤΕΛΕΣΗ ΕΡΓΑΣΙΩΝ ΣΥΝΤΑΞΗ ΜΕΛΕΤΗΣ ΚΑΙ ΥΠΟΒΟΛΗΣ ΟΛΟΚΛΗΡΩΜΕΝΗΣ (ΠΛΗΡΟΥΣ) ΜΕΛΕΤΗΣ

ΔΟΚΙΜΑΣΤΙΚΗ ΛΕΙΤΟΥΡΓΙΑ - ΠΑΡΑΚΟΛΟΥΘΗΣΗ ΑΠΌ ΤΟΝ ΑΝΑΔΟΧΟ ΕΚΤΕΛΕΣΗ ΕΡΓΑΣΙΩΝ

Η ΑΡΧΗ ΤΟΥ ΠΑΡΟΝΤΟΣ ΔΙΑΓΡΑΜΜΑΤΟΣ (ΧΡΟΝΟΣ 0) ΕΙΝΑΙ Η ΥΠΟΓΡΑΦΗ ΤΗΣ ΣΥΜΒΑΣΗΣ ΤΟΥ ΑΝΑΔΟΧΟΥ

<u>Σημείωση :</u> Τυχόν διακοπές εργασιών λόγω ειδικών καιρικών συνθηκών δεν απεικονίζονται ιδιαίτερα, αλλά έχουν ληφθεί υπόψη στους συνολικούς χρόνους.

### *6.4.2. Sub-Projects of the Main Project*

The examined works, dam and irrigation networks, constitute an integrated set of works, although distinct from each other.
Each part includes sub-projects, as follows:

**i) Gravity Dam of Roller Compacted Concrete (RCC):**

In the examined dam, as detailed in section 6.1.1.2, the sub-projects include the spillway, the intake and outlet conduit with valve house, the diversion conduit, and the energy dissipation works.

**Irrigation Networks**

In the examined irrigation network, as detailed in section 6.1.2, the sub-projects include the main water transmission pipelines, pumping stations, and reservoirs.

**Required Construction Materials (type, quantities, method and place of supply)**

A detailed presentation of borrow pits is provided in section 6.2.1. In this section, only the quantities of materials required for the construction of the dam are briefly presented. These quantities are derived from the Quantities – Preliminary Cost Estimate of the Dam's Preliminary Design.

**Borrow pit materials**

As stated in section 6.2.1, the following borrow materials are required depending on the dam type:

- For the construction of an **Earthfill Dam with a Clay Core**:
  - Clay materials for the construction of the core: Estimated volume ~92,100 m³
  - Sand-gravel materials for the construction of filters and drains: Estimated volumes ~39,350 m³ and 29,400 m³, respectively
  - Granular or rocky materials for the construction of the support shoulders and external protection zones: Estimated volumes ~530,000 m³ and 24,000 m³, respectively

The required borrow pit materials for the construction of the earthfill dam total **898,125 m³ = (39,350 + 29,400 + 530,000 + 24,000) × 1.5**.

- For the construction of a **Gravity Dam of Roller Compacted Concrete (lean RCC):**

- Rock materials for the construction of the dam embankment: Estimated volume ~196,000 × 1.5 = 294,000 $m^3$

For the construction of the overall irrigation network, it is estimated that approximately **52,500 $m^3$** of quarry materials, sand, or crushed aggregates will be required.

**Materials for Disposal**

The estimated excavation volume for the construction of the RCC gravity dam amounts to **214,600 $m^3$ (64,700 + 149,900)**. These materials may be partially used for the construction of the embankment to reinforce the stability of the dam's left abutment. Since the design of this embankment will be carried out within the framework of the Final Design, the exact final surplus volume to be transferred to the disposal area is not yet known.

For the construction of the irrigation network, the estimated excavation volume amounts to **350,000 $m^3$**, of which approximately **183,000 $m^3$** will be used for backfilling trenches and about **167,000 $m^3$** will be disposed of in selected sites, borrow pits, or spread over farmland or public land.

According to the information in section 6.1.2, a total of **five (5) main water transmission pipelines** will be constructed, as shown in Figure 1 of that section and in drawings GO-1 to GO-8. The total length of the main pipelines amounts to approximately **17 km**.

In drawing **TS**, a typical cross-section of excavation and pipeline installation is presented.

### *6.4.3. Liquid Waste Discharges*

The examined works by their nature are not related to the production of liquid waste. During the construction phase, some substances may possibly escape from the construction sites. In the corresponding section, relevant measures and guidelines will be provided to prevent and address this possibility.

### *6.4.4. Surplus or Unusable Materials or Solid Waste*

The examined works by their nature are not related to the production of solid waste in the full sense of the term.
During the construction phase, some solid waste may be generated at the construction sites.

In addition, unsuitable excavation products could be considered as solid waste; however, these are addressed in the previous section on disposal sites. In the corresponding section, relevant measures and guidelines will be provided to prevent and address this possibility.

#### *6.4.5. Air Pollutant Emissions from the Construction of the Project*

The project and its operation are not related to the emission of any form of air pollutants.
Only during the construction phase is the emission of dust into the air expected, resulting from earthworks and other construction activities, mainly involving excavations, transportation, and deposition of required materials. These are common situations of temporary nuisance and can be easily managed, as described in the corresponding section.

#### *6.4.6. Noise and Vibration Emissions*

The project and its operation are not related to the generation of noise and vibrations. Only during the construction phase is an increase in noise expected, due to the operation of excavation machinery and vehicles transporting materials required for earthworks and other construction activities, both at the construction sites and at the borrow pits.
These are common situations of temporary nuisance and can be easily managed, as described in the corresponding section.

#### *6.4.7. Electromagnetic Radiation Emissions*

The examined works are not related to the issue of electromagnetic radiation.

### 6.5. Operation Phase – Proposed Development Plan of the Area

This section presents the development plan of the area under irrigation, as outlined in the Agro-technical Report prepared within the framework of the broader project contract.

#### *6.5.1. General Directions of the Development Plan*

In the study area, it is estimated that the development of crops will follow a moderate growth model. Within this model, the following general principles will be applied:

- Conversion of rainfed crops into irrigated crops.

1. Expansion of the area occupied by open-field vegetable crops.
2. Increase of areas covered by greenhouses.

3. Expansion of orchard cultivation.
4. Increase of table grape cultivation.

This model is consistent with the country's general policy for the production of horticultural products. These crops are among those promoted at the national level.
The construction of the dam and the distribution network is expected to contribute to the conversion of lands currently left fallow or cultivated with low-yield arable crops into greenhouse crops and vegetable cultivation.
There are no organizational, administrative, or legislative measures required to enable the implementation of the development plan.

### *6.5.2. Current Situation*

The data concerning the current situation in the study area are analyzed in the relevant section of Chapters 8.6 and 8.7 of this EIA. Comparative data on production levels, crop types, etc., are also provided in the appendix of this document, which contains the tables of the Proposed Development Plan.

### 6.5.3. Future Situation

The construction of the dam and the distribution network is expected to have a significant impact on the crops of the region. The development plan prepared for the study area was based on the assessment of data regarding the evolution of existing crops over the past 20–30 years, combined with the dynamics introduced by the availability of water. At the same time, an effort was made to take into account both the experience of local stakeholders—farmers and agronomists—as well as the data and requirements of the market, the capabilities, and the productive potential of the region.

The development plan was formulated by grouping crops into homogeneous categories. This categorization is considered to provide greater reliability in the projections, while at the same time, without deviating from a secure estimate, it allows the inclusion of specific variations that may occur during some of the years of operation. These variations may affect individual crops within each category but will not influence the overall area allocated to each category.

In the appendix of this EIA, selected tables from the Development Plan are attached, referenced in the respective sections of the text.

The development plan is represented by the areas and the percentage share of each crop per estimation year in Appendix II of the Agro-technical Study. The year 2014 is considered the reference year or the current situation, while 2021 is regarded as the first year of project operation. It is assumed that the changes between 2014 and 2020 will not be significant in terms of percentage variation compared to the existing situation, and that actual changes will begin after the commencement of the dam and network operation. The development assessment, presented in Appendix II, covers the first 20 years of the project's operation. At the end of this period, a new equilibrium will be established without exhausting the productive potential of the project's perimeter. After this 20-year period, no significant differentiations are expected. For such changes to occur, new factors would have to drive the area into a new productive equilibrium.

For the realization of the development assessment of the area, a conservative growth model was preferred. This model may temporarily be exceeded during the studied time frame or may not fully follow the estimated increase. However, it is estimated that the final ratio of crops will not show significant deviations from the projected ones.

For the preparation of the development plan, the following assumptions were made:

1. There will be an increase in the areas cultivated with vegetables, both open-field and greenhouse.
2. Due to the particular climate, the cultivation of early vegetables and fruits will be favored.
3. The dominant crops of the existing situation will not be replaced by new ones, but for the purposes of the study, it was assumed that crops will be converted from rainfed to irrigated across the entire area.
4. The current state of crops is underestimated compared to the real capacities and prospects of the area, which is the earliest ripening continental region in Europe.
5. The increase in areas cultivated with orchards and vegetables will take place through the replacement of olive groves and arable crops, without this conversion affecting the importance of these crops for the region.

The individual areas and the share of each crop in the total area of the study region are presented in detail in Table II.2 of Appendix II of this document and in summary in the table below.

Excerpt from Table II.2 of the Development Plan: Estimation of annual changes in the percentage share of each crop in the total area of the project perimeter over a 20-year horizon.

| YEAR | Present (2021) | 20th Year of Project Operation (2041) |
|---|---|---|
| Watermelon – Melon | 0.01 | 0.11 |
| Early Potato | 0.03 | 0.29 |
| Autumn Potato | 0.02 | 0.11 |
| Winter Vegetables (Open-field) | 0.03 | 0.32 |
| Summer Vegetables (Open-field) | 0.01 | 0.14 |
| Arable Crops | 5.20 | 4.69 |
| Greenhouses | 0.03 | 0.46 |
| Orchards | 6.89 | 7.45 |
| Subtotal without Olives | 12.22 | 13.58 |
| Olives | 84.09 | 82.99 |
| Partial Subtotal | 96.31 | 96.57 |
| Fallow Land – Pastures | 3.69 | 3.43 |
| **Total** | 100.00 | 100.00 |

According to the development plan, the cultivation of olive trees from 84.09% in the current situation will be reduced to 82.99% upon completion of the development plan. Accordingly, greenhouse crops will increase from 0.03% to 0.46%, summer outdoor vegetable crops will increase from 0.01% to 0.14%, winter outdoor vegetables from 0.03% to 0.32%, and orchards will similarly increase from 6.89% to 7.45%. Compared to the current situation, arable crops will increase from 5.26% to 5.21% (with an increase, however, in the percentage cultivation of potatoes, watermelons, and melons), while the share of fallow land – pastureland will decrease from 3.69% to 3.43%.

The increase in the gross income of agricultural holding owners, according to the data of the current situation and given that the cultivated area within the project's perimeter cannot be increased as there are no additional areas available for exploitation, can only be achieved through the increase of irrigated land area and through crop restructuring. The restructuring of crops must include the changes already mentioned among the different cultivations.

For livestock farming, no significant change is expected. Consequently, the development plan does not include any alteration of the animal species or population. In the area, all necessary resources are available, and those that are not can be acquired for the proper implementation of the development plan. There are no specialized means or materials required.

The investments expected to be made by private individuals for the implementation of the development plan concern:

1. The construction of greenhouses.
2. The construction of net-houses.
3. The establishment of permanent plantations (orchards).

4. The construction of irrigation networks.
5. The construction of water storage tanks.
6. The expansion and/or establishment of processing units.
7.

For the implementation of all these investments, the producers–investors of the study area can utilize the financial instruments that will be made available by the Hellenic State. These include Improvement Plans, the Development Law, or other programs that will be announced and will include relevant expenditures.

The timeline of the development plan will follow the completion of the works. Figures 6.5 and 6.6 present the indicative construction schedule of the project. After the completion of the project, which is set for 2021, the gradual utilization of the project by the area's producers will begin. The possible progress of private works for the exploitation of the network, as well as the progress of the irrigable area, is shown in Table V.8 of the annex to the Agrotechnical study, while in Table V.9 (in Annex 2 of the present EIA), the progress of the irrigated area is presented as a percentage. From these tables, it is estimated that after a period of 4–5 years, full utilization of the land will be achieved at 100% of the capacities provided by the irrigation project.

The increased production quantity of products in the study area is not expected to create negative pressures on their prices. The prices of the products are influenced by factors that cannot be affected by the cultivation area, as it is shaped in the region. For the purposes of fiscal investigation, the prices during the operation of the dam are assumed to be equal to those of the current situation.

### 6.5.4. Economic results after the completion of the project

The financial data as they will be shaped after the completion of the development program are presented in the tables of Annex IV of the Agrotechnical Study. In the calculations of the future situation, the same assumptions as those of the current situation have been made, and corresponding values of the individual parameters have been used as in the current situation, regarding the value of products, production indices, as well as interest rates, so that the magnitudes of the project's impact are comparable.
From the tables of Annex IV of the Agrotechnical Study, it emerges that the production value per average stremma after the completion of the project will amount to €1,018.27. Table IV.3 contains the distribution of A.W.U. (Annual Work Units) per year after the completion of the project, which amount to 861,540.00, while their monthly distribution is shown in Table IV.11 (in Annex 2 of the present EIA). In Table 6.6 below, the requirements in A.W.U. for the basic categories – crops are presented in aggregate, as well as their percentage ratio after the completion of the project.

**Table 6.6. Requirements in A.W.U. and their percentage ratio**

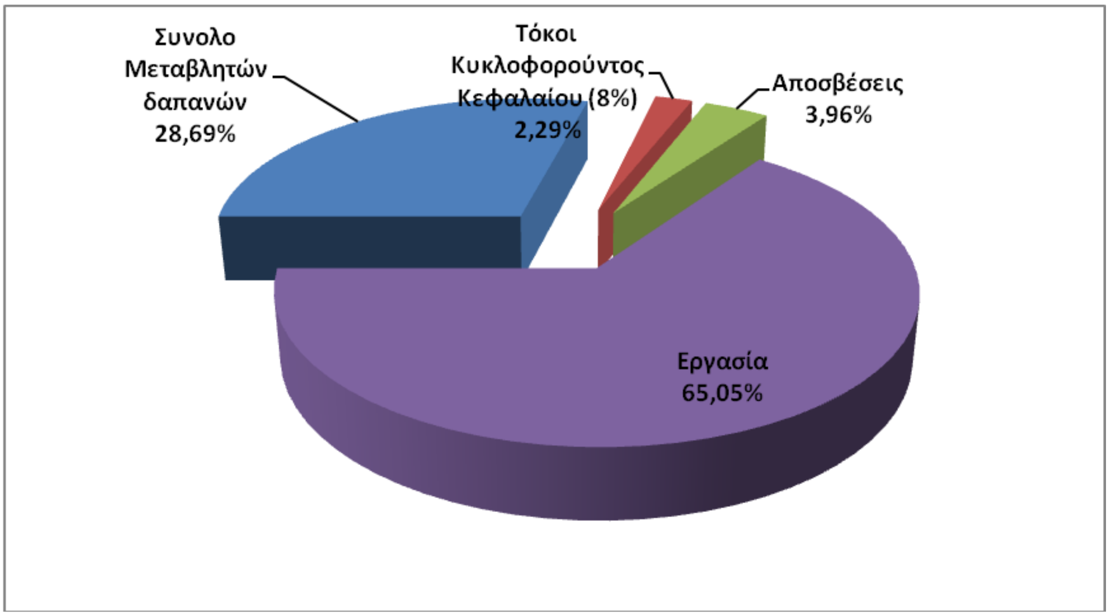
| No. | Crops | Area | Total | % Ratio |
|---|---|---|---|---|
| 1 | Olives | 29,047.00 | 689,681.00 | 80.05% |
| 2 | Greenhouses | 80.00 | 92,745.00 | 10.77% |
| 3 | Vineyards – Raisins | 2,457.20 | 38,719.40 | 4.49% |
| 4 | Others | 3,415.80 | 40,395.00 | 4.69% |
| | **Total** | **35,000.00** | **861,540.40** | **100.00%** |

The variable expenses per stremma of cultivation are shown in Table IV.4 (in Annex 2 of the present EIA). These do not include the irrigation cost after the completion of the project, as this will be included in the Administrative and other costs of the project, which are analyzed in the financial investigation.

The total agricultural production expenses after the completion of the project are presented in Table IV.5 (in Annex 2 of the present EIA). According to this, after the completion of the project, 65.05% of the total expenses will concern labor costs, 28.69% the cost of variable expenses, 2.29% the cost of interest on working capital, while 3.96% will concern depreciation, with 3.76% relating to capital and 0.20% to capital interest.

In summary, these data are presented in the following figure.

**Figure 6.7. Allocation of crop production expenses upon completion of the project**



In Table IV.11 (in Annex 2 of the present EIA), the degree of utilization of the A.W.U. made available to the holding after the completion of the project is presented. For the reasons of relativity of this specific parameter, for this specific project, which were analyzed previously, it is only noted that there is an increase in the required A.W.U. and a decrease in surpluses throughout the entire year. This parameter shows us that the project will create an increase in employment. These increased requirements are estimated to be covered partly by seasonal staff and partly by leading to an increase in the permanent population that is expected to exist in the area in the future.

In Table IV.12 (in Annex 2 of the present EIA), the revenues and expenses for each production sector (crop production, livestock production), as well as the corresponding total figures after the completion of the project, are presented in aggregate. From this table, it emerges that in the study area, out of the total value of gross production, 16.12% will consist of variable expenses, 1.29% of interest on working capital, 2.08% of depreciation without interest, and 0.13% of interest on depreciation. Furthermore, 23.38% of the gross production value will consist of the remuneration of family labor, while only 35.90% will consist of the remuneration of paid labor (for the reasons analyzed in the previous paragraph).

Out of the total gross production value, 21.11% will constitute the profit of the holding upon completion of the project. These results do not take into account any taxes paid; the total wages will be €837,240.40, while the same wage level as in the current situation has been used, which is €25.00 and €35.00 respectively for crop and livestock production.

### 6.5.5. Comparison of economic results of the current and future situation

The comparison of the current situation with the situation as it will be shaped after the completion of the project will provide us with the economic benefits that will arise from the project’s implementation.

#### 6.5.5.1. Total production value

This comparison can be made by comparing the data of the tables in Annex III and Annex IV of the Agrotechnical Study. Comparing the total production value between the current situation and the future one (Table IV.13 in Annex 2 of the present EIA), we find that the total production value upon completion of the project increases from €16,760,291.70 to €36,395,789.35. This increase, at the completion of the project, of €19,635,497.65 compared to the current situation corresponds to a percentage increase of 117.15%. This increase is due to the conversion of crops into irrigated ones and the increase of cultivation areas with higher yields (greenhouses and outdoor vegetables) as foreseen in the development plan.

#### 6.5.5.2. A.W.U. & created employment positions

From the comparison of total labor requirements in the current and future situation (Tables III.3 and IV.3 of the Agrotechnical Study in Annex 2 of the present EIA), we can observe that the total required A.W.U. increase from 463,341 in the current situation to 861,540 in the future one. This increase corresponds to a percentage increase of 85.96% compared to the current situation. Olive cultivation will continue in the future to present the highest requirements in A.W.U..

After the implementation of the project, there will also be changes in the monthly labor requirements. The total A.W.U. after the project implementation increase by 398,199 A.W.U.. These labor requirements will be covered by seasonal personnel and/or by new permanent residents of the area, contributing to the population growth of the region.

These jobs do not include the new positions that will be created to serve the additional population that will settle in the area to cover the new jobs within the perimeter of the project.

#### 6.5.5.3. Total expenses

Total expenses after the completion of the project are increased due to the change in crops and the increase of the areas that will be occupied by crops with higher input and labor requirements. Indicatively, it is noted that the total expenses per stremma on average in the study area before the project implementation amount to €258.66. The corresponding cost after the implementation of the project is estimated to amount to €577.32. Consequently, there is a change of €156.36, which corresponds to 54.02% of the total expenses of the current situation.

#### 6.5.5.4. Livestock production

Between the current situation and that which will be shaped after the implementation of the project, no changes or differentiations are expected either in the type or in the size of livestock units. As has already been mentioned, livestock farming does not constitute a significant sector for the study area, for reasons already explained. Consequently, in the present analysis, no further elaboration of the sector will be made. For the purpose of depicting the contribution of livestock production to the local economy and employment, the tables include detailed calculations also for this sector, which, however, does not present differentiations before and after the implementation of the project.

#### 6.5.5.5. Revenues and Expenses

The comparison of revenues and expenses between the current situation and the situation that will be formed after the completion of the project shows significant changes (Table IV.13 in Annex 2 of the present EIA).

With the implementation of the project, the profit of the holding increases from 0.81% to 21.11% of the Gross Production Value. This increase is due to the fact that, under the development plan, low-yield crops are expected to be replaced with crops of higher yield and greater profit margins. The net added value shows a significant change, rising from 73.92% to 80.51% after the completion of the project. The percentage decrease of interest on working capital by 61.21% and of depreciation interest by 61.28%, as a proportion of the gross production value, is due to the fact that upon completion of the project, the increase of the gross production value is very large compared to that of the current situation.

The remaining parameters are calculated in the relevant Table IV.13, where the comparison is also made. According to the data of this table, in absolute figures, the profit of the holding increases by 5,589.07%, an extremely high percentage due to the small corresponding figure of the current situation. Family income increases by 110.27%, the holding's income increases by 136.68%, and the net added value increases by 136.50%.

Correspondingly, the gross production value increases by 117.15%, the variable expenses excluding interest and the interest on working capital increase by 61.21%, the gross added value increases by 132.67%, while the gross added value excluding interest increases by 136.50% after the project's implementation.

### 6.5.6. Investigation of Economic Results of the Proposed Plan

#### 6.5.6.1. Introduction

The investigation of the project's profitability is carried out at the level of the national economy, taking into account the increase of the gross added value, i.e., after subtracting from the gross production value all variable expenses.
The estimation is based on the data available at the time of drafting the present study. Consequently, as construction cost, the one foreseen by the project's tender has been used.
More detailed determinations will be made during the drafting phase of the Final Design Study (M.O.S.), once all the other studies have been finalized.

The project's lifetime has been considered equal to 50 years, while the current interest rate at 6.5% is deemed satisfactory given the circumstances.
The estimation of the IRR (Internal Rate of Return), i.e., the interest rate at which the flow of expenses incurred for the project's implementation is equalized or discounted (converted to present value), also constitutes an indicator of the profitability of the development plan.

### 6.5.6.2. Total Investment Expenses – Inflation

The total investment expenses, which are presented in Table V.2 of Annex V of the Agrotechnical Study and attached in Annex 2 of the present EIA, concern the studies, the construction cost of the dam, the irrigation network, and the installation of equipment therein.

According to the relevant contract that has already been signed, the studies amount to €1,274,740.00.

According to the project file, the construction cost, as pre-estimated by the Contracting Authority, amounts to €120,000,000.00, of which €90,000,000.00 concerns the dam and €30,000,000.00 the networks. A more accurate estimate of the construction cost will result from the Final Design Study of the Dam and the Irrigation Network, the preparation of which will commence in the coming months. The final construction cost figures, as they will result from the Final Design Studies, will be taken into account in the Economic Feasibility Study (EFS) of the project, which follows all the studies.
For the purposes of the present study, the contractual construction cost, as defined by the Contracting Authority, is taken into consideration. For the purposes of this study, it has been estimated that a discount rate of 15% will apply. This percentage is considered sufficient at the current stage of the studies.

Based on these figures and for a total net agricultural area included within the project perimeter and to be covered by the irrigation network, equal to 35,000.00 stremma, it appears that the total construction cost of the project is equal to €101,575,000.00.
In addition to the construction cost of the irrigation network, the total expenses also include the costs for the implementation of private works. These expenses include the installation of local irrigation networks (per land parcel), the construction of greenhouses for the area provided for in the development plan, as well as the construction of special structures, including net-houses and tall tunnels, for the expansion of outdoor horticultural crops expected to occur according to the development plan. The area of each of these parameters is consistent with the development plan, while the prices used are representative of market prices. The cost

of private investments also included the cost of the increase in working capital that will be required after the investment is realized. The total cost of private investments is estimated at €20,900,000.00.

Together with inflation, the total investment cost is expected to amount to €135,000,414.97. Of this, €110,786,983.00 is estimated to be covered by the special state budget, while €24,213,431.96 is estimated to be private investments including inflation. For the purposes of the study, private investments are estimated to be financed through loans, for which the interest rate has also been set at 6.5% for the needs of this study.

Inflation, both for public and private investments, was calculated cumulatively on a semi-annual basis. The inflation rates are consistent with the fiscal targets set by our country for the coming years. For the calculation of inflation in private investments, it was assumed that the expansion of greenhouse areas and outdoor vegetable cultivation would be completed by the second half of 2026, and that of outdoor horticultural crops by the second half of 2025, whereas the development plan refers to their increase over a longer period, covering 30 years. The scenario used for the calculation of inflation is less favorable and, in any case, ensures a higher degree of security for the project's implementation. The choice was made for the sake of simplification of the calculations.

#### 6.5.6.3. Administration, Operation & Maintenance Expenses

This category of expenses includes the costs that will be necessary for the operation of the organization (TOEB) during the first year of the full operation of the network. This cost includes administrative expenses, maintenance expenses, and the renewal of materials.

Administrative expenses include the salary cost of one administrative employee as well as two (2) workers. All of them will be employed throughout the year. In addition to salaries, employer contributions have also been calculated. Administrative expenses also include the cost of renting office space, the installation and payment of connections to utility and communication networks, as well as the supply of consumables and stationery necessary for the operation of the organization. The total of these expenses is estimated at €51,810.00, of which 90%, an amount equal to €46,629.00, constitutes the actual expenses used for the study's calculations.

The calculation of maintenance and renewal costs is presented in the corresponding tables, and no further analysis is carried out in this section other than the reminder that these costs depend on the lifespan of the products. For the calculation of expenses–benefits discounting, a discount rate of 6.5% was used. As maintenance factors, 1% is taken for Civil Engineering works and a depreciation factor over 50 years equal to 0.0068 (interest rate 6.5%), while for the Electromechanical equipment a maintenance factor of 2% and a renewal every 20 years with a factor of 0.099 (interest rate 6.5%) are applied.

For the reasons mentioned in the paragraph concerning the calculation of the dam's cost, the amounts of these specific categories will be more accurate after the precise measurement of the project and the selection of the materials to be used.

The total administration, operation & maintenance expenses during the first year of full production amount to €1,521,043.54.

#### 6.5.6.4. Electricity Expenses

The annual electricity expenditure is calculated using the formula (Ministry of Public Works – Circular No. D. 22.200/30-7-1977):

$$\Psi\varepsilon = \sigma_{\nu} \times \frac{\Pi \times \Omega \times H}{367 \times n_2} \times \delta_{\varepsilon}$$

where:

$\sigma\nu$ = the percentage of P irrigated in the nth year (100%)

Π = the net irrigable area in stremma (35,000 stremma)

Ω = the required volume of water for one irrigation period, in $m^3$/stremma

H = the average manometric head in m, equal to 70 meters

$n_2$ = pumping station efficiency factor, taken as 0.80

$\delta\varepsilon$ = the cost of electricity for agricultural use, amounting to €0.06539 per KWh.

A more accurate determination of this specific expense will be made after the completion of the project's design and the precise determination of the manometric head of each zone and the overall method of water distribution. For the entire area, the water will be pumped into tanks and from there will be conveyed by gravity.

According to the calculations of the study, the electricity cost will be €156,816.96 (Table V.12 of Annex 2 of the present study). The data will be revised in the techno-economic study.

### 6.5.6.5. Cost of Irrigation Water

The cost per cubic meter of water to be used for irrigation, after the construction of the works, results from the annual expenses required for administration, operation, energy, maintenance, depreciation, and renewal of the works, divided by the total volume of water used for irrigation during the irrigation period, thus:

**Water cost = 8,633,410.00/8,564,043.54 = €0.99 per cubic meter**

According to Greek legislation (Legislative Decree 1277/72), producers are not burdened with depreciation and renewal expenses of the works. Therefore, the price per cubic meter of water to be paid by the producers will be determined by the expenses of operation, administration, energy, and maintenance, depending on the progress of the project's construction, thus for the completed project:

**Water cost = 8,633,410.00/1,521,043.54 = €0.18 per cubic meter** (Table V.12 of Annex 2 of the present study).

Based on the results of the calculations for the cost of water per $m^3$, the corresponding cost of water per representative stremma per year for the study area is €44.00/stremma.

### 6.5.6.6. Evolution of Irrigable Area and Income Increase

The estimate for the increase of the irrigable area as well as the increase in income is described in detail in the corresponding Tables V.9 and V.11 of Annex 2 of the present study. Table V.9 shows that by 2026, 100% of the irrigable area will have been covered. This assumption is made despite the fact that in that year, the construction of greenhouses in the area expected to be reached by the completion of the development plan will not have been completed. This assumption is consistent with the development plan, since even if the crops at that time are not those foreseen in the development plan, they will be irrigated.

The evolution of income, as a percentage of the estimated final increase, is shown in Table V.11 of Annex 2 of the present study. It is estimated that by 2029, 100% of the increase in Gross Added Value will have been achieved.

### 6.5.6.7. Cash Flows (Expenses – Benefits) of the Entire Area

In cash flow Table V.13, the total cash flows for the realization of investments, their replacement, as well as other expenses for the operation of the network are presented, compared with the benefits from the increase in revenue that will result from the project's implementation. From this table, the final cash flow (inflow or outflow) emerges, which is the result of the network's operation per year as well as the corresponding cumulative total amount for the entire 50-year period during which the network's operation is examined.

From the data of Table V.13, the figures of the productivity and efficiency coefficients of the irrigation project are derived. The IRR is estimated at 10.60%, while the Benefit/Cost Ratio is equal to 1.41. The values demonstrate that the project has good profitability in terms of the national economy.

In addition, in the remaining tables of Annex V (13–16), sensitivity analysis is carried out with calculations where construction costs have increased by 15% while revenue has remained stable; with calculations where expenses remained stable and revenue decreased by 15%; and with calculations where both expenses (construction costs) have increased by 15% and revenue has decreased by 15%.

The results of these analyses are presented in summary in Table V.17 of Annex 2 of the present study. From the overall sensitivity analyses, it is demonstrated that the investment, according to the data included at this stage of the study, is advantageous in every tested case. The final evaluation will be made during the drafting of the Economic Feasibility Study.

### 6.5.6.8. Productivity & Efficiency Coefficients of the Project

The relative cost of investments per hectare for public investments is estimated to amount to €31,653.42. The corresponding private cost is estimated at €6,918.12, while the total amounts to €38,571.55. This high cost is justified by the fact that the construction cost is an estimate and not an actual cost, and because this cost also includes the cost of crop restructuring and the conversion of areas with permanent plantations into greenhouse cultivations, which have both high initial investment costs and high operating costs.

The criterion of the Benefit–Cost Ratio is the ratio of the sum of discounted benefits (Σ), which are the increases in Gross Added Value, to the sum of discounted costs (Σ), i.e., construction expenses, operation of works, administration, energy, maintenance, and renewal. For the present project, according to the calculations of Table V.13, this

criterion takes a value equal to 1.41. This result shows the economic stability of the project under study.
The criterion of Net Present Value (NPV) is the difference between the present value of benefits (sum of discounted benefit flows) and the present value of costs (sum of discounted cost flows), at the same interest rate (6.5%) and for a period of 50 years, which is the estimated lifespan of the project.
In the project under study, the values of the Net Present Value under the various sensitivity analysis scenarios are presented in summary in Table V.17 of the Agrotechnical Study and attached in Annex 2 of the present study. According to the data of that table, the construction of the project is considered economically advantageous.

### 6.5.7. Results – Conclusions

The area covers 35,000 stremma, which will be fully irrigated. The study area is flat and/or presents mild slopes, which become steeper on the northern side and above the settlement of Kallithea.

The area is covered by permanent plantations of olive trees, raisin vineyards, and arable crops, and to a lesser extent by other crops. Livestock farming does not constitute a significant sector for the study area. The presence of permanent plantations and greenhouses excludes the possibility of land redistribution. The existence of a rich agricultural road network allows the irrigation network to largely follow the existing rural roads, and where necessary, improvement or extension works can be carried out. In the study area, drainage is sufficient, and no drainage works are required.
For the calculation of crop water requirements, data from the nearest meteorological stations were used. The method applied for the calculation of these requirements is the empirical Blaney–Criddle method.

According to the development plan, a future increase is expected mainly in greenhouse and outdoor horticultural cultivation, and a decrease in the areas occupied by permanent olive plantations and arable crops. No changes are expected in the livestock sector.

According to the aforementioned data of the Agro-economic-technical study and the proposed development plan:

1. The discharge of the hydrants is proposed to be 6 lit/sec, the downstream pressure of the hydrant 2.5 atm, and the hydrants will be single-outlet with pressure and discharge regulators. The choice of design and operation of the

network based on these characteristics was made to exclude possible waste from the installation and use of irrigation systems other than drip irrigation and to favorably affect the configuration of construction cost.

2. The irrigation unit of 36 stremma is a size sufficient to ensure the satisfactory operation of the network without creating conflicts among producers during its operation.
3. It is proposed that the operation follows the CLEMENT method with free demand and 16-hour irrigation within 24 hours. This proposal takes into account the type of crops included in the development plan as well as social criteria related to the ease of water distribution to all producers throughout the year.
4. The implementation of the project is economically advantageous, and the incurred expenses (public and private) are justified by the expected benefits.

### 6.6. Hydrological Data – Water Balance

Presented in this section are the data of the Hydrological Study, which was prepared within the framework of the same contract, with the purpose of calculating:

- the monthly inflows (balance) for the sizing of the dam,
- the flood inflows into the Minagiotiko reservoir for the sizing of the dam’s spillway.

The Hydrological Study was based partly on the data of the Introductory Report, which was prepared by the consultant and submitted with document no. 19122/16-03-2015 of the Consultant.
In addition, the Hydrological Study took into account the Preliminary Study: *“Study of Reservoirs in the Provinces of Pylia and Trifylia, Prefecture of Messinia”* (Study No.: 9481731), which was carried out in 1998 for the Ministry of Agriculture, by the consultants: YDROTEK HYDRAULIC STUDIES Ltd, P. Manousos & G. Aranitis. The study concerned the identification of sites for the construction of reservoirs and dams to cover irrigation and water supply needs in the western part of the Prefecture of Messinia (Provinces of Pylia and Trifylia). The study examined various dam and reservoir sites for the wider area of the Pylia and Trifylia provinces.

An essential parameter that must now be taken into account in the preparation of hydrological studies is Directive 2007/60 (European Parliament and Council, 2007) on the assessment and management of flood risks. This Directive requires the study not only of high-probability floods (e.g., with a return period of 10–50 years) and medium-probability floods (e.g., with a return period of 100 years), but also of low-probability floods (e.g., with a return period of 1,000 years).

The Hydrological Study investigates flood events of both high and low frequency of return. It should be noted that, for the Water District of Western Peloponnese, the Flood Risk Management Plan per catchment area is still under preparation.

### 6.6.1. Processing of Hydrological Samples

#### 6.6.1.1. Available Data

In the study area, there is a number of meteorological and rainfall stations (Table 6.7). The geographical locations of these stations are presented in Map I-1 of Annex I of the Hydrology. As shown in this map, the distribution of rainfall stations in the wider area is uneven. There is no station within the catchment area of the Minagiotiko dam. The determination of the representative station of the catchment area of the dam is carried out using the Thiessen polygon method. In Figure I-2 of Annex I of the Hydrology, the Thiessen polygons formed for the wider study area are presented. From this figure, it emerges that the representative station is Methoni (Hellenic National Meteorological Service – HNMS). The available time series of the Methoni station were purchased from HNMS.

**Table 6.7: Rainfall stations in the wider study area**

| Station | Authority | Elevation (m) | Available time series | Type of instruments | Catchment area |
|---|---|---|---|---|---|
| Kremmydia | Ministry of Rural Development & Food (ΥΠΑΑΤ) | 341 | 1982–2007 | Rain gauge | Rema Choras–Giannouzaga |
| Pylos | Ministry of Rural Development & Food (ΥΠΑΑΤ) | 50 | 1990–2007 | Rain gauge, Temperature, Sunshine, Evaporation | Rest of Peloponnese |
| Gargalianoi | Ministry of Rural Development & Food (ΥΠΑΑΤ) | 50 | 1986–2007 | Rain gauge | R. Filiatrino – Selas |
| Mouzaki | Ministry of Rural Development & Food (ΥΠΑΑΤ) | 461 | 1983–2007 | Rain gauge, Temperature | R. Filiatrino – Selas |
| Zevgolatio | Ministry of Rural Development & Food (ΥΠΑΑΤ) | 67 | 1980–2007 | Rain gauge, Temperature, Humidity, Evaporation | Pamisos |
| Dorio | Ministry of Rural Development & Food (ΥΠΑΑΤ) | 165 | 1982–2007 | Rain gauge | Pamisos |

| | | | | | |
|---|---|---|---|---|---|
| Kefalovryso | Ministry of Public Works & Environment (ΥΠΥΜΕΔΙ) | 455 | 1971–2010 | Rain gauge | Pamisos |
| Methoni | Hellenic National Meteorological Service (HNMS/EMY) | 62 | 1954–2015 | Rain gauge, Temperature, Humidity, Sunshine, Evaporation, Wind | Rest of Peloponnese |

The stations under the jurisdiction of the Ministry of Rural Development & Food (ΥΠΑΑΤ) have, on average, time series of 25 years in length, with several gaps, mainly during the last 15 years. In addition, in all rainfall stations of the Ministry of Rural Development & Food, the primary available time series extend up to 2007, when recording ceased. Regarding the rainfall station of the Ministry of Public Works & Environment (ΥΠΥΜΕΔΙ) (Kefalinos), the available data were mainly collected from the Hydroscope database, and the time series extends from 1945 to 2010.

#### 6.6.1.2. Description of the Catchment Area

Based on the characteristics of the catchment area, a first estimation of the concentration time can be made. The more elongated the catchment, the longer the concentration time. The circularity values (C) range from 0 to 1, where 1 corresponds to the shape of a perfect circle. Circularity (C) is calculated from the following relation:

$$C = \frac{4\pi A}{P^2}$$

, όπου: *A*: η επιφάνεια της λεκάνης απορροής (km2)
*P*: η επιφάνεια της λεκάνης απορροής (km)
Η επιφάνεια της λεκάνης απορροής του φράγματος Μιναγιώτικο είναι ίση με 28,9 km2 και έχει περίμετρο 27,22 km. Το μέσο υψόμετρο της λεκάνης είναι ίσο με 249m. Με βάση τα παραπάνω η κυκλικότητα της λεκάνης είναι ίση με 0,49, γεγονός που καταδεικνύει ότι ο χρόνος συρροής στη λεκάνη απορροής του φράγματος Μιναγιώτικο είναι σχετικά μεγάλος.

#### 6.6.1.3. Υπολογισμός χρόνου συγκέντρωσης

Για την εκτίμηση του χρόνου συγκέντρωσης της λεκάνης *tc* γίνεται χρήση της σχέσης Giandotti, καθώς πρόκειται για σχετικά ορεινή λεκάνη:

$$t_c = \frac{(4A^{0.5} + 1.5L)}{0.8 * (H_\mu - H_o)^{0.5}}$$

where:
tc = the concentration time in hours (h),
L = the length of the main stream from the catchment boundary to the examined point in km,
Ho = the elevation at the point of flow calculation (control elevation),
Hm = the mean elevation of the catchment in m.
Based on the above formula, it is found that the concentration time is equal to 3.2 h.

#### 6.6.1.4. Meteorological Data

Table 6.8 below presents the meteorological stations in the wider study area. The length of the available temperature time series differs significantly from station to station. The stations with the longest time series are Methoni and Mouzaki (55 and 24 years respectively). The Methoni and Pylos stations are strongly influenced by the sea, and their mean annual temperature is 18°C. In contrast, a decrease in mean annual temperature is observed with altitude, as at the Mouzaki station the mean annual temperature is 17.3°C. Furthermore, the temperature is lower (16°C) when the sea influence decreases (Zevgolatio).

**Table 6.8: Meteorological stations with available temperature time series in the wider area of the dam.**

| Station | Authority | Elevation (m) | Mean annual temperature (°C) |
|---|---|---|---|
| Methoni | HNMS | 62 | 18.0 |
| Mouzaki | Ministry of Rural Development & Food (ΥΠΑΑΤ) | 461 | 17.3 |
| Pylos | Ministry of Rural Development & Food (ΥΠΑΑΤ) | 50 | 18.2 |
| Zevgolatio | Ministry of Rural Development & Food (ΥΠΑΑΤ) | 67 | 16.0 |

#### 6.6.1.5. Homogeneity Check of Data

In Figure 6.8 below, the primary annual precipitation values for all rainfall stations in the area are presented. It should be noted that years with incomplete primary data have been excluded. Before any processing, the data are checked in order to eliminate obvious errors and to ensure that the available measurements are reasonable. In addition, the time series are checked for the detection of artificial changes in the measurement conditions, which may affect the results.

Homogeneity checks of time series are empirical techniques for identifying artificial changes that influence the measurement outcomes. Through these techniques, data adjustment is achieved, meaning the modification of measurements to remove systematic errors, while at the same time providing a reliable method for evaluating data quality. The Hydrological Study presents in detail the check for systematic errors in the available annual time series, using the double mass curve method.
Based on the conclusions of the Hydrological Study [et al., 1988 & Dingman, 1994], it is concluded that no significant inhomogeneity is observed in the available rainfall data, and therefore adjustment of the time series is not required.

### 6.6.1.6. Completion of Hydrological Samples

For the extraction of monthly time series of areal precipitation, the corresponding samples of the rainfall stations in the area were collected. To utilize these data, it was deemed necessary to complete or extend the point samples of the stations that presented gaps, since the primary data of the rainfall stations of the Ministry of Rural Development & Food (ΥΠΑΑΤ), but also partly of the Hellenic National Meteorological Service (HNMS), exhibited significant deficiencies.
The issue of sporadic gaps in measurements is common and is mainly due to equipment failures or observer constraints. The filling of these gaps was based on the data from neighboring stations. The calculations are presented in detail in the Hydrological Study.

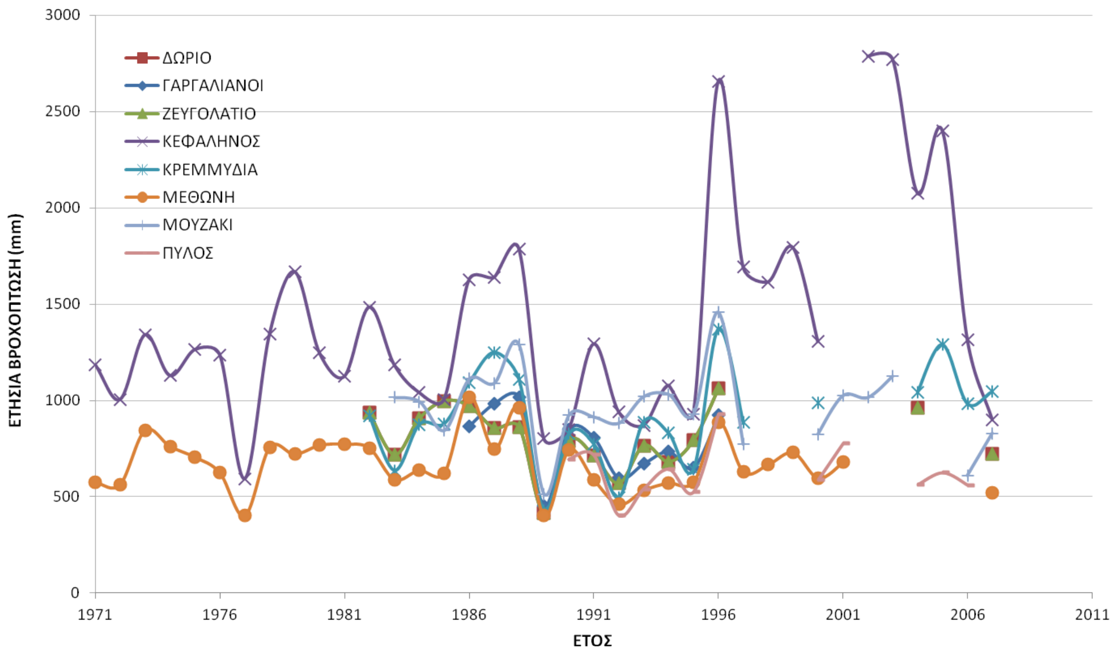


**Figure 6.8: Diagram of annual precipitation for the rainfall stations of the study area**.

#### 6.6.1.7. Areal Precipitation

The rainfall heights, as recorded by the rainfall stations, represent only the point where the precipitation was measured. However, for the estimation of the water balance, areal precipitation is important, as it represents the spatial distribution of rainfall in the catchment area. The conversion of point rainfall to areal rainfall is done through areal integration methods. In general, the denser the network of rainfall stations, the more successful the areal integration of rainfall.

In the literature, the methods used for areal integration are divided into direct integration methods and surface fitting methods. In the present study, a direct integration method was used: the Thiessen method. The calculations are presented in detail in the Hydrological Study.

In Figure I-2 of Annex I of the Hydrological Study, the Thiessen polygons formed for the wider study area are presented. Based on Hydrology, the equivalent areal rainfall height is shown in Table 6.9 and is estimated at 741.7 mm.

**Table 6.9: Calculation of the mean equivalent areal rainfall height.**

| Station | Mean Elevation (m) | Mean Annual Rainfall (mm) | Catchment Area within Subzone ($km^2$) | Station Influence Coefficient | Equivalent Areal Rainfall Height (mm) |
|---|---|---|---|---|---|
| Kremmydia | 341 | 956 | 7.38 | 0.254 | |
| Pylos | 50 | 630 | 8.29 | 0.286 | |
| Methoni | 62 | 693 | 13.37 | 0.460 | |
| **Average** | | 760 | | 1.00 | **741.7** |

#### 6.6.1.8. Elevation Adjustment of Precipitation

As shown in Map I-1 of Annex I of the Hydrological Study, the distribution of rainfall stations in the wider area is uneven. As a result, areal precipitation is underestimated, since rainfall height increases as a function of elevation. Therefore, if the mean elevation of the rainfall stations ($z_σ$) corresponds to the mean elevation of the catchment area ($z_s$), then the elevation distribution of the stations is representative. However, if these elevations show significant deviation, then correction of the areal precipitation is required.

In the wider project area, the mean elevation of the rainfall stations ($z_σ$) is 206 m, while the mean elevation of the catchment area ($z_s$) is 249 m. Consequently, the elevation distribution of the stations is not representative and requires correction. The calculations are presented in detail in the Hydrological Study.

Based on the Hydrological Study, the mean annual elevation-corrected areal rainfall height (sh) is estimated at 830.5 mm. In Table 6.10 below, the final time series of monthly elevation-corrected areal precipitation for the catchment area of the Minagiotiko stream is presented.

#### 6.6.1.9. Calculation of Evaporation from Free Surface

Unlike precipitation, natural evaporation is very difficult to measure reliably. The usual measuring instrument is the evaporation pan, which calculates water loss from a small basin. The difference in scale in terms of surface area and water volume between the pan and a hydrological basin results in an overestimation of the actual evaporation value. In addition, problems often arise related to the placement, maintenance, and security of the instrument, which render it completely unreliable.
Despite these measurement problems, the available evaporation data from the Pyrgos station, provided by HNMS (Annex IV of the Hydrological Study), are presented. At the Methoni meteorological station, from which all other meteorological variables were obtained, no evaporation measurements were available. The available time series covers the period 1983 to 2003, with gaps particularly in the years 1993 and 1998. The available evaporation values will be used as a reliability check for the estimates of evaporation and potential evapotranspiration.

#### 6.6.1.10. Calculation of Potential Evapotranspiration

As mentioned earlier, natural evaporation is very difficult to measure reliably. Consequently, the indirect estimation method of evaporation and potential evapotranspiration, based on measurements of other meteorological variables that affect it, is preferable. The calculations are presented in detail in the Hydrological Study.

##### 6.6.1.10.1. Comparison of Method Estimates – Available Data

In Tables V-9 and V-10 of Annex V of the Hydrological Study, the estimates of evaporation and potential evapotranspiration for the Methoni station are presented, based on the Penman-Monteith and Hargreaves methods. In addition, Annex IV presents the evaporation measurements from the HNMS station in Pyrgos. It is observed that the Hargreaves method underestimates evapotranspiration in coastal areas, where the difference between maximum and minimum temperature is reduced due to sea influence. In contrast, while the Penman-Monteith method correctly approaches the total annual potential evapotranspiration, it leads to an overestimation of potential evapotranspiration during the winter months.

These observations are presented below, summarized in Figure 6.9, and are confirmed by comparison with the measurements from the HNMS station in Pyrgos. However, the measurements from the Pyrgos station are not representative of the actual evaporation at the reservoir site, as the measurement was made in a fully exposed area to winds, without obstacles, which does not correspond to the actual conditions at the reservoir location. For this reason, the potential evapotranspiration calculated using the Penman-Monteith method will be used, as it provides an estimate more representative of the actual evaporation in the project area. Nevertheless, to address the overestimation of potential evapotranspiration during the winter months, the values are reduced by the ratio of the mean annual monthly measured evaporation to the mean annual monthly potential evapotranspiration according to Penman-Monteith.

**Table 6.10: Final time series of areal elevation-corrected monthly rainfall for the catchment area of the Minagiotiko stream.**

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1954 | 230.77 | 163.36 | 70.88 | 60.91 | 9.85 | 0.00 | 0.00 | 0.00 | 0.00 | 127.31 | 254.40 | 203.11 |
| 1955 | 174.45 | 57.10 | 79.05 | 109.62 | 7.39 | 0.00 | 0.00 | 18.70 | 42.21 | 214.98 | 189.79 | 77.04 |
| 1956 | 150.26 | 273.66 | 137.84 | 3.36 | 10.41 | 1.46 | 0.00 | 0.00 | 34.82 | 23.29 | 202.89 | 167.73 |
| 1957 | 117.12 | 15.45 | 73.23 | 49.83 | 110.74 | 39.19 | 0.00 | 8.96 | 19.26 | 87.34 | 170.31 | 84.43 |
| 1958 | 140.30 | 33.03 | 105.48 | 35.49 | 70.43 | 3.02 | 0.00 | 0.00 | 73.56 | 39.64 | 201.55 | 182.06 |
| 1959 | 149.48 | 12.20 | 135.71 | 74.68 | 11.20 | 36.38 | 0.00 | 5.71 | 31.58 | 98.87 | 78.38 | 144.22 |
| 1960 | 128.43 | 44.45 | 108.05 | 76.48 | 0.45 | 1.12 | 0.00 | 0.00 | 102.01 | 10.64 | 102.56 | 222.26 |
| 1961 | 189.79 | 67.29 | 104.92 | 23.07 | 5.60 | 38.97 | 0.00 | 0.00 | 30.23 | 230.66 | 118.69 | 195.39 |
| 1962 | 162.13 | 129.77 | 37.51 | 20.27 | 43.22 | 1.12 | 2.58 | 0.34 | 94.28 | 90.70 | 225.62 | 238.39 |
| 1963 | 120.26 | 110.18 | 107.83 | 20.15 | 21.50 | 2.69 | 0.00 | 2.46 | 59.01 | 584.93 | 37.62 | 91.37 |
| 1964 | 99.77 | 67.07 | 72.78 | 14.67 | 5.71 | 2.46 | 0.00 | 0.00 | 16.91 | 53.97 | 121.94 | 70.65 |
| 1965 | 174.11 | 205.47 | 32.02 | 62.03 | 18.03 | 3.36 | 0.00 | 41.76 | 0.00 | 41.54 | 126.41 | 113.20 |
| 1966 | 109.84 | 46.58 | 115.89 | 6.72 | 15.56 | 3.25 | 1.79 | 0.00 | 51.73 | 30.57 | 162.02 | 204.79 |
| 1967 | 126.19 | 58.34 | 61.02 | 64.61 | 7.84 | 5.49 | 0.00 | 8.62 | 8.96 | 70.65 | 59.23 | 159.22 |
| 1968 | 116.23 | 76.14 | 43.22 | 5.04 | 6.27 | 10.19 | 0.00 | 0.00 | 9.41 | 114.66 | 120.70 | 276.12 |
| 1969 | 120.48 | 52.51 | 123.17 | 24.97 | 11.87 | 0.22 | 0.00 | 0.00 | 8.17 | 65.73 | 66.40 | 300.88 |
| 1970 | 154.30 | 84.99 | 47.70 | 21.72 | 10.30 | 0.00 | 0.22 | 0.00 | 5.04 | 102.68 | 13.77 | 180.45 |
| 1971 | 127.31 | 115.33 | 75.58 | 2.24 | 5.37 | 2.80 | 0.11 | 0.22 | 14.33 | 106.15 | 94.06 | 99.65 |
| 1972 | 167.84 | 149.59 | 24.97 | 84.87 | 1.68 | 0.00 | 1.46 | 0.56 | 0.00 | 82.97 | 81.87 | 108.95 |
| 1973 | 198.52 | 138.28 | 72.22 | 60.91 | 8.17 | 0.00 | 0.00 | 8.73 | 89.13 | 163.48 | 90.70 | 116.56 |
| 1974 | 183.30 | 108.39 | 109.62 | 23.63 | 3.81 | 0.00 | 0.00 | 13.32 | 101.78 | 97.75 | 94.06 | 117.35 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1975 | 61.92 | 80.73 | 45.80 | 10.30 | 50.83 | 16.91 | 0.00 | 1.34 | 0.22 | 106.15 | 193.93 | 222.37 |
| 1976 | 77.48 | 53.75 | 73.45 | 69.53 | 12.54 | 7.95 | 0.22 | 4.14 | 5.49 | 109.62 | 114.10 | 171.87 |
| 1977 | 83.75 | 27.21 | 24.30 | 37.96 | 0.78 | 0.67 | 0.00 | 0.00 | 49.71 | 45.46 | 108.45 | 130.47 |
| 1978 | 172.99 | 144.55 | 78.60 | 68.75 | 21.39 | 0.67 | 0.00 | 0.00 | 35.27 | 72.67 | 105.70 | 147.91 |
| 1979 | 92.71 | 85.80 | 20.49 | 72.44 | 21.95 | 0.22 | 0.00 | 4.48 | 1.46 | 83.53 | 331.54 | 102.34 |
| 1980 | 178.93 | 92.15 | 101.11 | 38.18 | 29.34 | 1.90 | 0.00 | 0.00 | 37.29 | 187.44 | 85.99 | 106.82 |
| 1981 | 218.01 | 75.24 | 17.47 | 38.85 | 23.18 | 0.11 | 7.84 | 0.00 | 40.09 | 48.04 | 197.18 | 199.87 |
| 1982 | 155.17 | 62.48 | 230.44 | 64.47 | 83.52 | 0.00 | 1.98 | 6.69 | 5.66 | 98.11 | 207.92 | 188.14 |
| 1983 | 42.91 | 123.57 | 93.42 | 11.94 | 0.00 | 4.21 | 0.00 | 38.19 | 11.99 | 93.98 | 141.76 | 279.62 |
| 1984 | 186.90 | 231.40 | 102.51 | 125.05 | 1.96 | 0.00 | 0.85 | 18.63 | 2.64 | 135.13 | 129.93 | 147.94 |
| 1985 | 228.49 | 79.15 | 114.68 | 66.56 | 4.46 | 0.00 | 0.00 | 0.00 | 7.73 | 161.13 | 174.49 | 170.82 |
| 1986 | 247.11 | 170.46 | 121.22 | 21.17 | 22.02 | 14.02 | 0.00 | 0.00 | 215.28 | 327.09 | 127.16 | 184.24 |
| 1987 | 195.51 | 140.28 | 225.65 | 49.67 | 4.62 | 0.00 | 1.99 | 26.59 | 3.13 | 188.00 | 287.91 | 68.06 |
| 1988 | 201.75 | 154.74 | 145.48 | 33.31 | 21.06 | 0.34 | 0.00 | 1.12 | 24.76 | 114.96 | 408.11 | 288.02 |
| 1989 | 39.02 | 19.80 | 35.50 | 40.07 | 57.19 | 0.57 | 1.99 | 0.00 | 100.10 | 105.32 | 79.87 | 93.92 |
| 1990 | 36.64 | 96.09 | 2.48 | 37.79 | 4.18 | 4.42 | 0.00 | 9.39 | 32.43 | 56.78 | 162.06 | 397.67 |
| 1991 | 127.03 | 56.07 | 49.39 | 101.94 | 70.41 | 0.00 | 2.58 | 0.00 | 1.41 | 120.76 | 87.01 | 136.30 |
| 1992 | 33.79 | 45.89 | 42.62 | 74.70 | 28.30 | 42.42 | 8.89 | 0.00 | 2.77 | 22.43 | 79.49 | 126.24 |
| 1993 | 47.96 | 144.92 | 79.94 | 32.82 | 28.15 | 5.54 | 0.00 | 0.00 | 15.61 | 7.29 | 225.94 | 112.02 |
| 1994 | 136.84 | 149.53 | 30.20 | 51.38 | 12.89 | 0.00 | 0.00 | 0.00 | 0.34 | 132.76 | 67.10 | 155.88 |
| 1995 | 143.09 | 45.70 | 56.11 | 9.04 | 5.89 | 1.97 | 1.42 | 20.93 | 50.01 | 12.11 | 142.48 | 158.69 |
| 1996 | 246.57 | 163.36 | 157.30 | 47.18 | 27.86 | 19.43 | 0.00 | 10.87 | 61.51 | 153.81 | 68.10 | 188.36 |
| 1997 | 66.35 | 100.66 | 57.56 | 57.01 | 34.30 | 2.92 | 0.00 | 11.63 | 39.52 | 53.34 | 112.45 | 233.52 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1998 | 96.44 | 42.67 | 88.06 | 15.16 | 35.20 | 1.03 | 0.00 | 4.46 | 51.71 | 46.17 | 202.64 | 241.62 |
| 1999 | 75.54 | 118.63 | 73.96 | 85.46 | 4.48 | 0.00 | 0.00 | 7.09 | 125.89 | 15.28 | 181.98 | 161.70 |
| 2000 | 49.91 | 205.20 | 34.56 | 33.56 | 25.15 | 5.81 | 0.11 | 0.00 | 19.57 | 123.71 | 148.42 | 130.24 |
| 2001 | 64.89 | 182.54 | 31.24 | 141.58 | 21.79 | 6.83 | 0.00 | 3.47 | 21.11 | 37.69 | 246.48 | 175.27 |
| 2002 | 90.67 | 15.27 | 113.68 | 89.03 | 11.16 | 0.07 | 29.50 | 14.57 | 123.70 | 94.87 | 194.86 | 323.90 |
| 2003 | 273.69 | 202.82 | 71.77 | 61.37 | 63.89 | 46.79 | 4.86 | 12.21 | 58.01 | 78.10 | 66.72 | 204.38 |
| 2004 | 240.89 | 38.01 | 63.46 | 88.88 | 12.13 | 12.84 | 12.81 | 4.18 | 49.94 | 15.98 | 106.92 | 182.17 |
| 2005 | 136.52 | 137.49 | 92.06 | 17.95 | 19.71 | 5.98 | 0.00 | 0.00 | 29.19 | 48.80 | 278.03 | 153.85 |
| 2006 | 127.27 | 124.91 | 106.81 | 39.93 | 29.48 | 12.12 | 22.35 | 6.76 | 73.42 | 110.46 | 69.27 | 40.94 |
| 2007 | 11.86 | 113.48 | 39.11 | 26.80 | 71.30 | 23.15 | 0.00 | 0.00 | 24.37 | 130.11 | 123.15 | 160.22 |
| 2008 | 71.21 | 37.96 | 31.02 | 82.75 | 7.95 | 0.34 | 0.00 | 0.00 | 24.56 | 19.47 | 94.65 | 136.46 |
| 2009 | 260.34 | 149.46 | 132.74 | 75.76 | 38.04 | 11.04 | 0.00 | 5.41 | 68.97 | 127.65 | 122.72 | 203.23 |
| 2010 | 166.95 | 70.54 | 26.43 | 0.78 | 8.96 | 5.82 | 0.00 | 0.00 | 5.93 | 79.83 | 15.90 | 71.44 |
| 2011 | 201.43 | 131.34 | 61.81 | 81.29 | 18.59 | 0.11 | 0.00 | 0.00 | 23.74 | 59.57 | 13.21 | 107.16 |
| 2012 | 5.82 | 93.27 | 30.90 | 25.64 | 4.14 | 0.22 | 0.11 | 2.02 | 0.00 | 17.47 | 100.21 | 158.44 |
| 2013 | 64.38 | 96.85 | 46.92 | 0.11 | 0.00 | 0.00 | 0.00 | 0.11 | 0.22 | 68.64 | 82.07 | 66.96 |
| 2014 | 171.20 | 85.21 | 159.00 | 33.82 | 2.24 | 9.52 | 0.00 | 0.00 | 17.02 | 104.92 | 44.00 | 140.41 |

### 6.6.1.11. Incorporation of Climate Change in the Estimation of Evaporation

Long-term observations in the North-Western Mediterranean indicate an increase in surface water temperature of 1°C over the last 30 years. For the Eastern Mediterranean, recent research has shown that between 1982 and 2003 the temperature increased by 2.6°C (EEA Interim Report, 2006).

If we also wish to make a forecast for the prevailing conditions during the operational period of the project, we must take into account, when estimating the water balance, the impacts of climate change. The tools currently used for climate change simulation share similarities with the models used for short-term weather forecasting.

These tools are the Coupled Atmospheric-Ocean General Circulation Models (AOGCMs). They are models based on the fundamental physical principles of the Earth system, such as the basic equations of fluid mechanics and radiation transfer. Since knowledge of certain physical processes is still limited, parameterizations are used in climate simulations, while simplifying assumptions are made for certain phenomena.

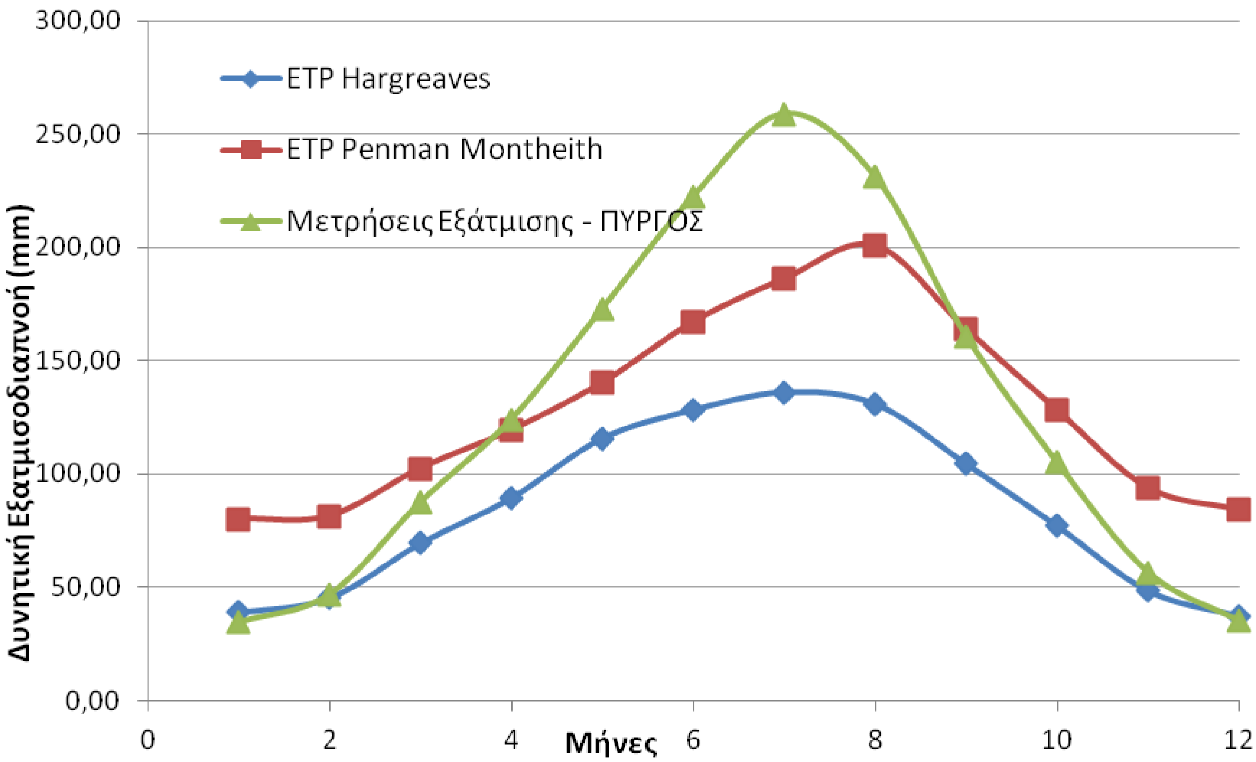



**Figure 6.9: Comparison of estimates of mean monthly potential evapotranspiration (Hargreaves & Penman) and available evaporation measurements (Pyrgos).**

The AOGCMs are divided into Atmospheric General Circulation Models (AGCMs) and Ocean General Circulation Models (OGCMs), while they can also be coupled with each other (AOGCMs) as well as with other models. Furthermore, in order to simulate climatic conditions in specific regions of the planet and not globally, Regional Climate Models (RCMs) are used, which apply downscaling techniques. These models operate at higher spatial resolution, but over a more limited area.
The estimates of the models are based on different assumptions (emission scenarios) regarding the future evolution of greenhouse gas emissions, as formulated by the Intergovernmental Panel on Climate Change (IPCC) of the United Nations. The development of these scenarios was based on certain key factors related to the evolution of global population, energy-related policies, the rate of economic growth, future technological development, as well as the extent to which decisions on economic, social, and environmental issues are made at the local or international level (Table 6.11).

For example, the A1B family of scenarios describes a future in which the world will experience economic growth, the planet's population will increase and reach its peak in the middle of the century, and then decline.

**Table 6.11: Summary of scenarios for future greenhouse gas emissions up to 2100 (Source: IPCC).**

| | |
|---|---|
| Scenario A2 | Moderate increase in average global per capita income. Particularly high energy consumption. Rapid growth of the global population. Slow and partial technological development and moderate to significant changes in land use. Rapid increase in $CO_2$ concentration in the atmosphere, reaching 850 ppm by 2100. |
| Scenario A1B | Rapid economic growth. Particularly high energy consumption, but alongside the spread of new and efficient technologies. Use of both fossil fuels and alternative energy sources. Small changes in land use. Rapid increase in global population until 2050 and gradual decline thereafter. Significant increase in $CO_2$ concentration in the atmosphere, reaching 720 ppm by 2100. |
| Scenario B2 | Development of the global economy at a moderate pace. Slower technological changes compared to the A1 and B1 emission scenarios. Rapid increase in global population. Increase in $CO_2$ concentration in the atmosphere at slower but steady rates, reaching 620 ppm by 2100. |
| Scenario B1 | Significant increase in average global per capita income. Low energy consumption. Reduction in the use of conventional energy sources and a shift to technologies using renewable energy sources. Rapid increase in global population until 2050 and gradual decline thereafter. Increase in $CO_2$ concentration in the atmosphere at slower rates, especially from 2050 onwards, reaching 550 ppm by 2100. |

With regard specifically to the region of South-Eastern Europe and in particular the Eastern Mediterranean, where the project area is located, based on climate change studies that have been conducted (Alpert et al., 2008; Logothetis/Aristotle University of Thessaloniki, 2005, etc.), all models and all scenarios predict a temperature increase. More specifically:

- For scenario A1B (which assumes an average increase in emissions), the range of temperature rise will be between 2.3–4.3°C by 2100. Results showed that in South-Eastern Europe the rate of temperature increase is higher during July. In addition, for the Mediterranean region, an increase in flood events and a decrease in rainfall are expected.
- For scenario A2 (which assumes a rapid increase in emissions), the projected temperature rise is between 4–6°C by 2100 (Alpert et al., 2008).

Furthermore, Karavokyris and Partners (2010) examined, for a number of reservoirs in Cyprus, the effect on evaporation of the increase in:

a) temperature,
b) temperature and relative humidity, and
c) temperature, relative humidity, and wind speed.

It was found that evaporation values are mainly affected by the increase in temperature and, to a lesser extent, by the increase in wind speed.
Based on all of the above, for the simulation of climatic conditions during the operational period of the project, the following assumptions are made:

a) temperature increase of 2°C during the summer months and 1°C during the winter months, and
b) increase in wind speed by 10%.

Figure 6.10 presents the estimates of potential evapotranspiration with and without the impact of climate change. For the estimation of potential evapotranspiration, the Penman-Monteith and Hargreaves methods were used. We observe an increase in potential evapotranspiration of 14% and 4%, respectively, in the estimates of the Penman-Monteith and Hargreaves methods.

Since the Penman-Monteith method better approximates maximum potential evapotranspiration during the summer months—which represent the most adverse period—the estimated value will be increased by 14%. This adjusted evaporation time series will be used in the calculation of the water balance.

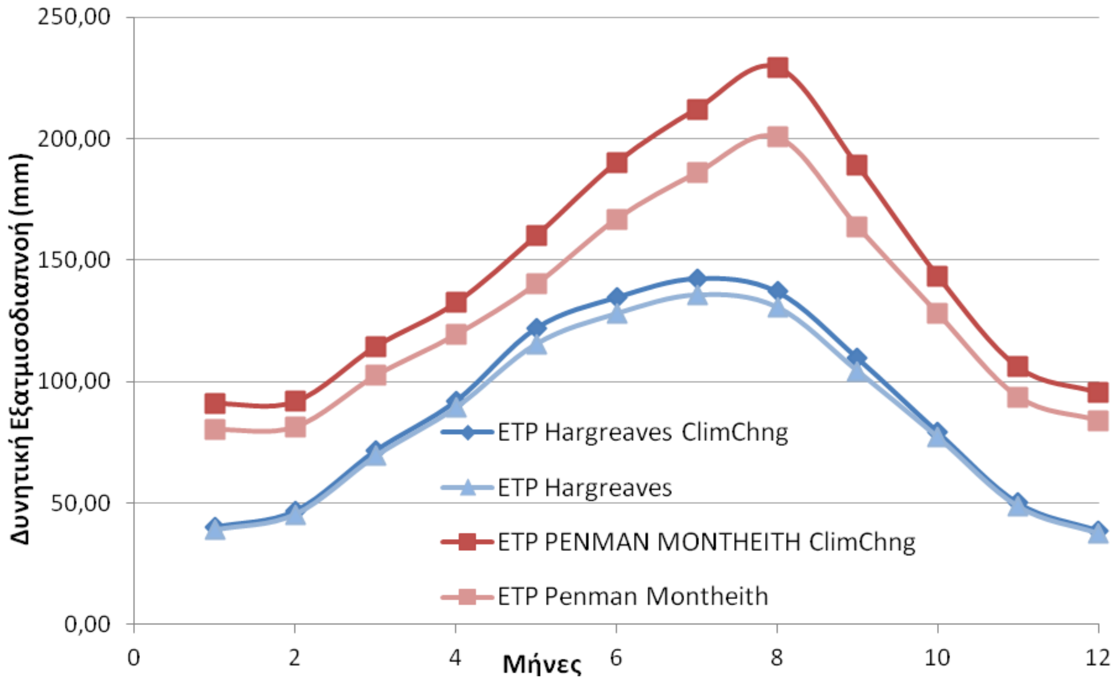



**Figure 6.10: Comparison of estimates of mean monthly potential evapotranspiration (Hargreaves & Penman) with or without the impact of climate change.**

### 6.6.1.12. Incorporation of Climate Change in the Estimation of Rainfall

According to the report of the European Environment Agency (EEA, 2012), a general decrease in rainfall is projected for the region. However, research on the simulation of the impact of climate change on rainfall in the South-Eastern Mediterranean is limited.

Based on the results of Van der Linden and Mitchel (2009) and Tapiador (2010), a reduction in rainfall between 5% and 20% is expected. Furthermore, all studies predict an increase in the frequency of extreme rainfall events (Albert et al., 2008).

Based on all the above, for the simulation of climatic conditions during the operational period of the project, the following assumption is made: a reduction of mean monthly rainfall by 5% during the winter months and by 10% during the summer months.

### 6.6.1.13. Geological and Soil Characteristics of the Catchment

Below are the findings from the geological surveys carried out so far in the project area, compiled within the framework of the present study.

In general, the geological structure of the area consists of flysch, Pliocene, and recent soil formations. Specifically:

- **Flysch formations**, which constitute the geological bedrock of the area and belong to the Gavrovo–Tripolis geotectonic zone, consist of alternating conglomerates, sandstones, and siltstones, with a rocky or semi-rocky structure.

- **Pliocene formations**, which have been deposited over the paleomorphological relief of the flysch, consist of marls and sandstones of semi-coherent structure.
- **Recent soil formations**, which have been deposited along the wider bed of the stream (alluvial deposits) or on the slopes of the area (colluvium and weathering products), consist of a mixture of fine-grained and coarse-grained materials with a loose structure.

In Annex II of the Hydrological Study, the geological map (Drawing: II-1) of the wider study area is presented. Based on this map, we present the lithological groups of the catchment in summary form in **Table 6.12**.

**Table 6.12: Percentages of main geological formations within the catchment.**

| Lithological Groups | Covered Area (km²) | Percentage of Catchment (%) |
|---|---|---|
| Sandstones | 13.20 | 45.67 |
| Conglomerates | 1.13 | 3.91 |
| Silty-Sandy Formations | 14.57 | 50.42 |
| **Total** | 28.9 | 100.00 |

### 6.6.1.14. Vegetation Cover Characteristics of the Catchment

The determination of vegetation cover and land uses of the catchments in the study area is based on the *Corine Land Cover* maps of the Hellenic Mapping and Cadastral Organization (OKXE).

In Annex III of the Hydrological Study, a map is presented with the land cover data according to *Corine Land Cover* for the study area, at a scale of 1:20,000 (Drawing III-1 of the present EIA). From this map, it is shown that:

- the largest part of the catchment is covered by agricultural land with significant natural vegetation (57%),
- while significant portions of the catchment are covered by olive groves (19%), complex cultivation systems, and mixed forest (9%).

**Table 6.13: Main land cover types within the catchment.**

| Main land use category | Covered Area (km²) | Percentage of Catchment (%) |
|---|---|---|

| | | |
|---|---|---|
| Agricultural land with significant natural vegetation | 16.39 | 57 |
| Olive groves | 5.52 | 19 |
| Mixed forest | 2.62 | 9 |
| Complex cultivation systems | 3.79 | 13 |
| Non-irrigated arable land | 0.25 | 1 |
| Sclerophyllous vegetation | 0.30 | 1 |
| **Total** | 28.9 | 100 |

### 6.6.2. Calculation of Inflows to the Reservoir

The objective of this investigation is to estimate the extractable volume of water for irrigation from the reservoir under study. The calculation of the available extractable volume will be carried out through the water balance of the catchment.

For this purpose, internationally recognized models for water balance calculation were used. Their results are presented in the following sections. It should be noted that the input data of the models (rainfall, temperature, etc.), as well as their results (discharge), are given in dimensionless form (mm), so that they are comparable for all catchment sizes.

#### 6.6.2.1. Water Balance according to Thornthwaite

The runoff will be estimated based on the water balance of the catchment of the dam. The equation of the water balance of the catchment is expressed on a monthly basis and is calculated relative to the catchment area. The equation is given as:

$$P = Vs + Vi + Ur + \Delta S$$

where:

- **P**: the volume of incoming precipitation [mm],
- **Vs**: the volume of surface runoff [mm],
- **Vi**: the volume of groundwater runoff [mm],
- **Ur**: the volume of hydrological losses, e.g., potential evapotranspiration [mm],
- **S**: the volume corresponding to the increase in soil moisture [mm].

##### 6.6.2.1.1 Estimation of Available Soil Moisture

Available moisture is defined as the difference between the field capacity of the soil and the wilting coefficient. Field capacity is the soil’s moisture content after the removal of gravitational water. The wilting coefficient represents the soil's moisture content when plants can no longer absorb water and corresponds to the depletion of the entire available soil moisture (Table 6.14).

For the study area, the estimation of available soil moisture is carried out using the land cover maps *"Corine Land Cover"* of the Hellenic Mapping and Cadastral Organization (Section 6.6.1.14).

In Table VI-1 of Annex VI, which is attached in Annex 3 (Hydrology) of the present EIA, the land uses in the catchment area of the dam are presented, along with the calculation of the total available soil moisture. Based on the processed rainfall and potential evapotranspiration time series, the estimation of the mean monthly available soil moisture is provided in Table VI-2 of Annex VI, attached in the Hydrology annex of the present EIA.

**Table 6.14: Representative physical properties of soils (Source: Israelsen and Hansen, 1968).**

| Soil Texture | Porosity (%) | Dry Bulk Density (g/cm$^3$) | Field Capacity (%) | Wilting Coefficient (%) | Available Moisture (%) |
|---|---|---|---|---|---|
| Sandy | 38 | 1.65 | 9 | 4 | 8 |
| Sandy Loam | 43 | 1.50 | 14 | 6 | 12 |
| Loam | 47 | 1.40 | 22 | 10 | 17 |
| Clay Loam | 49 | 1.35 | 27 | 13 | 19 |
| Silty Loam | 51 | 1.30 | 31 | 15 | 21 |
| Clay | 53 | 1.25 | 35 | 17 | 23 |

#### 6.6.2.1.2. Estimation of Infiltration and Surface Runoff Coefficients

The coefficients represent free parameters for the water balance models. Their estimation was derived from the ongoing geological surveys, and their values vary depending on each geological formation. In Table 3 of Annex VI, attached in the hydrological appendix of the present EIA, the values of the effective infiltration and surface runoff coefficients for each geological formation of the catchment area are presented.

#### 6.6.2.1.3. Estimation of Annual Inflows into the Reservoir

Based on all the above, it was determined that the mean annual inflow into the reservoir is estimated at **9,049,875 m³**. The calculations were based, among other factors, on data from the geological surveys carried out to date.

## 6.6.2.2. Water Balance Using the GR2M Model

### 6.6.2.2.1. Description of the Functioning of the GR2M Model

The GR2M hydrological model is a lumped conceptual rainfall–runoff model with two free parameters, developed by the HYDRO group of the Irstea (ex. Cemagref) laboratory in France (Mouelhi et al., 2006). The model operates on a monthly time step, using rainfall and potential evapotranspiration time series as input data.
To simulate hydrological processes, two "reservoirs" are used:

- (a) the soil reservoir (X1), which simulates surface runoff and infiltration into the superficial soil layers, with capacity S, and
- (b) the subsurface reservoir, which simulates water storage and transfer in the groundwater layers, with a fixed storage capacity of 60 mm.

The soil–subsurface interaction is simulated via the "exchange" parameter X2. In summary, the model has two free parameters, X1 and X2, and its structure is presented schematically in the Hydrological Study. The structure of this model has been evaluated in more than 400 catchments of different climatic characteristics.
However, the ability of the model to simulate the water balance of a catchment depends on its calibration. Calibration is performed using historical (measured) runoff time series, optimizing the free parameters X1 and X2 accordingly. Thus, the parameters and initial conditions to be optimized are selected. The Nash–Sutcliffe efficiency coefficient is used as the performance measure to assess the fit between simulated and observed runoff:

$$NS = 1 - \frac{\sum_{i=1}^{n} (Q_o{}^i - Q_m{}^i)^2}{\sum_{i=1}^{n} (Q_o{}^i - \dddot{Q}_o)^2}$$

where:

- **$Q_i^o$**: observed (measured) discharge in month *i* [mm],
- **$Q_i^m$**: discharge calculated by the model in month *i* [mm],
- **$\bar{Q}_o$**: mean monthly observed discharge [mm].

### 6.6.2.2.2. Calibration Based on the Thornthwaite Time Series

In the study area, neither historical measured runoff time series are available nor can the parameters be fully estimated from neighboring catchments. For this reason, and because the operation of the model requires parameter calibration, both the estimated runoff time series according to Thornthwaite and the estimated surface runoff coefficient from the geological study were used. The estimated runoff time series depends significantly on the calibration period. Specifically, runoff was calculated using successive calibration periods: 1957–2011, 1957–1989, and 1990–2011. The correct choice of the calibration period is critical for the proper operation of the GR2M model. It was estimated that the simulated discharges best describe actual conditions when calibration takes into account the period 1990–2011.

##### 6.6.2.2.3. Estimation of Annual Inflows to the Reservoir

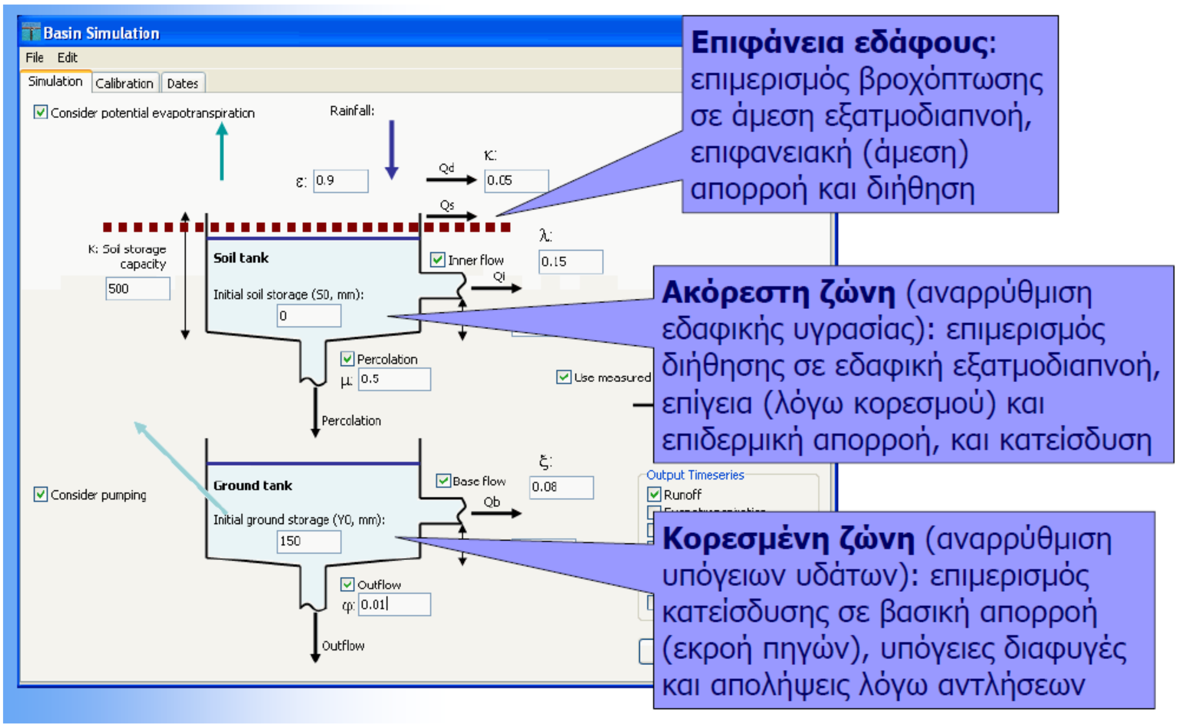
From the optimization of the parameters for the calibration period 1990–2011, the values of parameters X1 and X2 were estimated at 228.15 and 0.98 mm respectively, while the filling levels of the two reservoirs of the model were 116 and 60 mm, respectively. Based on the Nash-Sutcliffe coefficient, the adjustment of the simulated discharge was estimated at 90%.
Accordingly, the mean annual runoff to the reservoir was estimated at **8,746,888 m³**.

#### 6.6.2.3. Water Balance Using the ZYGOS Model

##### 6.6.2.3.1. Description of the Functioning of the ZYGOS Model

The ZYGOS routine is a conceptual lumped monthly water balance model and constitutes part of the HYDRONOMON platform developed by the Water Resources Department of NTUA and the Hydrocosmos Systems Consortium (NTUA-“ITIA”, 2010). The ZYGOS water balance model is based on the logic of the Thornthwaite equation. The model represents the basic hydrological processes of the soil, the unsaturated zone, and the aquifer (saturated zone) of a catchment. Depending on the basin and the processes simulated, the model includes from 1 to 9 free parameters (Figure 6.11). The model is designed primarily for estimating the water potential of small- and medium-scale catchments, for which discharge measurements are not available, using empirical values of the parameters. Where discharge measurements are available at the catchment outlet, automatic parameter estimation is possible through calibration. The input data of the model are the time series of areal precipitation and potential evapotranspiration. The time series are monthly, covering a common time period. The time series are normalized to the catchment area (in mm), so that comparison between different catchments is possible. The initial conditions of the model are soil moisture and groundwater storage.
In general, the model can be used whether or not a measured discharge time series is available. In the latter case, the parameters may be taken from a neighboring

catchment, if they share common characteristics, or the number of parameters used can be reduced. For the hydrological catchment of the Minagiotiko stream, due to lack of discharge measurements both within it and in neighboring catchments, no calibration was performed on the model. Furthermore, the simulation considered infiltration from the soil surface to the unsaturated zone, percolation into the saturated zone, as well as groundwater runoff.




### 6.6.2.3.2. Estimation of Annual Inflows to the Reservoir

For the estimation of the annual inflow, the free parameters of surface runoff (κ), effective infiltration (μ), flow in the surface soil layers (λ), and baseflow (ζ) were used. The values of these parameters were estimated, where possible, from the geological study. Thus, for these parameters the following values were derived:

| κ | μ | λ | ζ |
|---|---|---|---|
| 0.22 | 0.04 | 0.5 | 0.5 |

In addition, as initial conditions, the levels in the soil and subsoil reservoirs were set equal to 116 mm. Based on the above, the annual inflow into the reservoir is estimated at **9,410,087 m³**.

### 6.6.2.4. Water Balance Using the USGS Thornthwaite Model

#### 6.6.2.4.1. Description of the Model's Function

The USGS Thornthwaite water balance model was developed by the United States Geological Survey (USGS, 2007). The model calculates, on a monthly basis, the amount of water in the various phases of the hydrological cycle. **Figure 6.12** illustrates the different phases of the hydrological cycle and their interactions, as simulated in the USGS Thornthwaite model.

The model has three free parameters: **latitude, soil moisture, and direct runoff coefficient**. The input data to the model are the monthly time series of precipitation and temperature, while it computes the time series of runoff (surface or total), potential evapotranspiration, soil "reservoir" level, etc. The model includes a two-parameter subroutine for converting precipitation into snowfall, with criteria being temperature and the melt coefficient.

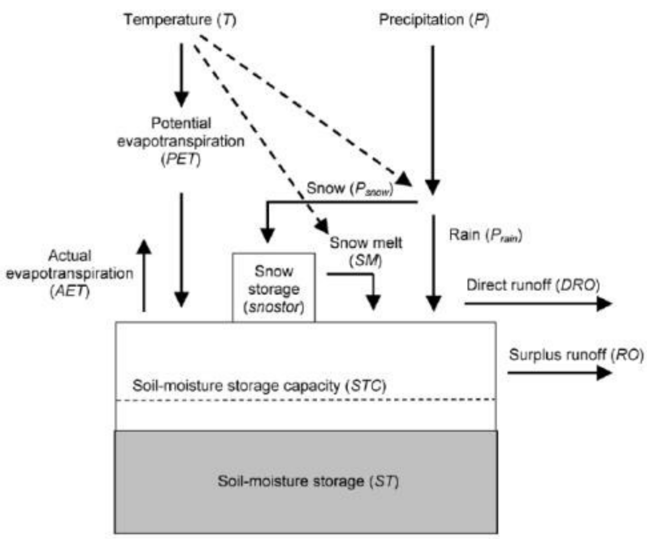



**Figure 6.12: Schematic of the operation of the USGS Thornthwaite model.**

#### 6.6.2.4.2. Estimation of Annual Inflows into the Reservoir

For the estimation of the annual inflow, the free parameters **latitude (Latitude)**, **soil moisture (So)**, and **direct runoff coefficient (k)** were used. The values of these parameters were estimated, where possible, from the geological study and from the land cover maps. For the parameters of the subroutine that simulates snowfall, the parameters (**threshold temperature Toρ, melt rate**) were estimated from the climatic data of the wider area. Accordingly, the following values were obtained for these parameters:

| k | So | Latitude | Top | Melt Rate |
|---|---|---|---|---|
| 0.22 | 116 | 37° | 0 °C | 50% |

Based on the above, the annual inflow into the reservoir is estimated at: **10,616,388.73 m³**.

### 6.6.2.5. Annual Inflows into the Minagiotiko Reservoir

The annual inflows into the reservoir were calculated successively using the three water balance models presented above. As derived, all three models provided estimates that varied between 3.3% and 17.0%. The lack of flow measurements in the Minagiotiko stream, as well as in neighboring catchments, makes the estimation of annual inflows rather difficult. Given that the ZYGOS model is the most adapted to Greek conditions and its free parameters were mostly estimated from the on-site geological conditions, the Consultant adopted its estimate for the annual inflows used for the sizing of the reservoir (**9,410,087 m³**).

### 6.6.2.6. Estimation of Water Supply Needs

Near the dam site is located the aqueduct of Lachanada, which is supplied by the "Mylou Vlassi" springs. These springs are located 6.75 km north of the village of Lachanada. The available water is used both for the water supply of the homonymous settlement and neighboring villages, as well as for the irrigation of the cultivated areas in its surrounding region.

The **Lachanada aqueduct** will be significantly affected by the operation of the dam. In order to ensure the uninterrupted supply of drinking and irrigation water to the settlements served by the Lachanada aqueduct, provision must be made for these needs to be covered either from the Minagiotiko reservoir or from another source.
For the calculation of the total water supply needs, the data from the study *"Water Supply and Partial Irrigation Project of the Community of Lachanada"*, prepared by the

Technical Service of the Prefecture of Messinia (1967), and provided to the Study Team by the Technical Service of the Municipality of Pylos-Nestor, were used.

Based on the data of this study, the water supply needs covered by the Lachanada aqueduct amounted to **36,956 m³**. However, local services (DEYA Methonis, Technical Service of the Municipality of Pylos-Nestor) indicated that the total capacity of the spring is now used exclusively for water supply, amounting to **252,288 m³**. According to the 2001 census data (ELSTAT), the permanent population of Lachanada and neighboring villages has decreased compared to 1961, but the population of Finikounda has increased significantly, due to tourism and the associated seasonal fluctuations.

The monthly distribution of water supply flow varies significantly between summer and winter months, as demand increases substantially in the summer. On this basis, the monthly values are calculated by multiplying the average monthly supply value by a coefficient:

- equal to **1.3** for the months from May to October, and
- equal to **0.7** for the months from November to April.

#### 6.6.2.7. Estimation of Ecological Flow

The determination of ecological flow is a critical parameter in the calculation of the water balance of the Minagiotiko dam's catchment. In the absence of a National Regulation that clearly specifies the methodology for estimating ecological flow, consultants often refer to the Joint Ministerial Decision (JMD) 49828/2008, which, however, applies exclusively to Small Hydroelectric Projects. Based on this legislation, the ecological flow is proposed as the largest of the following values:

- 30% of the average flow of June, July, and August (a),
- 50% of the average flow of September (b),
- or at least 30 l/s (c).

From the above scenarios, it appears that for the catchment under study, ecological flow values calculated under scenarios (a) and (b) yield unacceptably low results. The minimum requirement – according to scenario (c) – of **30 l/s** corresponds annually to **933,120 m³**.

The Consultant also referred to international methodologies for selecting the most appropriate method of ecological flow estimation. Simplified hydrological methods used in the rest of Europe generally take the **Mean Annual Flow (MAF)** as reference, with ecological flow calculated as a percentage of the MAF. For the Minagiotiko stream basin, the mean annual flow is **9,410,087 m³**. According to national legislations, this percentage varies by country (with higher thresholds applied in Germany and Canada).

Given that the climatic conditions of Greece share similarities with those of other Mediterranean countries (Italy, Spain, France), the ecological flow is calculated as 2.5%, 5%, and 10% of the mean annual flow, corresponding to **235,252 m³, 470,504 m³, and 941,009 m³**, respectively.

Based on all the above, an ecological flow equal to **933,120 m³** was selected, corresponding to **9.9%** of the mean annual flow (~9,410,087 m³), or **30 l/s**. It is noted that this value is distributed equally across each month of the year, i.e., **77,760 m³** (equivalent to 1/12 of the total annual ecological flow). Through the provision of this ecological flow, a continuous downstream discharge of the dam will be ensured, which during the summer months will significantly exceed the natural river flow.

### 6.6.3. Calculation of Sediment Yield – Dead Storage

For the quantitative estimation of soil erosion, a simple empirical method of soil loss assessment is applied. This method is the **Universal Soil Loss Equation (USLE)** [Wischmeier and Smith, 1965, 1978; Schwertmann, 1986], which was developed as a tool for estimating soil erosion and for evaluating the effectiveness of soil conservation practices.

According to this equation, soil erosion is influenced by rainfall characteristics, slope, vegetation cover, and management practices. Conversely, soil properties play a less decisive role in erosion rates. However, certain soils are more prone to erosion than others, even under identical conditions. This difference is attributed to their **erodibility**.

The general equation is expressed as:

$$SE=R\cdot K\cdot LS\cdot C\cdot PSE$$

where:

- **SE**: Soil loss per unit area of the catchment [t/ha],
- **R**: Rainfall erosivity factor [MJ mm $ha^{-1}$ $h^{-1}$],
- **K**: Soil erodibility factor [t h $MJ^{-1}$ $mm^{-1}$],
- **LS**: Dimensionless topographic factor,
- **C**: Dimensionless vegetation cover factor,
- **P**: Dimensionless land management (erosion control) factor.

### 6.6.3.1. Rainfall Erosivity Factor (R)

Rainfall erosivity (R) refers to the erosion potential of precipitation and surface runoff. The erosive power of rainfall results partly from the direct impact of raindrops and partly from the runoff generated by rainfall.

The value of the R-factor is defined as the sum of all **$EI_{30}$** values for all major rainfall events during a hydrological year, where **$EI_{30}$** is the product of the **kinetic energy (E)** of the rainfall and the maximum **30-minute rainfall intensity ($I_{30}$)** for each storm event.

To establish the **$EI_{30}$ index** over a hydrological year, it is necessary to have pluviograph data with a 30-minute time step, which are often unavailable. For this reason, the technique proposed by **Renard and Freimund (1994)** is applied, whereby the rainfall erosivity factor **R** is correlated with other, more easily accessible variables.

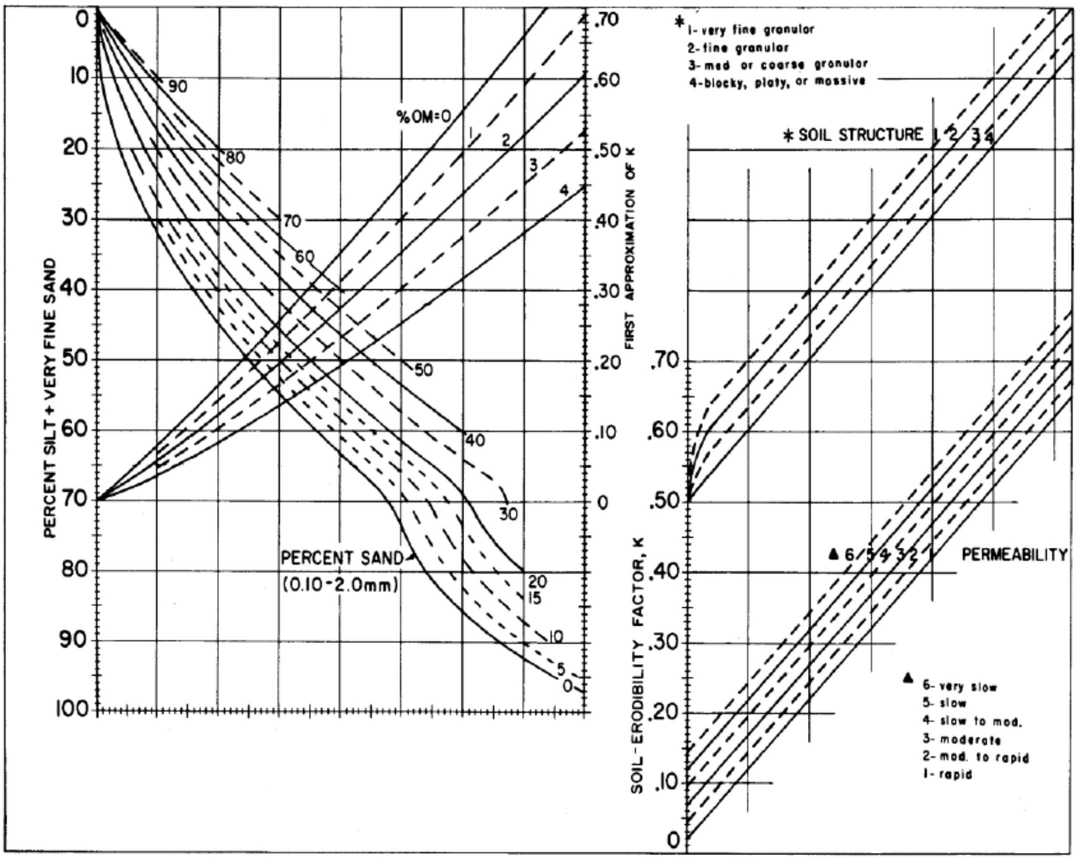
The calculation employs the **Modified Fournier Index (MF)**, which is a function of the mean monthly precipitation pip_ipi (mm) and the mean annual precipitation PPP (mm). The relationship is expressed as:

$$R = 0.7397 MF^{1.847}, MF < 55mm$$

$$R = 95.77 - 6.081 MF + 0.477 MF^{2}, MF > 55mm$$

$$MF = \frac{\sum_{i=1}^{12} p_i^{2}}{P}$$

where the **Fournier Index (MF)** is a function of the mean monthly precipitation pip_ipi (mm) and the mean annual precipitation PPP (mm). For the catchment area of the **Minagiotiko dam**, the rainfall erosivity factor **R** on an annual basis is calculated as **4,901.69**.




The soil-erodibility nomograph. Where the silt fraction does not exceed 70 percent, the equation is $100\ K = 2.1\ M^{1.14}\ (10^{-4})\ (12 - a) + 3.25\ (b - 2) + 2.5\ (c - 3)$ where $M =$ (percent si + vfs) (100 − percent c), $a =$ percent organic matter, $b =$ structure code, and $c =$ profile permeability class.

**Figure 6.13: Nomograph for calculating the soil erodibility factor (K).**

### 6.6.3.2. Soil Erodibility Factor (K)

Soil erodibility (K) refers to the amount of soil lost from a standard experimental plot of 22.1 m in length and with a 9% slope, under conditions of soil tillage and continuous fallow. The K factor is an empirical criterion of soil erodibility and is influenced by the complex interactions of various physical and chemical properties of the soil.

As mentioned earlier, soil properties contribute less to the rate of erosion. However, some soils are more sensitive to erosion than others, even when all other factors are identical. The soil erodibility factor K results from the physical composition of the soil material in terms of clay, silt, and sand. In cases where soil data are not available, K values are approximately estimated from the geology of the area, by making assumptions about the physical composition of the soil materials in clay, silt, and sand fractions produced by the weathering of parent rocks.

In this case, the value of the soil erodibility factor K is derived from the nomographs (Figure 6.13).

Table 6.15 presents the percentages occupied by the main lithological groups of the catchment area of the Minagiotiko dam and the estimated value of the soil erodibility factor K, as derived from the nomographs of the **USLE Handbook** (Wischmeier & Smith, 1978).

**Table 6.15: Characteristic values of the K factor for each geological formation.**

| **Lithological Groups** | **Covered Area** | **Percentage of the Basin (%)** | **Soil Erodibility Factor (K)** |
|---|---|---|---|
| Sandstones | 13.20 | 45.67 | From |
| Conglomerates | 1.13 | 3.91 | Geological Study |
| Silty-Clayey | 14.57 | 50.42 | |
| **Total** | 28.9 | 100.00 | 0.12 |

### 6.6.3.3. The Topographic Factor

The slope-length factor (L) and the slope-gradient factor (S) in the USLE represent the effect of topography on soil erosion. The LS factor is the ratio of the amount of soil lost from the eroded area to the amount of soil lost from a standard experimental plot 22.1 m long, with a 9% slope, and under continuous fallow conditions. The slope of inclined areas affects soil erosion. When all other factors influencing erosion remain constant, soil losses increase with increasing slope gradient.

The topographic factor LS consists of the product of the slope-length factor L and the slope-gradient factor S. Specifically, the slope-length factor L is calculated using the following equation:

$$L = \left(\frac{\lambda}{22.1}\right)^m$$

where:

λ:is the slope length on a horizontal plane, and

m : is an exponent, which is equal to 0.5 if the slope is ≥ 5%, 0.4 if the slope is between 3 and 5%, 0.3 if it is between 1 and 3%, and 0.2 if the slope is ≤ 1%.

The slope-gradient factor S is calculated using the following equation:

$$S = \frac{0.43 + 0.3s + 0.043s^2}{6.574}$$

where:

s : is the slope (%).

The LS factor is calculated from the Digital Terrain Model (DTM), which was processed using ArcGIS software.
Based on the above, it follows that the value of the LS factor is equal to 0.77.

### 6.6.3.4. The Cover-Management Factor

The C factor of the Universal Soil Loss Equation represents the effect of agricultural management practices as well as the effect of vegetation in reducing soil loss. The cover-management factor C is derived from land use diagrams. For each coded land use found in the catchment area of the Minagiotiko dam, a C factor value is assigned, using values from international literature adapted to the description of the specific land uses (Wischmeier and Smith, 1978; Schwertmann, 1986; Chrysanthou and Pyliotis, 1995; Zarris et al., 2007).

**Table 6.16: Values of the C factor for each land use according to CORINE.**

| Main Land Use Category | Covered Area | Percentage of Basin (%) | C Factor |
|---|---|---|---|
| Agricultural areas with significant natural vegetation | 16.39 | 57 | 0.100 |
| Olive groves | 5.52 | 19 | 0.100 |
| Mixed forest | 2.62 | 9 | 0.001 |
| Complex cultivation systems | 3.79 | 13 | 0.180 |
| Non-irrigated arable land | 0.25 | 1 | 0.300 |
| Sclerophyllous vegetation | 0.30 | 1 | 0.030 |
| **Total** | 28.9 | 100 | 0.103 |

### 6.6.3.5. The Soil Management Factor Against Erosion

The P factor applies only to arable land and represents the measure of soil loss reduction due to practices that enhance field resistance against erosion, provided they are followed.

Such practices include plowing and planting along contour lines (P = 0.6–0.9), strip cropping parallel to contour lines (P = 0.3–0.45), and the construction of a series of small embankments perpendicular to the slope direction (P = 0.12–0.18).
In the case where no practice is followed, the P factor is equal to one (P = 1) (completely unmanaged basin), whereas in the case where all necessary measures for erosion reduction are taken, the P factor is equal to 0.1 (fully managed basin).
For the catchment area of the Minagiotiko dam, the P factor was considered equal to

one, since it is assumed that no erosion control measures are applied throughout the basin.

#### 6.6.3.6. Mean Annual Erosion

Based on the Renfro relation, presented in Eq. 13 of the following paragraph, the mean annual soil erosion G for the catchment area of the Minagiotiko dam was calculated at 45.48 t/ha or 4547.86 t/km².

#### 6.6.3.7. Mean Annual Sediment Yield

The mean annual sediment outflow, and consequently the mass of suspended sediment transported each year by surface and concentrated runoff and discharged into the sea, is calculated based on the mean annual erosion within the catchment. The mean annual sediment yield (SY (t/km²)) represents a proportion of the total erosion, since part of the eroded material is deposited in areas of the catchment with gentle slopes or within river channels with mild gradients (e.g., floodplains). This proportion of soil erosion that is transported to the sea as sediment yield is called the sediment delivery ratio (SDR). This coefficient is generally less than one and decreases as the catchment area increases. With the increase of the catchment area A (km²), the areas with gentle slopes that retain part of the erosion also increase. Consequently, in the study area, the sediment delivery ratio SDR is estimated based on the Renfro relation (1972):

$$\log(SDR) = 1.877 - 0.1419 * \log(25.9 * A)$$

Therefore, the sediment delivery ratio is equal to 16.7%, and the mean sediment yield G is equal to 759.80 t/km²/yr. According to Zarris et al. (2007), this value is particularly low for Greek conditions, based on corresponding measurements from 14 rivers in Northwestern Greece. Conversely, this value falls within the range of corresponding data from Italy and Spain.

### 6.6.4. Estimation of Dead Storage Volume of the Minagiotiko Dam

For the calculation of the dead storage volume of the Minagiotiko dam, it is necessary to estimate the expected volume of sediment deposits F for a 50-year operation period of the dam:

$$F = 50yrs * \frac{G * A * SDR}{p_F}$$

Based on this equation, and assuming that the density of deposited sediments pF is equal to 1.2 t/m³, the expected volume of sediments F is equal to 1.56 hm³.

This does not mean that this entire amount of sediments will be deposited in the reservoir. In reality, only a fraction of the incoming sediment yield will be deposited in the reservoir. This fraction is called **trap efficiency**, and it is a function of the reservoir volume and the inflowing discharge. The relationship that gives the trap efficiency is provided by Brune (1953), according to which the trap efficiency β is equal to:

$$\beta = \frac{V/W}{0.012 + 0.0102(V/W)}$$

where: **V** is the storage capacity of the reservoir and **W** is the annual inflow into it. From the above equation, it follows that the trap efficiency β is equal to 51.25%. Therefore, the volume of sediments that will be deposited in the reservoir after 50 years, and consequently the dead storage of the dam, will be equal to **468,901.5 m³**.

### 6.6.5. Sensitivity Analysis of the Water Balance

#### 6.6.5.1. General Schematic Representation of the Minagiotiko Reservoir System

The system under examination consists of a single reservoir. The source of supply for the reservoir is the natural inflows, while the reservoir itself provides water to meet the needs of:

a) irrigation of the wider plain,
b) water supply of the settlements served by the Lachanada aqueduct, and
c) environmental conservation.

Based on the above, the water balance of the reservoir at a given time **t** is expressed by the following equation:

$$S_t = S_{t-1} + I_t + R_t - E_t - W_t - SP_t - SL_t$$

where:

**St, St-1** : useful storage of the reservoir at time steps *t* and *t-1* respectively (in volume units),
**It** : net inflow into the reservoir at time *t* (in volume units),
**Rt** : precipitation on the reservoir at time *t* (in volume units),
**Et** : evaporation from the reservoir at time *t* (in volume units),
**Wt** : withdrawal from the reservoir at time *t* (in volume units),

**SPt** : spillway discharge from the reservoir at time *t* (in volume units),
**SLt** : seepage losses at time *t* (in volume units).

It should be noted that from the water balance models presented in Chapter 6.6.2 the sum **It + Rt – Et** was calculated. It should be noted that precipitation and evaporation were derived from the calculations of Chapter 6.6.2, based on the surface area of the reservoir.

Furthermore, for each time step it is found that the useful storage of the reservoir is always greater than the storage corresponding to the dead volume and smaller than the storage corresponding to the maximum useful level of the reservoir. It is also assumed that seepage losses from the reservoir towards other catchments are considered negligible.

### 6.6.5.2. Calculation of Withdrawal Needs

Furthermore, the withdrawal from the reservoir is divided into:
a) the main outflow from the reservoir **RWt** for covering irrigation and water supply needs, and
b) the direct outflow **REt** for covering environmental conservation needs (ecological flow).

**Wt = RWt + REt**

Specifically, based on the relevant calculations of the corresponding sections, it is derived that on an annual basis, 252,288 $m^3$ and 933,120 $m^3$ are required for water supply and ecological flow, respectively.

The allocation of the calculated annual needs into monthly values – in the absence of specific data – will be carried out based on assumptions:

- For ecological flow, an equal monthly distribution is applied for each month of the year.
- For water supply, a) a multiplicative factor of 1.3 is applied to the average demand value for the months from May to October, when demand statistically increases, and b) a multiplicative factor of 0.7 is applied to the average demand value for the months from November to April, when demand statistically decreases.
- For irrigation, the respective monthly values are derived from the agrotechnical study of the Minagiotiko dam.

### 6.6.5.3. Simulation Strategy

The ultimate objective of the sensitivity analysis is the calculation of the reservoir's reliability in meeting a given target, e.g., irrigation, water supply, etc. From the volumetric survey of the reservoir – based on the topographic study prepared under the present contract (2015) – it is derived that the total volume of the reservoir is equal to **10,959,007 m³**.

In addition, the calculations showed that the dead storage volume is equal to **468,901.5 m³**. Therefore, the useful storage is equal to **10,490,105 m³**. The total annual demand (ecological flow, water supply, and irrigation) is equal to **9,120,760 m³**. However, the reliability of the reservoir will be determined by the satisfaction of volumetric, annual, and monthly demand.

Based on international literature, the reliability of the reservoir is calculated using various methods:

- **Reliability level on an annual basis:**

$$\alpha_T = P(W_T = D_T)$$

where $\alpha_T$ the reliability level, $W_T$ is the actual withdrawal (considered as a random variable) during the period **T** of one year and $D_T$ is the demand in the same period, while **P(.)** denotes probability.
Practically, with the above definition, reliability is equal to the probability of meeting demand over a time horizon equal to **T**. Empirically, this probability is calculated as the ratio **k'/k**, where **k'** is the number of annual periods in which the demand is met and **k** is the total number of simulation periods.

- **Reliability level on a monthly basis:**

$$\alpha_{\mathrm{M}} = P(W_{\mathrm{M}} = D_{\mathrm{M}})$$

where $\alpha_M$ the reliability level, $W_M$ is the actual withdrawal (considered as a random variable) during the period **M** of a computational time step (in this case, a month) and $D_M$ is the demand in the same period. Practically, with the above definition, reliability is equal to the probability of meeting the demand over a time horizon equal to **t**. Empirically, this probability is calculated as the ratio **n'/n**, where **n'** is the number of time steps in which demand is met and **n** is the total number of simulated time steps.

- **Volumetric expression of reliability:**

where $\alpha_E$ the reliability level, $W_E$ is the actual withdrawal (considered as a random variable) during the period **t** of a computational time step (in this case, a month) and

$D_E$ is the demand in the same period, while **E[.]** denotes the expected value. Empirically, this is calculated as the average of the actual withdrawals over the total number of simulated annual periods.

The aim of the simulation is to determine the relationship among these three quantities, namely reliability (or, equivalently, the probability of failure), useful storage capacity, and demand. Considering as given the demand for water supply, irrigation, and environmental conservation, as well as the useful storage in the reservoir. Obviously, the non-fulfillment of demand in a given year does not mean that it extends throughout the entire year, and furthermore, during the period when demand is not met, the withdrawal is not zero but satisfies $\mathbf{0 \leq W \leq D}$.

The basic simulation rules are as follows:

- The simulation strategy is to first meet the ecological flow, then water supply, and finally irrigation.
- Withdrawals cease when storage in the reservoir reaches the level of dead storage.
- The initial storage volume of the simulation is set equal to 2/3 of the total reservoir volume: **Scenario I1**.

Based on the above, the reservoir water balance simulation model operates on the basis of volumetric reliability — and not monthly reliability — since irrigation needs concern only a specific period of the year.

The results of the simulation are presented in Tables 6.17 & 6.18 below. From these tables, it follows that a demand equal to 9,120,760 m³ can be met.

The individual demands for water supply, ecological flow, and irrigation correspond to 252,288 m³, 933,120 m³, and 8,633,220 m³, respectively.

**Table 6.17: Results of reservoir water balance simulation.**

| SCENARIOS | Volumetric Reliability Level (%) | Monthly Reliability Level (%) | Annual Reliability Level (%) | Annual Withdrawal Target (m³) | Mean Annual Withdrawal (m³) | Mean Annual Deficit (m³) | Spills (%) |
|---|---|---|---|---|---|---|---|
| I-1 | **90.0** | 89.2 | 52.7 | 9,120,760.0 | 8,966,301.0 | 154,459.0 | 8.6% |
| I-2 | **100.0** | 90.9 | 52.7 | 9,120,760.0 | 9,120,760.0 | – | 9.1% |
| I-3 | **72.0** | 88.8 | 52.7 | 9,120,760.0 | 7,523,371.0 | 1,597,389.0 | 8.6% |
| I-4 | **91.0** | 89.4 | 52.7 | 9,120,760.0 | 8,843,213.0 | 277,547.0 | 8.8% |
| II-1 | **100.0** | 89.2 | 52.7 | 9,120,760.0 | 9,120,760.0 | – | 8.9% |
| II-2 | **100.0** | 89.4 | 52.7 | 9,120,760.0 | 9,120,760.0 | – | 9.2% |
| II-3 | **80.0** | 89.4 | 52.7 | 9,120,760.0 | 8,339,252.0 | 781,508.0 | 8.6% |

**Table 6.18: Percentage of demand coverage per water use.**

| SCENARIOS | Volumetric Reliability Level (%) | Water Supply Demand | Water Supply Withdrawals | Ecological Flow Demand | Ecological Flow Withdrawals | Irrigation Demand | Irrigation Withdrawals |
|---|---|---|---|---|---|---|---|
| I-1 | 97.0 | 252,288 | 252,288 | 933,120 | 933,120 | 8,633,220 | 8,478,761.0 |
| I-2 | 100.0 | 252,288 | 252,288 | 933,120 | 933,120 | 8,633,220 | 8,633,220.0 |
| I-3 | 80.0 | 252,288 | 252,288 | 933,120 | 933,120 | 8,633,220 | 7,035,831.0 |
| I-4 | 98.0 | 252,288 | 252,288 | 933,120 | 933,120 | 8,633,220 | 8,355,673.0 |
| II-1 | 100.0 | 252,288 | 252,288 | 933,120 | 933,120 | 8,633,220 | 8,633,220.0 |
| II-2 | 100.0 | 252,288 | 252,288 | 933,120 | 933,120 | 8,633,220 | 8,633,220.0 |
| II-3 | 90.0 | 252,288 | 252,288 | 933,120 | 933,120 | 8,633,220 | 7,851,712.0 |

Nevertheless, the corresponding monthly reliability is equal to 89% (failure 10.2%). During the calculation of monthly reliability, the following were observed:

- reduced inflows during the years 1965 to 1969 and 1977 to 1981. This is a result of multiple consecutive years with extremely low inflows and continuous demand,
- in the last 25 years (1986–2011) the inflows were higher and the demand was covered more satisfactorily,
- in July, August, September and October there is a systematic deficit in demand coverage,
- minor spillages (8.6%).

In addition, during the calculation of volumetric reliability, it was observed that the initial filling volume of the reservoir is a critical parameter in the simulation. However, this parameter does not significantly affect monthly and annual reliability. Thus, if the initial simulation volume is set equal to:

- 80% of the total reservoir volume (Scenario I2), monthly reliability increases slightly (90.9%). This increase is accompanied by a small rise in spillages (9.1%),
- 50% of the total reservoir volume (Scenario I3), monthly reliability decreases marginally (88.8%), while spillages remain stable (8.6%).

Given that annual reliability remains low, while demand is difficult to meet during the summer months, the scenario of demand redistribution for irrigation was also examined (Scenario I4). This scenario entails zero demand during the winter months – when demand is already reduced – and coverage of demand during the summer months. Thus, for an initial simulation volume equal to:

- 2/3 of the total reservoir volume: volumetric reliability equals 91%, while monthly reliability remains practically unchanged at 89.4%. Spillages also remain stable (8.8%).

The scenario of a higher dam and consequently larger storage volume was also examined. In this scenario, the spillway level was set at +124 m and the total storage volume equals 12,590,768.93 m$^3$. Thus, for an initial simulation volume equal to:

- 2/3 of the total reservoir volume (Scenario II1), volumetric reliability increases (100%), while monthly reliability also increases (89.2%). The number of spillages rises slightly (8.9%),
- 80% of the total reservoir volume (Scenario II2), volumetric reliability increases (100%), while monthly reliability also increases (89.4%). The number of spillages rises slightly (9.2%).
- **50% of the total reservoir volume (Scenario II3):** volumetric reliability increases (80%), while monthly reliability increases (89.4%). The number of spillages rises slightly (8.6%).

In conclusion, for all scenarios examined, the needs for water supply and ecological flow are fully covered, while shortages concern exclusively irrigation. Furthermore, the initial volume affects only volumetric reliability, while it practically does not influence the calculation of monthly and annual reliability. Annual reliability, and to a lesser extent monthly reliability, is mainly affected by the reservoir level at the spillway crest and consequently by the total storage volume of the reservoir.
For all scenarios examined, satisfactory monthly reliability (~90%) was achieved, while annual reliability remains low (~60%). The irrigation shortages observed in certain years mainly concern the summer months (July to October). Based on the simulation, these shortages can be addressed through proper management of reservoir inflows, i.e., by ensuring an initial storage volume greater than or equal to 80% at the beginning of the summer period.

Additionally, the scenario of redistribution of irrigation demands was examined (Scenario I4) – with zero demands during the winter months, so as to cover the increased summer demands. Such a scenario does not significantly improve annual reliability, which remains low.

It should be noted that the choice of a higher dam (Scenarios II1 to II3) improves volumetric reliability; however, it has minimal impact on monthly and annual reliability. Consequently, the increase in reservoir storage volume does not compensate for irrigation demand shortages in the long term. The reason is that these shortages are mainly due to limited inflows into the reservoir from May to September.

These shortages can be addressed through proper management of reservoir inflows, i.e., by ensuring an initial storage volume greater than or equal to 80% at the beginning of the summer period.

### 6.6.6. Conclusions

In summary, the following conclusions arise from the present hydrological study:

- The expected annual inflows into the reservoir were estimated using the ZYGOS model and correspond to **9,410,087 m³**.
- Furthermore, based on the calculated volume of sediments to be deposited in the reservoir after 50 years, the dead storage of the dam is estimated at **468,901.5 m³**.
- From the results of the reservoir water balance simulation, it was found that the mean annual withdrawal was estimated at **9,120,760 m³**. The individual demands for water supply, ecological flow, and irrigation correspond to **252,288 m³**, **933,120 m³**, and **8,633,220 m³**, respectively. Based on the above, it follows that volumetric reliability is **90%**, while monthly reliability is **89.2%** (failure rate ~10.8%). It should be noted that, according to the simulation, without proper management of inflows into the reservoir, there will be years in which demand will not be fully met. For this reason, reservoir operation management must ensure at least **80% reservoir fullness** in order to adequately meet demand.
- From the analysis of maximum rainfall intensities, the final form of the surface-normalized rainfall intensity-duration-frequency (IDF) curve is given by the relation:

$$i(d,T) = \frac{12.28 * (T^{0.15} - 0.55)}{(1 + d / 2.0)^{0.50}}$$

Based on the IDF curve, the design flood hydrographs (Table 6.19) were derived for the dimensioning of:

- the spillway, based on the PMF and a return period **T = 10,000 years**,
- the diversion works, for return periods **T = 20 and T = 50 years**.

**Table 6.19: Summary results of flood simulation**

| Event/Return Period | 12-hour Rainfall Depth (mm) | Peak Flood (m³/s) | Runoff Depth (mm) | Runoff Coefficient |
|---|---|---|---|---|
| PMF | 382.30 | 265.50 | 338.58 | 0.89 |
| 10,000 years | 281.63 | 193.90 | 246.42 | 0.87 |

| | | | | |
|---|---|---|---|---|
| 50 years | 102.62 | 66.90 | 84.62 | 0.82 |
| 20 years | 83.68 | 53.70 | 67.96 | 0.81 |

### 6.7. Termination of Operation – Site Restoration

For the projects examined in this section, the issue of restoring borrow pits, aggregate extraction sites, and construction sites is included.

In the case where borrow pits are developed outside the reservoir basin, after the completion of material extraction works, the required restoration should be carried out primarily using surplus excavation materials from the project. In other words, these sites should also be used as spoil disposal areas.

In any case, the final approach will be determined by the Technical Environmental Study (TES), which will be prepared and submitted by the contractor at subsequent stages of the project's design and implementation, when more detailed and accurate data will be available from the execution of more specific studies at later stages.

Regarding the construction sites, at this stage it is not possible to select their locations. The selection will be made after the completion of the final designs and, in any case, will be finalized within the framework of the aforementioned TES. It is also evident that these sites will be restored.

### 6.8. Emergency Conditions and Environmental Risks

With respect to the issue of dam safety and the potential creation of hazardous situations, the required Flood Wave Study in case of dam failure has not yet been carried out at this stage. This study is conducted during the Final Design of the dam. Its conclusions may be taken into account within the framework of the TES or a study for the amendment of the Environmental Impact Assessment Approval (EIA Approval) of the project, which may be prepared due to modification or supplementation of the technical design data arising from subsequent study stages.

However, within the framework of the dam design, the guidelines of the Hellenic Committee on Large Dams (HCLD, 2016) and corresponding international guidelines (see section 6.1.1.2.9. of the present EIA) have been considered, and the examined dam has been classified under Category 1 of potential consequences, for the selection of the design flood, the safety control, and consequently the design of the dam crest works, spillway, and energy dissipation structures.

# 7. ALTERNATIVE DAM SOLUTIONS

Initially, based on the contractual data of the project, the originally proposed dam type is an earthfill dam with a clay core. During the preparation of the Preliminary Design of the Minagiotiko Dam, and by considering the results of the supporting studies, the Study Team investigated the techno-economic feasibility of the earthfill dam solution, while at the same time examining the option of a gravity dam made of roller-compacted concrete (RCC).

In this Preliminary Design, the following criteria were identified as critical for the design and the selection of the dam type: the qualitative suitability and quantitative adequacy of the construction materials (supporting body materials, core materials, filter and drainage gravels, rockfill materials, concrete aggregates, etc.), the foundation conditions, the available options for the construction of the spillway, the seismicity of the wider area and its potential impact on the project.

During the Preliminary Design, the results of the geological/geotechnical investigations were taken into account. As part of the material survey, 17 exploratory boreholes were drilled between October 19–20, 2015 and December 13–22, 2015, and samples were taken from five quarry sites. These investigations showed that no alluvial gravelly materials suitable for fine filter and drainage zones were available for use in an earthfill dam with a clay core. Consequently, the Study Team examined the alternative of a gravity dam made of roller-compacted concrete (lean RCC), given the adequacy of aggregate materials from quarries for the construction of the dam body.

The Study Team thoroughly examined the following options:

- An **earthfill dam with a clay core** and a frontal spillway on the left abutment (see drawing series No. 2.1 to 2.8 of the Preliminary Design).
- A **gravity dam from roller-compacted concrete (lean RCC)** with the spillway integrated into the dam body (see drawing series No. 3.1 to 3.16 of the Preliminary Design).

## 7.1. Option 1: Earthfill Dam with Clay Core

This is an earthfill dam with a central clay core. The general arrangement of the works is presented in Drawing 2.1 of the Preliminary Design. The dam crest is placed at elevation +127.00. The works include the dam body, the spillway with the energy dissipation works, the diversion–outlet–water intake works, and the service and restoration roads.
The dam body consists of the following zones, as shown in Drawing 2.2 of the Preliminary Design:

- **Zone 1:** Impervious core of clay materials, preferably sourced from borrow pits D-6, D-7, D-9, and D-4.
- **Zone 2:** Fine filter of quarry gravelly materials.
- **Zone 3:** Coarse filter–drainage zone of quarry gravelly materials.
- **Zone 5:** Supporting shells made of materials from borrow pits (L1, L2, or L3) in the wider area.
- **Zone 6:** Backfilling of excavations at the downstream toe of the supporting shell using random excavation materials.
- **Zone 7:** Rockfill protection of upstream slopes.
- **Zone 8:** Rockfill protection of the downstream slopes.
- **Zone 9:** Pavement.

**Foundation Conditions of the Dam and Spillway**

The foundation conditions of the dam and the spillway are considered moderate to—at certain locations—unfavorable, due to:

a) the relatively large thickness of soil or quasi-soil formations, and
b) the degraded qualitative characteristics of the flysch formations.
For this reason, it is proposed that the foundation of the dam core be placed on the flysch bedrock formations that are sound to slightly weathered and slightly to—at certain locations—moderately fractured. These formations are usually associated with the conglomerate formations of type C2, which have a sandstone–calcareous cementing matrix and strong bonding, as well as with sandstone/siltstone formations with generally similar qualitative characteristics (Geotechnical Layer IV / Engineering–Geological Zone 1).
The foundation of the supporting shells is proposed at shallower depths after removal of the materials of the surface weathering mantle. For the earthfill dam solution, it is proposed that the foundation be sealed by creating a cutoff and a grout curtain starting from the foundation surface of the core, along the dam axis.

**Dam Axis & Crest**

The dam axis was positioned approximately 90 m downstream of the confluence of the two branches of the Minagiotiko stream, in order to:

a) capture the flow of both branches within the reservoir, and
b) minimize, as much as possible, the volume of embankment.

The Full Supply Level (FSL) of the reservoir was set at elevation +122. This elevation was selected based on the results of the sensitivity analysis of the reservoir's water balance. The dam crest was set at elevation +127, taking into account the routing of the maximum flood level through the reservoir. The crest of the dam has a total width of 10.00 m.

**Design of the Spillway and Diversion Works**

As part of the Preliminary Design, the hydraulic design of the spillway was carried out based on the routing of the design flood hydrograph through the reservoir and the spillway. The routing data were derived from the preceding Hydrological Study. For the determination of the spillway type, hydraulic, geological, geotechnical, and environmental design parameters of the project were considered, in cooperation with the entire study team.

Following extensive research in the international literature, the final selection and hydraulic design of the spillway type were completed. The **Frontal Spillway** solution was chosen. However, during the design, it was found that, due to the morphology of the left abutment, the spillway of an earthfill dam would be very steep, requiring large-scale excavations and high retaining walls in the chute channel.

The spillway is a free frontal type, with a crest length of 28 m. It is located on the left abutment of the dam, and its works include:

- The approach channel, the inlet structure, the spillway body, and the bridge providing access to the left abutment at the location of the works.
- The chute channel, 143 m long, through which the spillway discharges are conveyed to the stilling basin and from there to the final recipient.
- The shaping and protection of the stream bed downstream of the point where the spillway discharges exit from the flip bucket structure.

The diversion works consist of the cofferdam, the inlet and outlet structures of the flood, and the diversion tunnel. After the completion of the construction of the dam body and spillway works, the diversion tunnel is sealed with a concrete plug at the position of the core upstream of the dam axis. The outlet–water intake pipe is placed inside the accessible section of the tunnel downstream of the plug. The intake–outlet structure is formed by constructing a tower with a sill elevation at +98.50. At the downstream end of the tunnel, the valve house is planned to be constructed, which will commence after the plugging of the tunnel.

The summary data of the dam are presented below:

**Reservoir**

- Full Supply Level of the reservoir (spillway crest elevation): +122.0
- Minimum Supply Level of the reservoir (intake sill): +95.0
- Effective water depth: 23.5 m
- Total reservoir volume: 10,959,007 $m^3$
- Useful reservoir volume: 10,490,105 $m^3$
- Reservoir surface area at spillway crest elevation: 886,733 $m^2$

**Dam**

- Dam type: Earthfill
- Total embankment volume: 719,000 $m^3$
- Maximum height: 49 m from foundation
- Crest length: 230 m
- Crest elevation: +127.00
- Crest width: 10 m

**Spillway**

- Spillway type: Free frontal
- Spillway crest elevation: +122.00
- Spillway crest length: 28.0 m
- Channel length: 143.2 m
- Maximum spillway discharge: 205.9 $m^3/s$
- Reservoir elevation for maximum spillway discharge: +125.41

**Temporary diversion – outlet – intake**

- Type of structure: Pipe
- Length of temporary diversion conduit: 325.00 m

### 7.2. Solution 2: Gravity Dam of Lean RCC

This solution constitutes the proposed option which is examined in the present Environmental Impact Assessment (EIA) and is presented in detail in Chapter 6, while in this section its basic characteristics are outlined for comparison purposes and to justify its selection:

**Catchment area**

- Catchment area: 28.9 $km^2$
- Mean elevation of the catchment: +249
- Elevation of the natural streambed at the dam axis: ~+78
- Mean annual rainfall: 760 mm
- Mean annual runoff: 8,747,000 $m^3$

- Specific sediment yield: 468,902 $m^3$

**Reservoir**

- Full Supply Level of the reservoir (spillway crest elevation): +122.0
- Minimum Supply Level of the reservoir (intake sill): +95.0
- Effective water depth: 23.5 m
- Total reservoir volume: 10,959,007 $m^3$
- Useful reservoir volume: 10,490,105 $m^3$
- Reservoir surface area at spillway crest elevation: 886,733 $m^2$

**Dam**

- Type of dam: Lean RCC
- Total embankment volume: 196,000 $m^3$
- Maximum height: 49 m from foundation
- Crest length: 177 m
- Crest elevation: +127.00
- Crest width: 10 m
- Slope inclinations: Horizontal 0.80 – Vertical 1.0
- Surface of upstream watertight facing: approx. 4,400 $m^2$
- Length of foundation plinth for watertight facing: approx. 180 m

**Spillway**

- Type of spillway: Integrated free spillway
- Spillway crest elevation: +122.00
- Spillway crest length: 24.0 m
- Maximum spillway discharge: 265.5 $m^3/s$
- Reservoir elevation for maximum spillway discharge: +124.50

**Temporary diversion – outlet – intake**

- Type of structure: Pipe
- Length of temporary diversion conduit: 450.00 m

**Concerning the available materials for the construction of the lean RCC embankment**

The rocky materials for the supply of aggregates to be used in the construction of the lean RCC embankment have been identified in the borrow pits L1, L2, and L3. These materials exist in large quantities and are deemed suitable based on the executed geotechnical and geological investigations.

The downstream face of the lean RCC embankment is designed to be inclined with a slope of 1.0 (vertical): 0.80 (horizontal) (Drawing 3.2.1 of the Preliminary Study of the dam). For protection purposes and to ensure higher construction quality, the downstream face of the lean RCC body is foreseen to be stepped, with the placement during construction of prefabricated concrete blocks (C16/20) of gamma (Γ)-shaped cross-section, with a height of 0.82 m and a base width of 0.66 m. These blocks will confine the placed and compacted layers of the lean RCC.

The upstream face of the lean RCC embankment has a slope of 1.00 (vertical): 0.80 (horizontal) and is formed with appropriate equipment, without the use of prefabricated elements, unless it is proven during construction trials that with the available equipment and applied methods a satisfactory construction of the upstream end of the lean RCC layers cannot be achieved. In such a case, the Contractor, without special compensation, shall apply a suitable confinement system for the lean RCC layers, subject to the approval of the Authority. In this case, the proper placement of perforated drainage pipes Ø200 between the watertight facing and the lean RCC must not be hindered.

**Upstream watertight facing**

The upstream watertight facing is constructed of reinforced concrete C20/25 with reinforcement S500, with a variable thickness between 30 cm and 60 cm, and is cast in situ, after the completion of the drainage system works described in the next paragraph. Casting of the facing is foreseen using a suitable sliding steel formwork system with integrated vibration equipment.

Since the upstream watertight facing constitutes the sealing element of the dam body, meticulous sealing of all construction and expansion joints of the facing, as well as at the contact of the facing with the foundation plinth and the crest walls of the dam, is foreseen, with the use of sealing tapes, sealing materials, etc.

At the stage of the Final Design, the possibility of using a waterproofing system with a geomembrane consisting of layers of geosynthetic material that provide waterproofing and drainage of the upstream face of the dam will be examined.

To collect and discharge any possible seepage through the upstream facing, an appropriate drainage system is foreseen. This system consists of perforated PVC pipes Ø200 wrapped in geotextile, placed at 3.0 m intervals along the upstream face of the lean RCC embankment inside a suitably excavated trench. The pipes discharge into the lower central collector conduit (PVC Ø630), which is foreseen to be embedded in the foundation plinth of the watertight facing.

### 7.3. Zero Scenario

With regard to the zero option, i.e., the non-construction of the works, given that this is an environmentally friendly project, institutionally compliant, and scheduled as highly economically efficient

## 7.4. Evaluation of Alternative Dam Solutions

### 7.4.1. Technical Evaluation – Proposed Solution

The selection of the dam type was made taking into account, on the one hand, the investigation of the hydraulic study both for the location of the dam axis and for the layout of the spillway, and on the other hand, the conclusions of the geological and geotechnical investigations concerning the materials from the 26 exploratory boreholes (Fig. 1.2), jointly assessing the following data:

1. Based on the Geological Study and the results of the geotechnical investigations, it emerges that the wider project area has been characterized by moderate to high seismic activity from historical times to the present. However, in the immediate vicinity of the project site, only small-magnitude seismic tremors (3 to 4 on the Richter scale) are reported, with just one seismic source of up to 5.0 on the Richter scale. Given this, it is deemed that both examined dam types can be designed safely in terms of their seismic performance. Within the framework of the Final Hydraulic Study, a special study on seismicity and seismic hazard will be prepared, in which the seismic design spectra will be determined.
2. The works of temporary diversion are generally similar for both examined dam types.
3. The foundation sealing works with the construction of a grout curtain are also similar for both examined dam types.
4. Regarding the availability of construction materials for the case of an earthfill dam, from the evaluation of the results of the geotechnical investigation carried out in the relevant borrow pits, the following conclusions emerge:
    - There is a surplus of fine-grained materials for the construction of the dam core. These materials can be produced — with priority — from borrow pits D-6, D-7, D-9, and D-4 (total volume: 457,000 $m^3$) and subsequently from the other borrow pits, excluding borrow pit D-10. The priority selection is due to the fact that the materials from these borrow pits exhibit better quality characteristics.
    - There are no materials of known volume and satisfactory grain size distribution for the production of filters and drains (Zones 2 and 3, see Fig. 2.2). The materials identified in the reservoir basin are of local character, as they were not found in all locations. It should also be noted that where they were found, they represent the deeper horizon and therefore excavation of the overlying materials is required. The materials identified are clayey/silty (as the percentage passing through

No200 sieve ranges from 21 to 41%, meaning material processing such as screening or washing is required) and their thickness is unknown.

For the investigation of rocky construction materials for the support zones and protective zones of the rockfill dam, as well as aggregates for the construction of the "roller-compacted lean concrete" type dam, the following borrow pits were selected:

- Borrow pit L1, located at a direct distance of approximately 6.0 km northwest of the Project site, specifically in the area of the settlement of Arapolakko. This area is composed of limestones with a thick-bedded structure, bituminous odor upon fracture, alternating with dolomites.

The Borrow Pit **L2**, located at a direct distance of approximately 1.0 km south-southeast of the Project site, specifically between the settlements of Vlasaiika and Lahanada. This area is composed of conglomerate formations of the flysch, which are strongly cemented and polymictic.

- The Borrow Pit **L3**, located at a direct distance of approximately 5.0 km north-northeast of the Project site, specifically in the area of the settlement of Kato Ambelokipoi. This area is composed of conglomerate formations with characteristics similar to those of Borrow Pit 2.

The materials that can be produced from the above borrow pits are quantitatively sufficient for any use in each dam type. Their qualitative suitability is examined in the Geotechnical Study.

5. In the case of constructing an earthfill dam with a clay core, it is necessary to build a spillway at the left abutment, involving large-scale excavations and concrete works. On the contrary, in the case of a gravity dam made of roller-compacted concrete (lean RCC), the spillway is formed on the crest and the downstream face of the dam, which simplifies and facilitates construction and reduces intervention in the natural environment of the area. With the spillway integrated into the dam body, neither large-scale excavations nor high retaining walls in the chute are required. Furthermore, the gravity dam with lean RCC is much safer in the event of overtopping.
6. The construction time for a rockfill dam with a clay core will be longer compared to the two other dam types, due to the larger volume of embankment and the need for construction of a diversion tunnel.
7. Based on the preliminary cost estimation, the solution of a gravity dam with roller-compacted concrete (lean RCC) is more economical by 20% compared to the solution of an earthfill dam with a frontal spillway, due to the significantly

smaller volume of excavations and the considerably reduced quantities of aggregate materials required.

### 7.4.2. Environmental Evaluation – Proposed Solution

When comparing the two dam types, environmental criteria were also examined, relating to:

1. The extent and volume of required excavations
2. The height and slopes of necessary embankments
3. The availability of required suitable materials
4. The required construction time

From the comparison of the solutions applying the above-mentioned criteria, the solution of the gravity dam with roller-compacted concrete (lean RCC) presents specific advantages and is more favorable, since:

1. Regarding excavations, fewer are required due to the smaller foundation base and land footprint.
2. Regarding slopes, lower heights are required.
3. Regarding the availability of necessary materials, it is not more difficult than the earthfill solution in terms of sourcing, but in addition, smaller quantities are required.
4. Regarding construction time, it is also more favorable, since a shorter period is required.

On the contrary, the solution of constructing an earthfill dam with a clay core, with the necessary construction of a spillway at the left abutment, presents specific comparative **"disadvantages"** and is environmentally less favorable, since:

1. Large-scale excavations of the foundation are required.
2. Large-scale excavations and concreting with steep slopes are required due to the lateral spillway.
3. The necessary suitable fluvial sand and gravel materials for the construction of filters and drains were not found in the project area and must be sought elsewhere, which, apart from increasing the cost, also causes environmental burden due to transport and the creation of additional borrow pits outside the reservoir basin and the project area.
4. The construction time of a dam with a clay core will be longer, due to the larger embankment volume, with a corresponding direct environmental cost (operation of construction sites) and indirect cost, namely the delay in

delivering the project and the anticipated environmental benefits (operation of the reservoir, aquifer recharge, discontinuation of the use of irrigation boreholes).

Taking the above into account, the Study Team considers the gravity dam with roller-compacted concrete (lean RCC) to be the most suitable solution.

# 8. EXISTING ENVIRONMENTAL CONDITIONS

## 8.1. Study Area

According to the applicable legislation and specifications of Environmental Impact Assessments (EIA), the study area is defined in relation to the examined dam, the reservoir, and the irrigation network. The dam and reservoir, which constitute the main intervention and the most significant works, are accompanied by the irrigated zone, an area which is currently agricultural land. The two borrow pits of rocky materials, L1 and L2, are also examined; of these, L2 is located within the wider irrigated zone, while L1 lies at its northwestern edge.
Regarding the irrigated zone, the present EIA examines the perimeter of this area, which covers approximately 35,000 stremmata (~3,500 ha), as well as the main water transmission pipelines, since the detailed study of the irrigation networks will be carried out at a later stage.

The dam, whose construction is expected to generate the most significant impacts, is located at a sufficient distance from settlements—the nearest being approximately 1,700 meters away—as well as from protected areas or monuments.
The irrigated zone surrounding the dam is examined with respect to a few central water transmission pipelines and regulation tanks. These works will mainly be constructed along existing provincial or rural roads and, due to their nature and scale, are considered minor works (excavation and backfilling), with limited expected impacts.

Since the Minagiotiko stream at this location constitutes the external boundary of the Natura 2000 area with code GR 2550003, the examined dam is partly adjacent to the Natura 2000 area.
According to the data of the Special Environmental Study conducted for this specific area, **all the proposed zones for the protection of nature, landscape, and the Regional Marine Zone are located outside the Terrestrial Eco-Development Zone in which the examined works are situated, and at a sufficient distance from it**.

Part of the irrigation network also concerns agricultural areas located within the Terrestrial Eco-Development Zone. Consequently, the entire Natura 2000 area was considered as the study area and was examined in the Special Ecological Assessment (SEA), which forms an annex to this EIA.

In addition to the aforementioned area, the irrigated zone also includes a large part of agricultural land lying outside the Natura 2000 area.

The relevant boundaries and characteristics of the project area are presented in maps of various scales within the present study; indicative examples include maps EIA-1, AP-1, AP-2, and AP-3.

## 8.2. Climatic and Bioclimatic Characteristics

### 8.2.1. Meteorology and Climatology of the Area

The annual rainfall is relatively high in the Ionian Sea and the coastal areas of western Greece (800–2,400 mm), and it increases continuously as one moves inland, reaching its highest values (>2,000–2,400 mm) (Karapiperis, 1974).

From the diagram of annual rainfall, which is presented below, it is evident that the linear trend of annual precipitation is increasing in the region of Western Peloponnese.

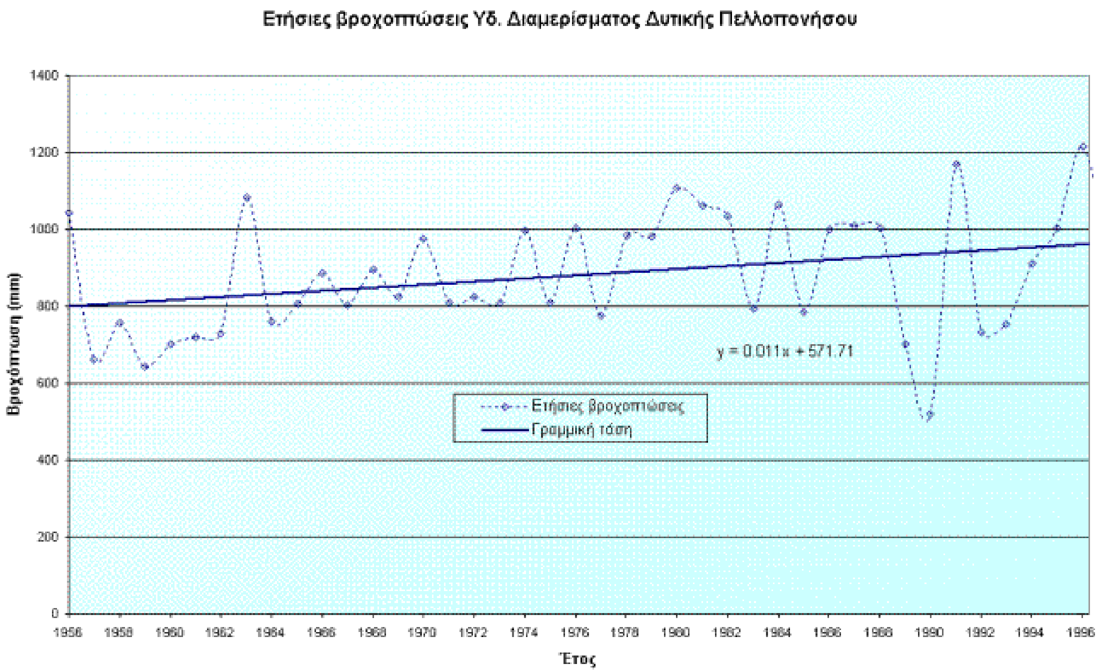



**Figure 8.1: Diagram of Annual Rainfall in the Water District of Western Peloponnese (Hydrological Data Bank, NTUA).**

In the following figure, the annual runoffs of the water district of Western Peloponnese are presented, as provided by the Hydrological Data Bank of the National Technical University of Athens.

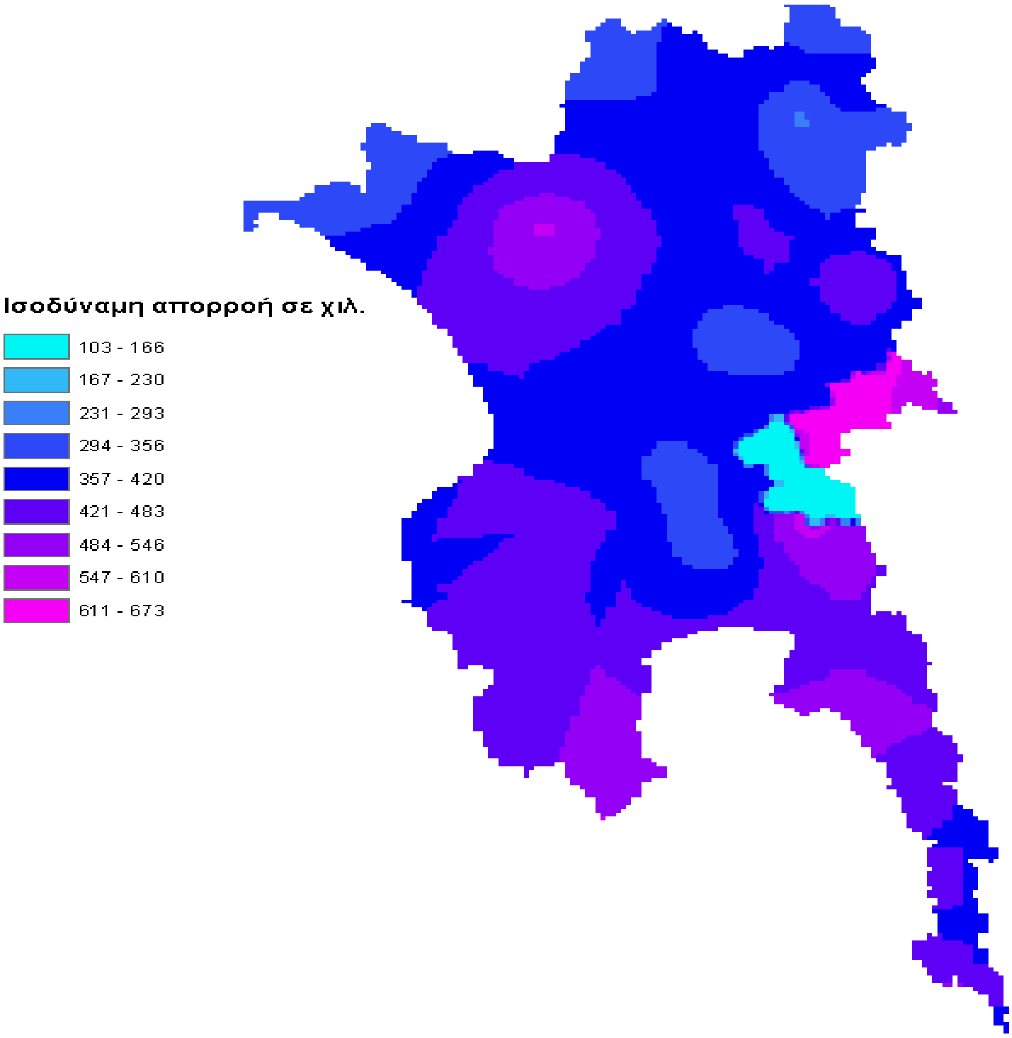



**Figure 8.2: Annual Runoff in the Water District of Western Peloponnese (Hydrological Data Bank, NTUA).**

The wider study area receives a high amount of atmospheric precipitation, which is unevenly distributed across the different seasons.

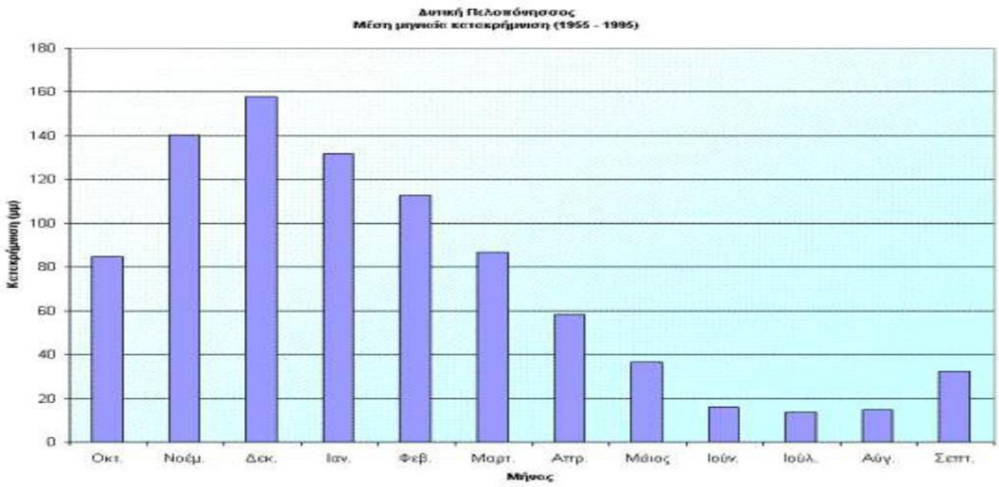



**Figure 8.3: Mean Monthly Precipitation of Western Peloponnese (Hydrological Information Bank, NTUA).**

The general conclusions that can be drawn for the wider area of the project site are as follows:

a) The mean annual precipitation is high.
b) The months with the highest rainfall are November and December. Conversely, the lowest values occur in July and August.
c) The lowest precipitation is recorded in July and August.
d) The highest percentage of annual rainfall is observed during the period from October to April.
e) The annual course of precipitation is exactly the opposite of that of temperature.

In the wider project area, the Methoni meteorological station operates (latitude 36.83, longitude 21.71, elevation 52 m). The station has been in continuous operation since 1956 under the responsibility of the Hellenic National Meteorological Service (HNMS). Due to its uninterrupted operation and its immediate proximity to the study area, its data are used in the present study. The dataset employed spans the years 1956 to 2011.

### 8.2.2. Meteorological Data

The primary data obtained from the HNMS concerning the Methoni station were processed and are presented in summary form below.

**Table 8.1 Meteorological Data of the Study Area**

| **Parameter** | | **Mean Monthly Temperature (°C)** | **Mean Monthly Precipitation (mm)** | **Mean Relative Humidity (%)** |
|---|---|---|---|---|
| **Month** | January | 11.27 | 109.36 | 73.43 |
| | February | 11.56 | 80.30 | 72.71 |
| | March | 13.05 | 65.11 | 73.37 |
| | April | 15.50 | 36.46 | 72.05 |
| | May | 19.13 | 16.88 | 73.92 |
| | June | 22.72 | 5.39 | 72.61 |
| | July | 24.98 | 0.98 | 72.73 |
| | August | 25.85 | 3.78 | 71.54 |
| | September | 23.67 | 32.20 | 69.62 |
| | October | 19.83 | 85.11 | 70.75 |
| | November | 16.07 | 111.88 | 74.66 |
| | December | 12.96 | 134.95 | 74.93 |
| **Total / Average** | | **18.05** | **692.20** | **72.69** |

The following diagram represents the ombrothermic diagram of the study area:

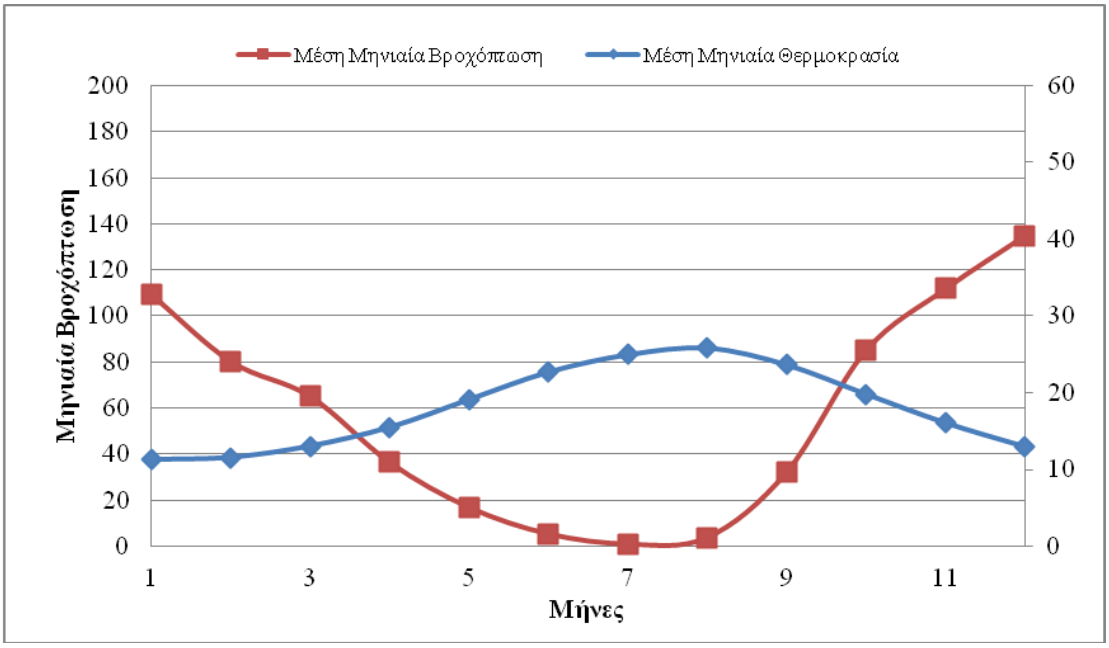



**Figure 8.4: Ombrothermic Diagram of Methoni Station**

From the ombrothermic diagram and the meteorological data, it can be easily concluded that the warm period lasts from May to October and the cold period from November to April.

The coldest months are January and February, while the hottest are July and August. The driest month of the year is July (0.98 mm), and the wettest is December (134.95 mm).

Snowfall in the area is minimal to nonexistent, usually occurring between December and March. The maximum number of snowfall days is estimated at 0.15 in January. In contrast, hail occurs more frequently than snow, generally between December and March, with the highest number of days being 0.7 in February and 0.4 in March. Frost appears only a few days during the winter months.

**Humidity**

The average relative humidity in the area ranges from 69.62% in September to 74.93% in December.

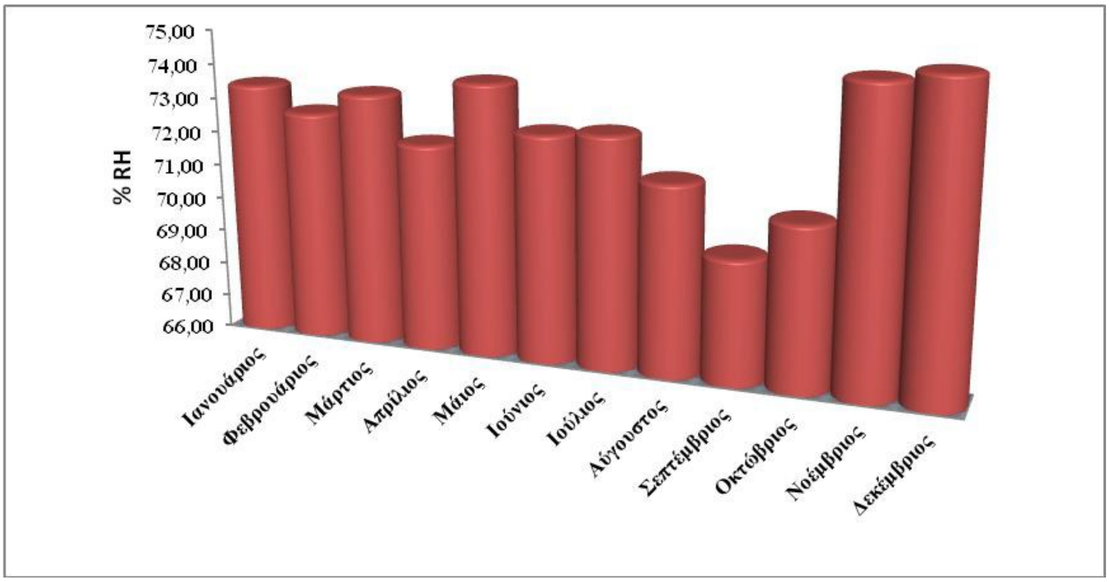



**Figure 8.5: Diagram of Mean Relative Humidity (Methoni Station)**

**Rainfall**

The mean annual rainfall at the Methoni Meteorological Station amounts to **692.2 mm**. The driest month is **July**, with an average rainfall of **0.98 mm**, while the wettest (rainiest) month is **December**, with **134.95 mm**.

As shown in the diagram below, rainfall distribution throughout the year is uneven, with the striking characteristic that during the six winter months, **86.2% of the total annual precipitation** is recorded.

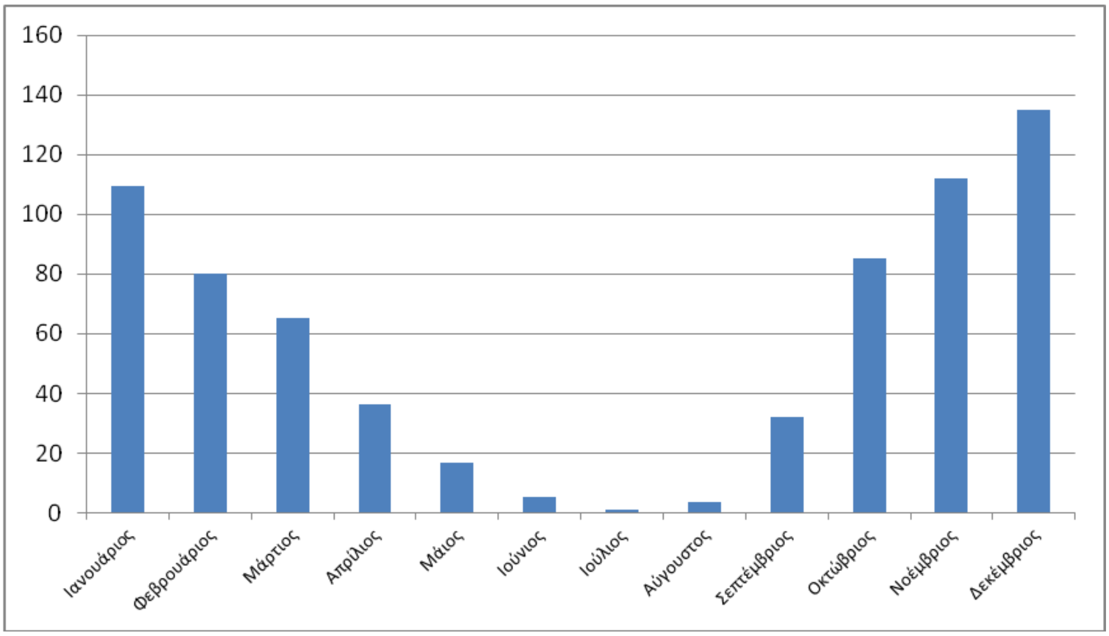



**Figure 8.6: Diagram of Mean Monthly Rainfall (Methoni Station)**

**Cloudiness**

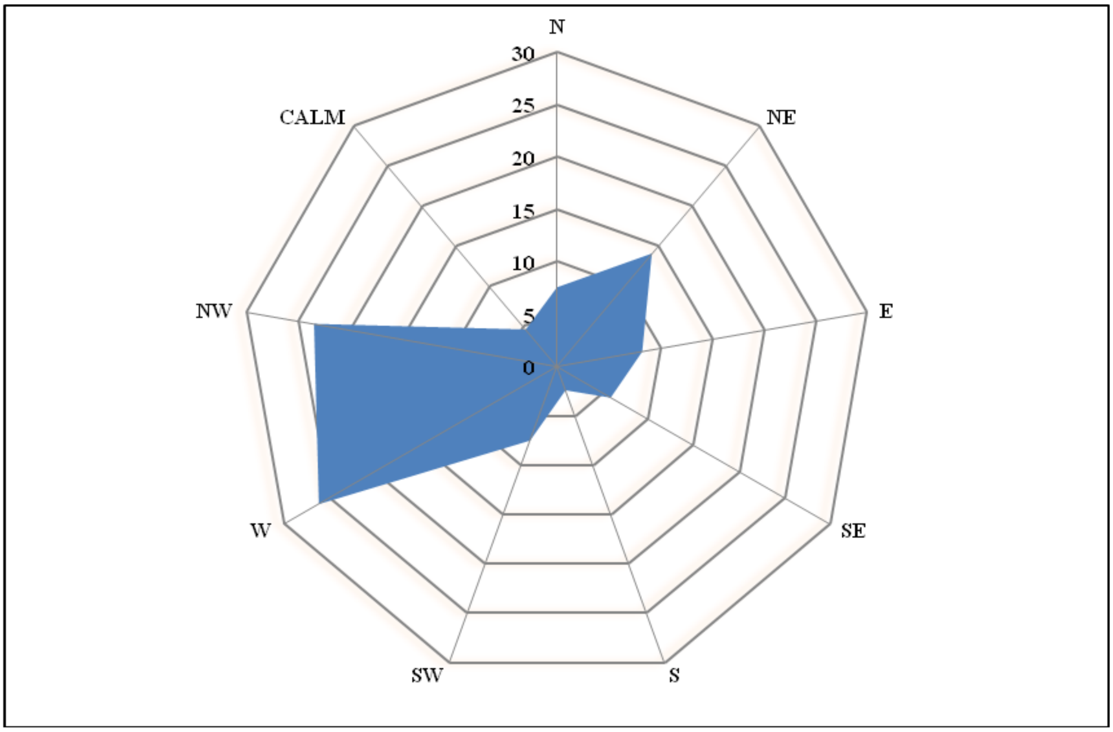
The average annual cloudiness ranges between 3.5 and 4.0 on a 0–10 scale, corresponding to the minimum cloudiness zone, which includes the southern part of Greece. The month with the highest cloudiness is February. The number of clear days in the western and southern parts is high, ranging between 140–150 days per year.

The distribution of sunshine is complementary to that of cloudiness. The southwestern Peloponnese records more than 2,800 hours of sunshine annually. Sunshine increases from north to south, with the highest number of sunshine hours occurring in July and the lowest in December.

**Winds**

In the study area, winds predominantly blow from northern directions during the winter period (October to February), while westerly winds prevail during the rest of the year (March to September).

More specifically, the percentage distribution of winds of different intensities and directions, relative to the total observed winds in the area, is presented in the following table. According to meteorological data, the most frequent prevailing winds are Westerly (26.20%), followed by Northwesterly (23.51%), Northeasterly (14.07%), and Easterly (8.25%). Northerly winds account for 7.56%, and Southwesterly winds for 7.49%. The calm period represents 4.63%. The remaining wind directions occur at percentages below 6%.




**Σχήμα 8.7:Ιστόγραμμα ανέμων περιοχής μελέτης**

**The classification of winds according to their intensity** is made into three categories: calm and light winds (0–3 Beaufort), moderate to strong winds (4–6 Beaufort), and very strong winds (≥ 7 Beaufort).

It is observed that for the largest part of the year, light winds prevail, while strong winds occur only during the winter months and at a very small percentage.

**Distribution of Wind Intensity**

| Wind Intensity | Percentage |
|---|---|
| 0 – 3 | 59.90% |
| 4 – 6 | 38.50% |
| ≥ 7 | 1.60% |

**Table 8.2: Wind Intensity and Direction**

| Percentages of wind speed and direction | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Intensity** | **Wind direction** | | | | | | | | | |
| | **N** | **NE** | **E** | **SE** | **S** | **SW** | **W** | **NW** | **CALM** | **Total** |
| **0** | | | | | | | | | 4.631 | **4.63** |
| **1** | 0.47 | 0.80 | 0.26 | 0.12 | 0.131 | 0.32 | 0.49 | 0.29 | | **2.88** |
| **2** | 3.51 | 7.36 | 2.08 | 1.27 | 0.745 | 1.94 | 4.48 | 3.87 | | **27.25** |
| **3** | 2.50 | 4.63 | 1.98 | 1.61 | 0.701 | 2.07 | 6.95 | 6.69 | | **27.14** |
| **4** | 0.89 | 1.13 | 2.07 | 1.69 | 0.537 | 1.60 | 8.21 | 7.95 | | **24.07** |
| **5** | 0.15 | 0.10 | 1.01 | 0.76 | 0.186 | 0.86 | 3.87 | 3.14 | | **10.07** |
| **6** | 0.03 | 0.03 | 0.62 | 0.37 | 0.066 | 0.44 | 1.57 | 1.26 | | **4.39** |
| **7** | 0.01 | 0.01 | 0.19 | 0.08 | 0.01 | 0.18 | 0.44 | 0.23 | | **1.14** |
| **8** | 0 | 0 | 0.033 | 0.011 | 0.011 | 0.09 | 0.16 | 0.06 | | **0.36** |
| **9** | 0 | 0 | 0 | 0 | 0 | 0.01 | 0.02 | 0.01 | | **0.04** |
| **10** | 0 | 0 | 0 | 0 | 0 | 0 | 0.01 | 0.01 | | **0.02** |
| **>11** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | **0** |
| **Total** | **7.56** | **14.07** | **8.25** | **5.91** | **2.39** | **7.49** | **26.19** | **23.5** | **4.631** | **100** |

### 8.2.3. Climate

From a climatic point of view, the Peloponnese can be divided into three parts: the western part, where the maritime Mediterranean type (humid climate) predominates, especially in the coastal areas; the eastern and most of the interior part, where the continental Mediterranean type (dry climate) prevails; and the mountainous region, which includes the high-altitude mountain ranges, where the mountain climate type predominates.

Beyond this basic climatic classification, the Peloponnese exhibits great climatic diversity.

Thus, the eastern coastal areas are rich in sunshine but relatively dry, the central mountainous region experiences severe conditions during the cold period with frequent frosts and abundant snowfall, while the western parts receive much higher rainfall and are warmer in winter compared to the eastern regions.

For these reasons, the eastern regions of the Peloponnese are poor in running waters and vegetation, whereas the mountainous and western parts have abundant springs, plentiful water, and rich vegetation.

The climatic conditions prevailing in the study area are considered favorable for most crops. This is the most important factor explaining why the area has developed into a center for the cultivation of vegetables (both open-field and greenhouse) and has now become a major production hub.

At the same time, the mild weather conditions prevailing during the winter months and the beginning of spring allow for extra-early cultivation of vegetables, thus providing the producers with the opportunity to achieve satisfactory incomes.

#### 8.2.3.1. Climate Classification

Many attempts have been made to express the overall impact of climate through numerical indicators. Such mathematical expressions or numerical values are called climatic or bioclimatic indices, depending on the aspect they influence.
For the climate classification of the study area, the following methods were used:

1. The Lang–Gracamin method
2. The Emberger climatic classification for Greece (Mavrommatis, 1980)

##### 8.2.3.1.1 Lang–Gracamin Method

According to this method, the climate of an area is characterized on the basis of the Lang aridity index (Trewartha and Horn, 1980), which expresses the ratio of the mean monthly precipitation in millimeters to the corresponding mean monthly temperature in degrees Celsius.

For the climate characterization of the area, the aridity index was first calculated (Table 8.4) based on the values in Table 8.3, and subsequently the "climatic classification" of each month was carried out (Table 8.4), taking into account the classes shown in Table 8.3, which are proposed by this specific method. For the calculation of the aridity index, the data of the study area, as determined previously, were used.

**Table 8.3. Climate classification based on the Lang aridity index**

| Lang Aridity Index | Climate Characterization |
|---|---|
| < 1.8 | Hyper-arid |
| 1.8 – 3.4 | Arid |
| 3.5 – 5.0 | Semi-arid |
| 5.1 – 8.3 | Sub-humid |
| 8.4 – 13.3 | Humid |
| > 13.3 | Hyper-humid |

**Table 8.4. Calculation of the Lang Aridity Index and Climate Classification for the Study Area (per month)**

| Month | Mean Precipitation (mm) | Mean Temperature (°C) | Lang Index | Climate Classification (Graham) |
|---|---|---|---|---|
| January | 109.36 | 11.27 | 9.70 | Humid |
| February | 80.30 | 11.56 | 6.95 | Moist |
| March | 65.11 | 13.05 | 4.99 | Sub-humid |
| April | 36.46 | 15.50 | 2.35 | Dry |
| May | 16.88 | 19.13 | 0.88 | Hyper-arid |
| June | 5.39 | 22.72 | 0.24 | Hyper-arid |
| July | 0.98 | 24.98 | 0.04 | Hyper-arid |
| August | 3.78 | 25.85 | 0.15 | Hyper-arid |
| September | 32.20 | 23.67 | 1.36 | Hyper-arid |
| October | 85.11 | 19.83 | 4.29 | Sub-humid |
| November | 111.88 | 16.07 | 6.96 | Moist |
| December | 134.95 | 12.96 | 10.41 | Humid |

**According to the above data and the climate classification based on Graham, the climate in the study area falls into the Dry category, bordering on the Hyper-arid zone**

#### 8.2.3.1.2 The Emberger–Sauvage Climate Classification

The Emberger–Sauvage method is considered the most appropriate for determining the bioclimate of Mediterranean regions. This method, based on Emberger's approach, defines bioclimatic zones that correspond to the succession of climate types according to variations in temperature and precipitation, either with altitude or with geographical latitude.

In particular, the variation with altitude of these climatic factors is expressed through the vertical succession of vegetation, or in other words, the altitudinal vegetation zones.

The ombrothermic index $Q_2$ for each meteorological station is assessed according to Emberger and Sauvage using a synthetic formula that takes into account total precipitation, the mean temperature, and the mean minimum temperature of the warmest and coldest months of the year respectively:

$$Q_2 = \frac{1000P}{\frac{(M+m)}{2}(M-m)} = \frac{2000P}{M^2 - m^2}$$

Where:
P = annual rainfall in millimeters.
M = the mean value of the maximum temperatures of the warmest month of the year.
m = the mean value of the minimum temperatures of the coldest month of the year.

The values M and m are expressed in absolute temperature degrees Kelvin (°K), where temperature (T) in °K corresponds to 273 + temperature in °C. The ombrothermic index Q2 for the Methoni Meteorological Station (whose data are considered to characterize the bioclimate of the entire study area) is calculated as follows:

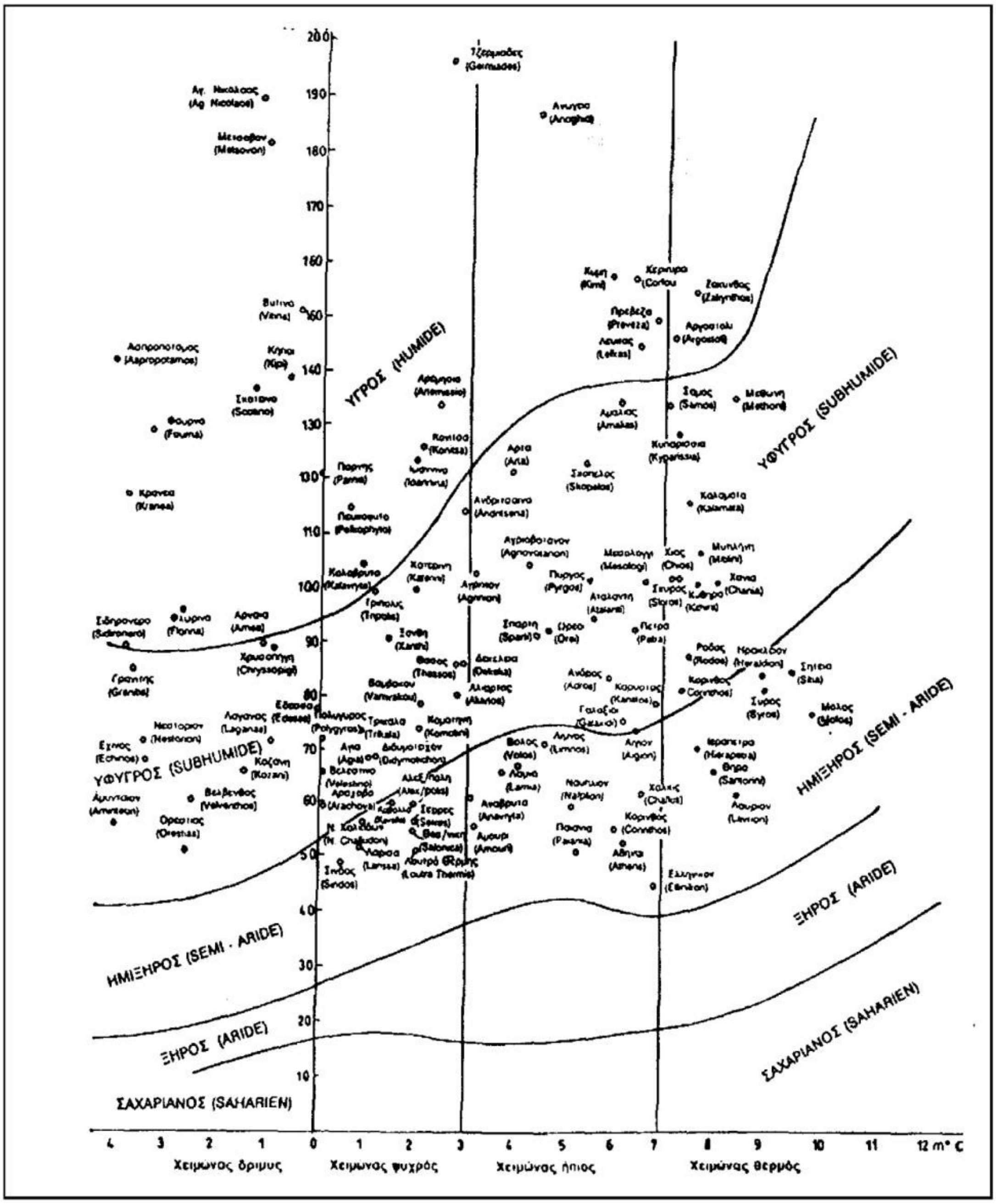
$$Q_2 = \frac{2000 \times 705.3}{(273+28.8)^2 - (273+7.8)^2} = 115.3$$

The ombrothermic index Q2 is used as the ordinate in a coordinate system, in which the abscissa is the index *m*, expressed this time in degrees Celsius. The smaller the value of the index Q, the drier the climate. On the basis of the values of Q and the value of *m*, Emberger compiles the so-called climatic diagrams. A corresponding diagram was prepared by Mavrommatis (1980) for Greece (Figure 8.8). Mavrommatis distinguishes the following bioclimatic zones:

- Humid zone
- Sub-humid zone
- Semi-arid zone

- Arid zone

**Figure 8.8: Emberger Climatic Classification for Greece (Mavrommatis, 1980)**




## Study Area

**According to the previous diagram and the Emberger classification, the study area is classified as *sub-humid with a warm winter*.**

### 8.2.4. General Ecosystem Characteristics

#### 8.2.4.1. Bioclimatic Elements

According to the classification by Mavromatis and based on excerpts from the bioclimatic map and the map of bioclimatic zones of Greece issued by the Ministry of Agriculture, Forest Research Institute of Athens, Division of Forest Ecology (G. Mavromatis), which are presented below, the bioclimatic elements for the areas under study are illustrated in the relevant map excerpts, Figures 8.9 and 8.10, and have the following characteristics:

In the study area of N. Sapientza, Schiza, Cape Akrita, and the Strait of Methoni, a sub-humid bioclimatic zone is observed.

**Bioclimatic Zone:** The study area belongs to the sub-humid bioclimatic zone with a warm winter and $m > 7$°C ($m$ = the mean minimum temperature of the coldest month, specifically 7.8°C).

**Character of Mediterranean Bioclimate:** The coastal, hilly, and sub-mountainous region exhibits a Mediterranean bioclimate with a distinctly meso-Mediterranean character. The xerothermic index is $75 < x < 100$, meaning that the biologically dry days during the xerothermic period range between 75 and 100.

**Figure 8.9: Excerpt from the Bioclimatic Zones Map of the Study Area**

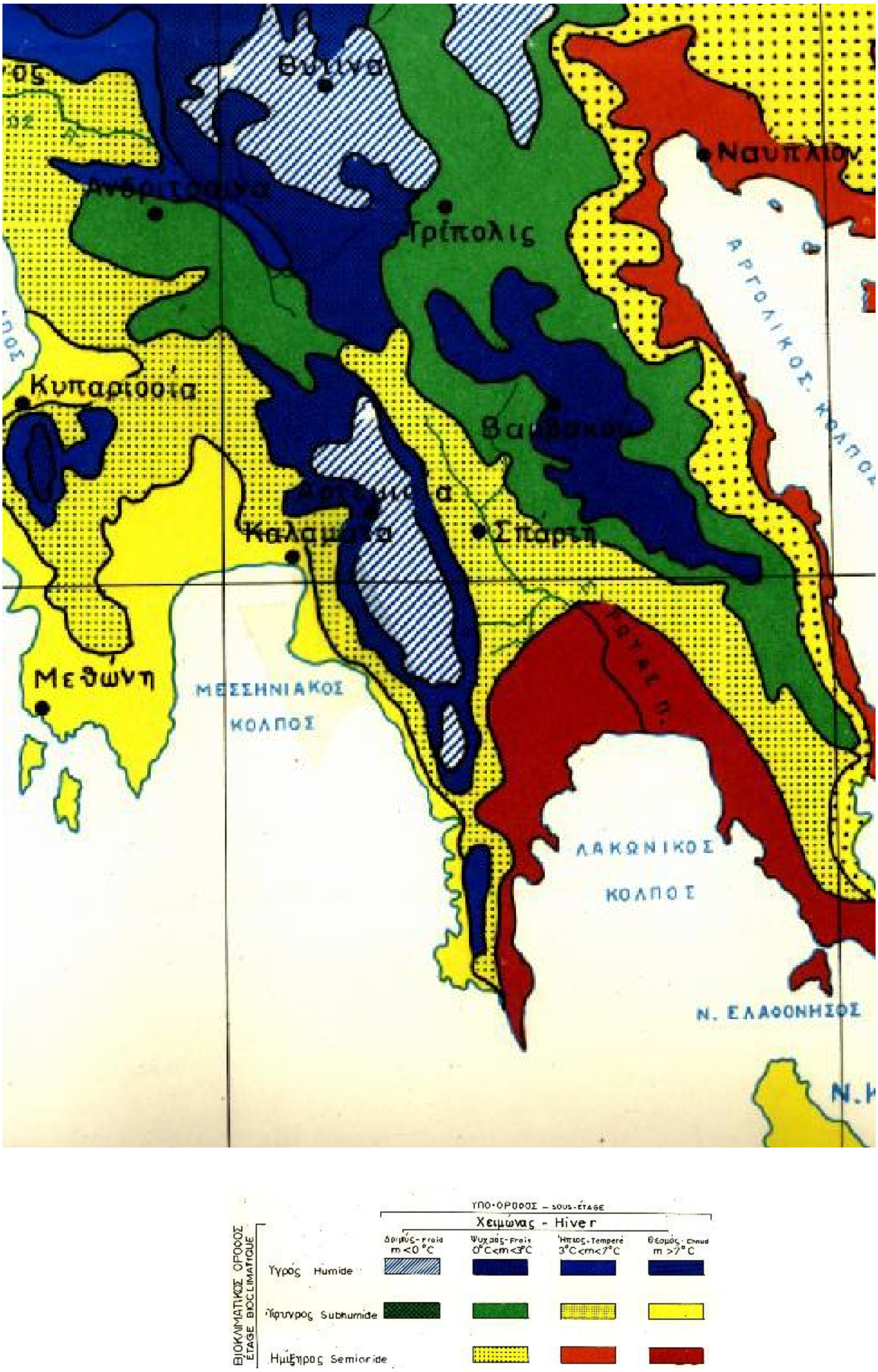
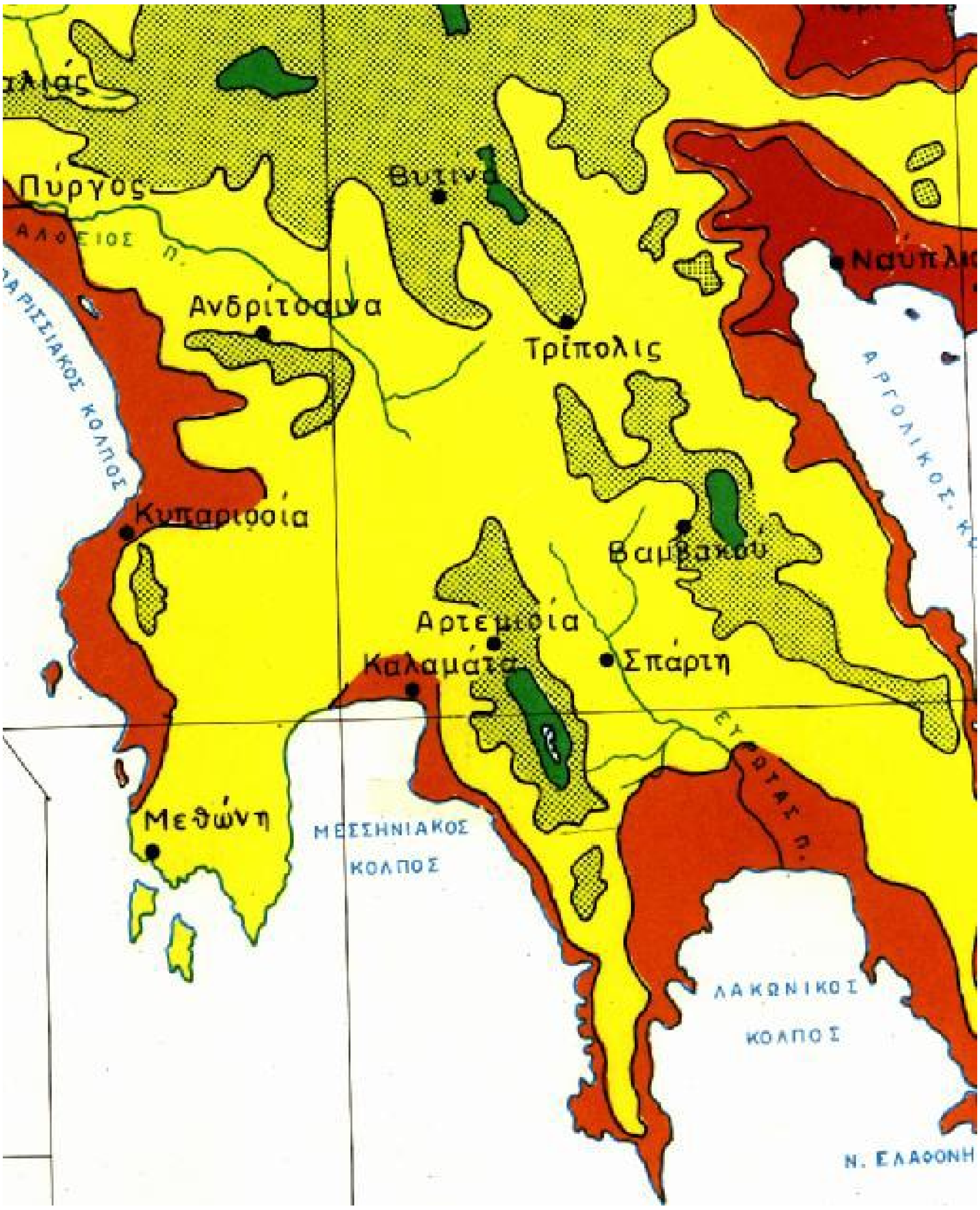
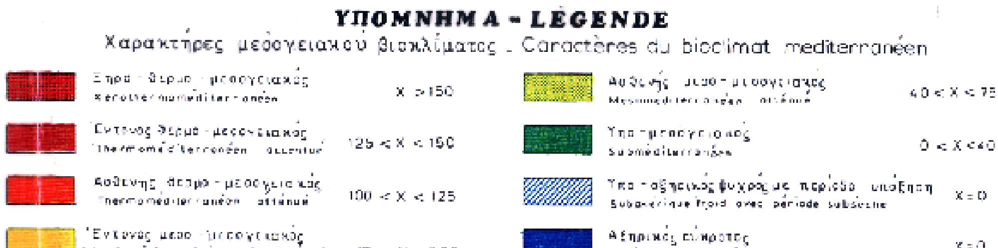


**Figure 8.10: Excerpt from the Bioclimatic Map of the Study Areas**




## 8.3 Morphological and Landscape Characteristics

The concept of landscape, its corresponding evaluation, as well as the perception and assessment of its value as a public good, was late to be institutionalized and granted protection, since the ratification of the European Landscape Convention (also known as the Florence Convention) was made by Law 3827 only in 2010. However, this convention marks a radical shift in the perception and very definition of the term *landscape*, defining it as: "an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors."

Specifically, landscape is understood as the set of perceivable elements of an area,

- natural (biotic or abiotic),
- anthropogenic, tangible,
- or intangible,

in whatever combinations they occur and have evolved over time.

Landscape elements are identified as the constituent features, whose repeated presence characterizes and structures the landscape, such as types and formations of vegetation, rocky outcrops, special constructions for activities (e.g., drainage and irrigation networks, terraces, linear plantings).

In the implementation of the European Landscape Convention, and within the framework of the revision and specialization of Regional Plans, a systematic recording and analysis of landscapes was undertaken in Greece for the first time. This included the recognition, at the level of the Region, of landscapes of particular importance, where coordinated actions of promotion and management will be prioritized, aiming to ensure the joint safeguarding and management of both nature and culture.

The following paragraphs present elements from the Landscape Study prepared within the framework of the Revision of the Regional Spatial Framework for the Peloponnese (2015), by *Doxiadis Associates S.A.*, which concern the broader study area.

### 8.3.1 Recording of the Overall Reference Landscape and its Subdivisions

The aforementioned Landscape Study, prepared within the framework of the Revision of the Regional Spatial Framework of the Peloponnese, applying a specific methodology and field research, identified the Landscape Zones of the Region, and classified landscapes into:

- "Landscapes of International Value"
- "Landscapes of National Value"
- "Landscapes of Regional Value"
- "Particularly Degraded Landscapes"

For this recognition, characteristic *point* features were used (monuments, archaeological sites, geotopes, etc.), as well as distinctive cultural and socio-economic activities of the areas (e.g., wine and olive routes, itineraries, etc.).

In the second phase of Evaluation and Analytical Mapping of the Landscape Units of the Regional Spatial Framework of the Peloponnese, the zones of landscapes of particular value were assessed on the basis of detailed descriptions of their main elements.

A total of 30 landscape units were recorded, while in some cases further subdivision into sub-units was carried out.

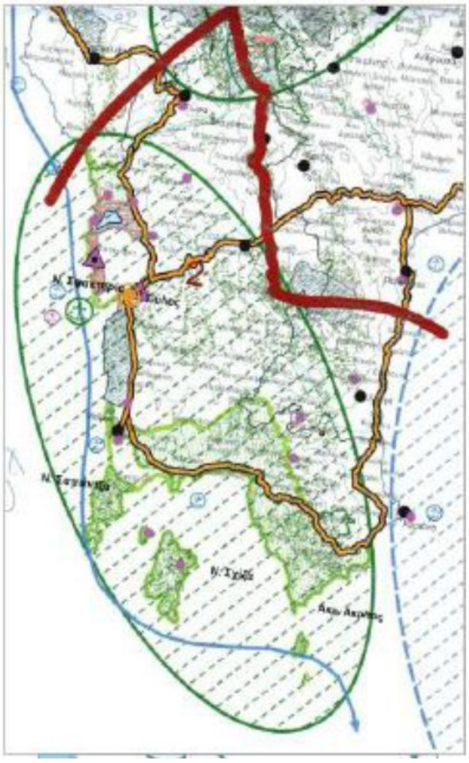
Subsequently, for each unit–subunit, the main landscape morphotypes were identified and classified into the following landscape types:

- agricultural,
- natural,
- coastal,
- settlements,
- industrial landscape.

The broader study area falls within the following landscape zones, with their geographical delineation presented in the figures that follow as well as in Map P2e of the landscape study of the Regional Spatial Framework of the Peloponnese Region:

- entirely within “LANDSCAPE ZONE 2 – METHONI, KORONI, PYLOS, COASTS AND ISLAND COMPLEX”,
- a large part of it within LANDSCAPE ZONE OF NATIONAL VALUE 2.1 “METHONI, ISLANDS SCHIZA, SAPIENTZA, VENETIKO, MARIANI,” which coincides with “TE 2-4 Areas of High Ecological Sensitivity.”

The characteristic features and a more detailed presentation of these are provided below.

#### 8.3.1.1. Landscape Units and Sub-units of the Wider Area

**"LANDSCAPE ZONE or LANDSCAPE UNIT 2 – METHONI, KORONI, PYLOS, COASTS AND ISLAND COMPLEX."**

Landscape Unit 2 covers the largest part of the southwestern peninsula of the Peloponnese, the "Pylia Peninsula." It includes the towns of Methoni, Koroni, and Pylos, as well as the coasts of the peninsula and the island complex of Schiza, Sapientza, Venetiko, and Mariani.

It is distinguished into two main sub-units based on the geographical division of the area:

- **TE 2-1 Continental Area**
- **TE 2-2 Island Area** (Schiza, Sapientza, Venetiko, Mariani), which is not geographically related to the subject of the present study and will not be further analyzed.

The **TE 2-1 Continental Area** concerns the largest part of the Pylia Peninsula. Its central area is dominated by Mount Lykodimos (960 m), as an extension of the Kyparissia mountain range. Lowland and hilly areas of relatively limited extent appear along the coastal zone and inland, interrupted and separated by the mountain masses of Mount

Lykodimos and its extensions. These areas are characterized by the region's primary agricultural production, olive groves. The coasts are intricate and diverse. The peninsula includes extensive sandy shores, rocky coasts, small beaches, and capes. A region with a particularly distinctive landscape is that around the Bay of Navarino, where there are areas of high ecological value, notable natural formations, significant settlements, and monuments, while the entire area is linked to important historical memories. Similarly, valuable settlement complexes exist throughout the coastal zone of TE 2.

Until recently, the area remained relatively isolated in terms of its connection with major transport routes. Thus, despite its important and notable natural and anthropogenic assets, it did not suffer significant degradation, unlike other similar areas, from the pressure of intensive tourism and residential development. Likewise, the size and morphology of the cultivated areas, combined with the main cultivated species, contributed to the area avoiding significant degrading pressures. Degrading pressures and threats for the area arise from the demand for construction volume and technical infrastructure due to the improvement of the area's connectivity and accessibility, wildfires, the "encroachment" of cultivation at the expense of areas of natural vegetation, natural processes such as localized coastal erosion, and pollution from isolated activities (e.g., olive mills, etc.). Another potential risk of degradation is linked to the possible lignite extraction in a specific field of the region.

Two additional categories have also been recorded as sub-units, based on corresponding institutional designations:

- **TE 2-3 Landscapes of Declared Exceptional Natural Beauty**
- **TE 2-4 Areas of High Ecological Sensitivity**, whose characteristics and landscape types are presented in the following sections.

#### 8.3.1.2. Landscape Types of the Wider Area

**A. In the TE 2-1 Continental Area, the following landscape types are identified:**

**<u>TE 2-1a Agricultural Landscape</u>**

In the lowland to hilly areas, the agricultural landscape is dominated by olive groves. Due to the relatively gentle relief, terraced cultivation is generally not present. As in the rest of Messenia, the olive groves and the olive oil produced are internationally recognized. The "Olive Routes" is an initiative under development, promoted by local authorities within the framework of broader actions covering wider areas of the country. The agricultural landscape also includes orchards and other crops. Vineyards are also present, mainly in upland areas exposed to the favorable influence of the

Ionian Sea (coastal vineyards). In the vineyards of Pylia, PGI Pylia wines (Local Wine of Pylia) are produced, offering opportunities for wine tourism (combined with the region's significant monuments and natural environment, wine tourism has become an important component of travel in Messenia).

A characteristic agricultural landscape is found in the plain of Gialova, which is combined with the wetland and the increased presence of water. Traditional rural constructions and forms of cultivation are found in various areas. The presence of greenhouses is limited.

The agricultural landscape of the area is characterized as interesting, mild, without significant degradation, with occasional mixing with natural vegetation. The added value of the agricultural landscape lies in the notable agricultural products and the promotional initiatives surrounding them (wine routes, olive routes, etc.). The landscape of olive groves harmoniously incorporates the rural settlements.
Threats to the agricultural landscape stem from pollution, wildfires, etc.

**TE 2-1b Natural Landscape**

**TE 2-1b.1 Mountainous & Semi-Mountainous Areas:** This sub-unit displays a variety of landscape forms in terms of relief formations—areas with gentler or steeper slopes, rocky or earthy textures, etc.—and vegetation cover, ranging from sparsely vegetated areas to dense shrubland or notable forests. Frequently, natural landscapes also include small patches of agricultural land, monuments, and chapels, which together create landscapes of particular interest.
It is considered an interesting natural landscape, largely in good condition, with a variety of forms and significant units in terms of vegetation, geological formations, views, etc. Monuments and chapels add further value to the natural scenery.
Threats derive from forest fires, erosion and desertification, the expansion of agricultural and residential uses, and large-scale technical works.
**TE 2-1b.2 Lowland & Coastal Zone:**

This zone also displays a variety of landscape forms. For the area near the project site, the following are noted:

- In the region from Finikounda to Methoni, natural vegetation appears in the form of patches among cultivated land and along streams.
- Areas with relatively pronounced relief and natural vegetation form north-south oriented strips ending at the coast (mainly two such zones).

This constitutes an interesting natural landscape, shaped by anthropogenic interventions (roads, cultivated areas, etc.) and scenic routes with notable views, in combination with the coastal landscape.

## TE 2-1c Coasts

**Information is provided only for the area adjacent to the project site.**

- (e) Coast west of Finikounda: This coastal stretch features extensive, noteworthy sandy beaches, subject to increased tourist use near the more developed settlements. In addition, rocky shores with steep formations are observed along the coastline, especially around the peninsula, with smaller or larger protected beaches and natural vegetation on the hinterland slopes. Significant natural formations are present along the coastal front (geotope). Overall, this is a valuable coastal landscape, varied, interesting, in good condition, with a high degree of naturalness and without major burdens.
- (f) Coastal area of Methoni: Characterized by an elongated sandy beach of varying width, which is used for tourism. The dominant feature of this coastal landscape, shaping its character, is the imposing castle. This constitutes an important and highly valuable landscape, of archaeological and historical interest, which also combines picturesque traditional elements with relative uniqueness at both national and international levels.

## TE 2-1d Settlements

- The inland settlements are primarily agricultural in character, with mild building density, low-rise houses usually with tiled roofs, retaining a picturesque appearance and traditional elements. In some cases, they are combined with interesting natural and agricultural landscapes.
- The coastal settlements combine agricultural and tourist activities, with a predominance of the latter. They also feature mild building density, generally low-rise houses usually with tiled roofs, while tourist activities dominate the coastal front. These are settlements of picturesque character, combined with valuable coastal areas.

**Tourist development:** Generally mild and integrated into the respective local contexts where it has taken place, characterized by small-scale buildings and relatively limited facilities. In addition, there are several tourist camping activities in the area.

**Important Cities**

**For the area in proximity to the project, the city of**

**Methoni:** The oldest surviving houses (excluding the castle) were not built before the 18th century, as evidenced by historical records that document the continuous destruction of the city. Nevertheless, the distinctive character of the medieval settlement was preserved, largely due to the long Venetian occupation and influence, combined with the economic decline of the 18th and 19th centuries, which reduced building activity during that period.

Methoni is one of the earliest post-revolutionary settlements designed according to an urban plan and has retained, without significant alterations, the original architectural features typical of southern Peloponnesian buildings of the past century. It forms the appropriate setting for the medieval fortress that rises at its southwestern edge.

The Venetian castle, dating back to the mid-14th century, occupies the peninsula that juts into the sea and extends along it. It is one of the most significant castles in Greece. It was built by the Venetians after they took control of the city in 1209 AD. In front of the sea gate of the castle, and standing within the sea itself, is the later-built **Bourtzi** (a fortified islet, circa 1500).

The medieval city developed inside the castle, expanding along a north-south axis. Today, the settlement within the castle is almost completely in ruins. The modern town (present-day township) is flat and developed along two main axes, which extend the castle's axis toward the mainland (to the north). These central, wide streets intersect with narrow perpendicular lanes, forming a rectangular urban grid. Along these streets is the commercial center, which also shows the densest development in continuous rows of buildings. There are no large public open spaces for gatherings.
The largest, more urban houses are built along the two main axes, while smaller, more modest dwellings are found in the peripheral areas.

In Homeric times, the city was called **Pidasos**, and Homer described it as **Ampeloessa** ("rich in vineyards"). He also listed it as the last of the seven "well-founded cities" offered by Agamemnon to Achilles to appease his wrath. Pausanias refers to the city as **Mothone**.

From the 4th century, Methoni served as the seat of the Bishopric of Methoni. The Venetians fortified the city and transformed it into a major commercial hub. The area experienced significant prosperity and became an important stopover between Venice and the Holy Lands. It remained under Venetian control until 1715, when the Ottomans reconquered the region.

Today, Methoni is recognized as an important, noteworthy landscape of archaeological and historical significance, well-preserved, and of both national and international scope. It has been officially declared a site of outstanding natural beauty.

**Other Important Cities Beyond the Wider Project Area**

**Pylos (or Neokastro):** Pylos, also known as Neokastro, is a small town, historically a significant maritime center, which in recent years has experienced notable tourist development, capitalizing on its scenic coastline. It is considered one of the safest anchorages in the Mediterranean. Pylos is referenced by Homer as the **Kingdom of Nestor**. The modern town was built around the castle, part of which is designated as a preserved monument. The castle itself is a declared archaeological site, constructed by the Ottomans in 1573 AD to control the southern entrance of the Bay of Navarino, and it remains in good condition. It is particularly noteworthy, dominating the southern part of the town and giving the coastal landscape its distinctive character.
The Bay of Navarino is historically significant due to its association with the decisive **Battle of Navarino (1827)** during the Greek War of Independence, and it also carries memories from World War II. The castle and surrounding landscape are officially recognized as a site of outstanding natural beauty (Government Gazette FEK 750/B/7-6-1976), with national and international importance.

**Koroni:** Koroni is built on a small rocky promontory and developed along two main directions:

1. From the port towards the hill with the castle, and
2. Along three main parallel streets.

The core of the settlement—comprising the commercial center, entertainment, and tourism—revolves around the central square with the church and the seafront. The urban system is shaped by the topography and consists of three main elements: the central square, main streets, and narrow, often sloped or stepped lanes connecting the different levels. Public buildings, mansions, and larger urban houses are located along the seafront, while smaller, traditional dwellings are situated toward the hill. Aside from the square as the public gathering space, the settlement displays architectural introversion: houses are built close together with high, closed façades facing the street, often without open spaces in front. Historically, Koroni experienced great prosperity. From the 13th to the 18th centuries, it was a flourishing commercial center. Its massive "Impregnable Castle" was among the most important fortresses of the Mediterranean. During the Middle Ages, Koroni functioned as a distinctly urban settlement with significant commercial and strategic value, serving as a fortified station for Venetian ships en route to the East. The Venetians occupied it in 1206 and held it for three centuries. From 1500 to 1828, Koroni declined, only to regain economic vitality in the 19th century. Later, with the economic stagnation of the Greek countryside, mass migration to cities during the interwar period, and shifts in lifestyle, the town once again fell into decline.

Today, the castle still offers a unique panoramic view of the Messinian Gulf. The settlement, amphitheatrically built on a low hill, commands vistas over the sea. In antiquity, the site of modern Koroni corresponded to the ancient city of **Asine**, referenced by Stephanus of Byzantium, Strabo, and recorded in Hierocles' *Synecdemus*. Pausanias mentions two different traditions regarding its name.
The city was conquered by the Venetians and later by the Ottomans. Today, Koroni represents an important, noteworthy landscape of both archaeological and historical significance, well-preserved, and of both national and international scope. It has been declared a site of outstanding natural beauty.

**B. Subunit TE 2-2: Island Area (islands of Schiza, Sapientza, Venetiko, Mariani) This area is located within the wider region of the project but is not directly involved with the works under consideration.**

**C. Subunit TE 2-3: Declared Landscapes of Outstanding Natural Beauty**

Within the wider project area, two sites have been declared as Landscapes of Outstanding Natural Beauty:
**AT1011083 Methoni**

**Integration into the Existing Institutional Framework:** Archaeological Site / Preserved Settlement / Listed Buildings / NATURA-2000 Network / Traditional Settlement.

**Socio-economic / Cultural Value:** Archaeological Interest / Scientific Research / Historical Interest / Cultural-Historical Tourism / Folklore Interest / Traditional Architecture / Connection with Popular Tradition / Tourist Interest / Aesthetic Value / Exceptional Natural Beauty / Well-crafted Anthropogenic Features / Panoramic View.

**Threats of Degradation:** The settlement has undergone significant interventions and alterations, while the castle still retains strong Venetian-period characteristics. Abandonment and ruin of the castle are ongoing issues. The abandonment and alteration of old buildings could irreparably damage the settlement.

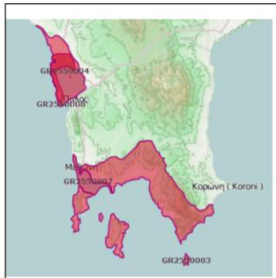
**AT1010013 Koroni**

**Integration into the Existing Institutional Framework:** Archaeological Site / Preserved Settlement / Listed Buildings / Historic Site / Landscape of Outstanding Natural Beauty.
**Socio-economic / Cultural Value:** Archaeological Interest / Scientific Research / Historical Interest / Cultural-Historical Tourism / Folklore Interest / Traditional Architecture / Connection with Popular Tradition / Tourist Interest / Aesthetic Value /

Significant Natural, Ecological, and Geomorphological Features / Exceptional Natural Beauty / Well-crafted Anthropogenic Features / Panoramic View.

**Threats of Degradation:** Numerous modifications and interventions are made to buildings that, even if not of high historical value individually, collectively give Koroni its distinctly harmonious and picturesque character, which is undeniably significant.

**D. Subunit TE 2-4: Areas of High Ecological Sensitivity**

| | Κωδικός τόπου: | Ονομασια | | ΒΙΤΟΠΟΙ CORINE |
|---|---|---|---|---|
|  | ΠΕΡΙΟΧΕΣ ΔΙΚΤΥΟΥ «ΦΥΣΗ 2000» | |  | A00010221 Ακρωτήριο Ακρίτας, Νήσοι Σαπιέντζα και Σχίζα<br>Η περιοχή προσφέρεται για μεταναστευτικά πουλιά. Επίσης υπάρχει παρουσία μεταναστατευτικών αρπακτικών πουλιών: Aquilla heliaca (Βασιλαετός), Aquilla chrysaetos (Χρυσαετός), Aquilla clanga (Στικταετός) και έχει αναφερθεί ότι είναι τακτικά στόχοι κυνηγών. Σημαντικό μέρος για την Μεσογειακή Φώκια (Monachus monachus). Άφθονη η παρουσία ψαριών. |
| | GR2550004 | LIMNOTHALASSA PYLOU (DIVARI) KAI NISOS SFAKTIRIA, AGIOS DIMITRIOS | | |
| | GR2550003 | NISOI SAPIENTZA KAI SCHIZA, AKROTIRIO AKRITAS | | |
| | GR2550007 | THALASSIA PERIOCHI STENOU METHONIS | | |
|  | ΑΛΛΟΙ ΒΙΟΤΟΠΟΙ | |  | A00010060, Διβάρι Πύλου<br>Υφάλμυρη λίμνη με βάλτους (το καλοκαίρι αποξηραίνεται μερικώς) και θάμνους στον κόλπο του Ναυαρίνου κοντά στην Πύλο. Υπάρχουν επίσης παλιρροιακοί λασπότοποι. Βραχώδεις λόφοι κοντά στον κόλπο.<br>Ορνιθολογικώς σημαντική περιοχή, καθώς αποτελεί σταθμό των μεταναστευτικών υδρόβιων πουλιών. Η σπουδαιότητα της περιοχής ως χώρος αναπαραγωγής δεν είναι αρκετά γνωστή αλλά πρέπει να ληφθεί υπόψιν (για την Πελοπόννησο). Το χειμώνα υπάρχουν περισσότερες από 2.000 Fulica atra (Φαλαρίδα) και πάπιες.<br>Το κυνήγι είναι μεγάλο πρόβλημα και η απαγόρευσή του θα αύξανε σημαντικά την σπουδαιότητα του υγροτόπου για τα μεταναστευτικά πουλιά. |
| | AB1080126 | ΜΕΘΩΝΗ Παραθαλάσσιο Τοπίο / Χωριό/Οικισμός | | |
|  | AB1080162 | ΚΟΡΩΝΗ Παραθαλάσσιο Τοπίο / Χωριό/Οικισμός | | |

In the wider area, the following have been designated as Areas of High Ecological Sensitivity:

For the aforementioned sites of the Natura 2000 network, <u>one of which is adjacent to the proposed works</u>, a Special Environmental Study (SES) has been carried out (relevant maps are presented below), in which protection zones are defined for both the terrestrial and marine environment.

**Figure 8.11: Extract from the map of the Special Environmental Study (SES) of the Natura 2000 sites GR2550003 and GR2550007 in the Methoni area, which have been designated as Areas of High Ecological Sensitivity.**

## 8.3.2. Elements of the Significance and Vulnerability of the Landscape

All the landscape types mentioned above have been characterized as noteworthy to highly noteworthy, while some of them are also institutionally protected either under the Archaeological Law or through other designations by the Ministry of Environment, Energy and Climate Change (YPEKA) as traditional settlements or protected natural environments (nature protection areas). The detailed characteristics have been provided in the corresponding reference paragraphs for reasons of textual coherence. Regarding the elements of vulnerability and threats to the landscape, these have also been provided but are summarized below: For TE 2-1, the Mainland Area, a relatively minor degradation is noted due to the cultivated crop type and the relief. The main pressure–threat identified is the demand for building volume and technical infrastructure. For the agricultural landscape, the main pressures–threats are pollution and fires. For the natural landscape, the threats mentioned are fires, erosion–desertification, and the expansion of agricultural and residential pressures. For TE 2-4, Areas of High Ecological Sensitivity, within the framework of the Special Environmental Study that has been carried out, the framework of the areas and the type of protection required have been thoroughly recorded in the corresponding chapter.

#### 8.3.3. Correlation of the characteristics of the landscape units and types with the characteristics of the projects

The general characteristics of the landscape units, particularly in the reference area of the examined projects (the dam and the irrigation network), are those of the agricultural landscape, with features of natural landscape derived from riparian vegetation along streams and small sections of forest–pastureland type areas. The projects under consideration in the present study constitute major developmental interventions with environmentally friendly infrastructures, which by themselves represent measures for the optimal management of natural resources, prioritizing the use of surface waters, optimizing their management, and at the same time providing substantial support to agricultural activity and strengthening the competitiveness of the primary sector.

Given these characteristics of the projects, it is evident that they will also help address the main aforementioned threats to the landscape, since the improvement of farmers' incomes will be sufficient to reduce the pressure from tourist housing demand. Through the examined projects, the aim is the preservation and reinforcement of this agricultural activity, which also constitutes the strongest structure for confronting the aforementioned degradation pressures and threats to the area, which stem from the demand for building volume, i.e., residential use through the conversion of agricultural land and activity into urban-touristic land use.

### 8.4. Geological, Tectonic, and Soil Characteristics

The elements of this chapter are derived from the geological study prepared within the same framework. This chapter presents data regarding the geotectonic setting and the seismicity of the wider area of the proposed Minagiotiko Dam, as summarized in the conclusions of the project's geological study.

#### 8.4.1. Geotectonic Setting and Seismicity of the Wider Area

### i) Geotectonic Setting

The wider area of the Project belongs to the Gavrovo–Tripolis geotectonic zone, which occupies most of the Peloponnese, a significant part of Western Mainland Greece, and extends northwards into Albania, Bosnia–Herzegovina, and Montenegro, and southwards into Kythera, Crete, Karpathos, Astypalaia, continuing further into Asia Minor.

The formations of this zone overlie the Platten Kalke unit in Central and Southern Peloponnese and Crete, while in the Pylos region they develop at the front of the tectonic nappe of the Pindos zone.

The orogenic tectonism of the Gavrovo–Tripolis zone took place during the Tertiary period. Specifically, the tectonism of the eastern part of this zone occurred during the Lower–Middle Oligocene, resulting in the folding of formations with thrusting towards the west–southwest. During this period, the overthrusting of the Pindos tectonic nappe also took place, covering the eastern part of the Gavrovo–Tripolis zone. Conversely, the western part of this zone, during the same period, was subject to intense subsidence, receiving vast volumes of clastic sediments that formed the Epirus–Akarnania foredeep, which was later tectonized during the Upper Oligocene–Lower Miocene.

With respect to the geotectonic setting of the immediate area of the Minagiotiko Dam, it should be noted that:

- The Project area belongs to the Gavrovo–Pylos geotectonic zone and is composed of flysch formations, as well as Pliocene and Holocene deposits.
- The flysch formations of the Gavrovo–Pylos zone are in tectonic contact with the formations of the Olonos–Pindos geotectonic zone. In this area, the Olonos–Pindos zone consists of flysch, limestones, and radiolarite formations that overlie the Gavrovo–Pylos formations.
- This overthrust, oriented north–south, passes through the settlements of Ampelokipoi – Militsa – Exochiko – Rizario, at a distance of approximately 2.0 to 2.5 km east of the dam site and the Minagiotiko reservoir basin.

## ii) Seismicity

The wider project area is characterized by moderate to intense seismic activity from historical times up to the present day (Figure 8.12, next page). The seismotectonic features of the area indicate the presence of an active extensional stress field with approximately west–east extension, as well as a compressional stress field with a southwest–northeast orientation of compression (Figure 8.13, following).

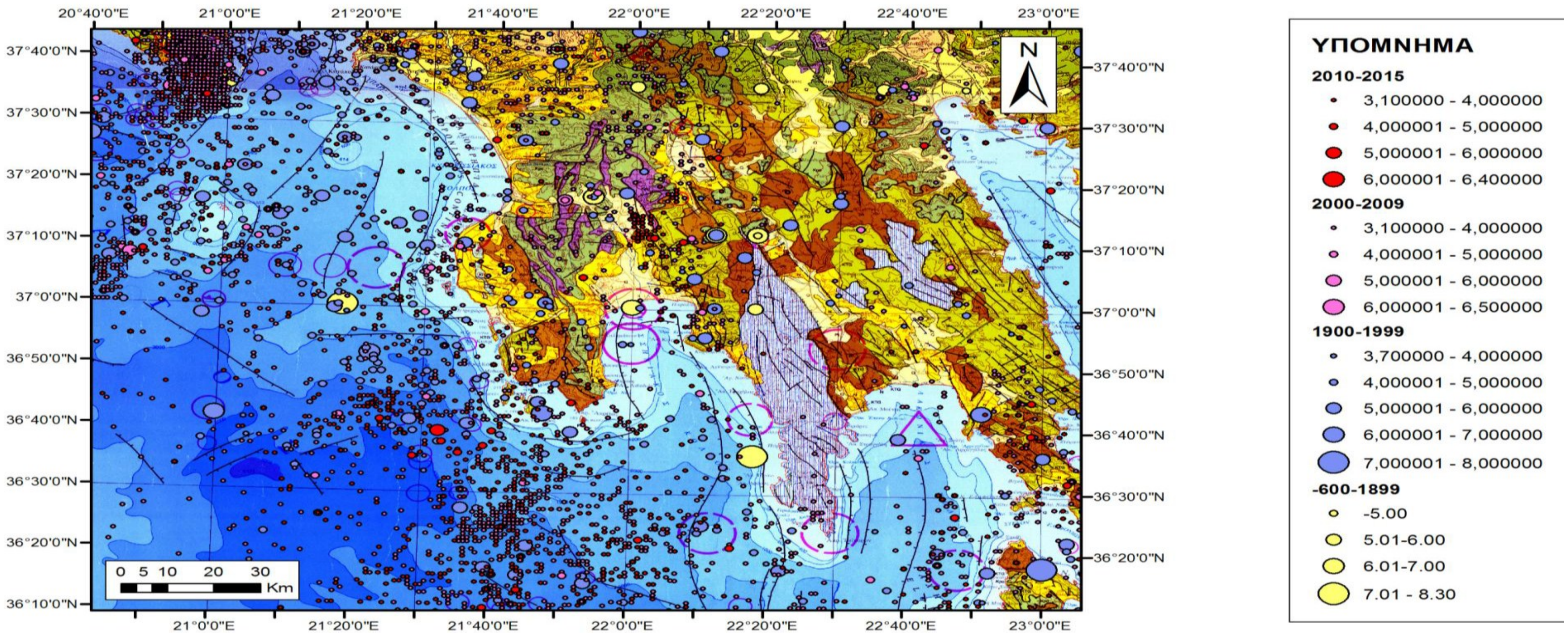



**Figure 8.12: Epicenters and magnitudes of all recorded seismic events in the wider study area (source: National Observatory of Athens; as a reference the Seismotectonic Map of Greece, IGME, was used).**

In **Figure 8.12**, the seismic events that have occurred in the wider project area during the period from **600 B.C. to the present** are depicted, and the following observations can be made:

a) In the wider area of interest, seismic events ranging from small to large magnitudes have been recorded.

b) In this area, a number of seismic foci are identified, which are associated with faults oriented almost north–south.

c) The main seismic activity of the area originates from the northeast, i.e., from the **Kalamata region**, from the west–northwest, i.e., from the wider area of **Zakynthos**, and from the west–southwest, i.e., at the boundaries of the **Hellenic Trench**.

In the immediate vicinity of the project site, seismic tremors of small magnitude (3 to 4 on the Richter scale) are reported, with only one seismic focus reaching up to **5.0 on the Richter scale** (Figure 8.12).

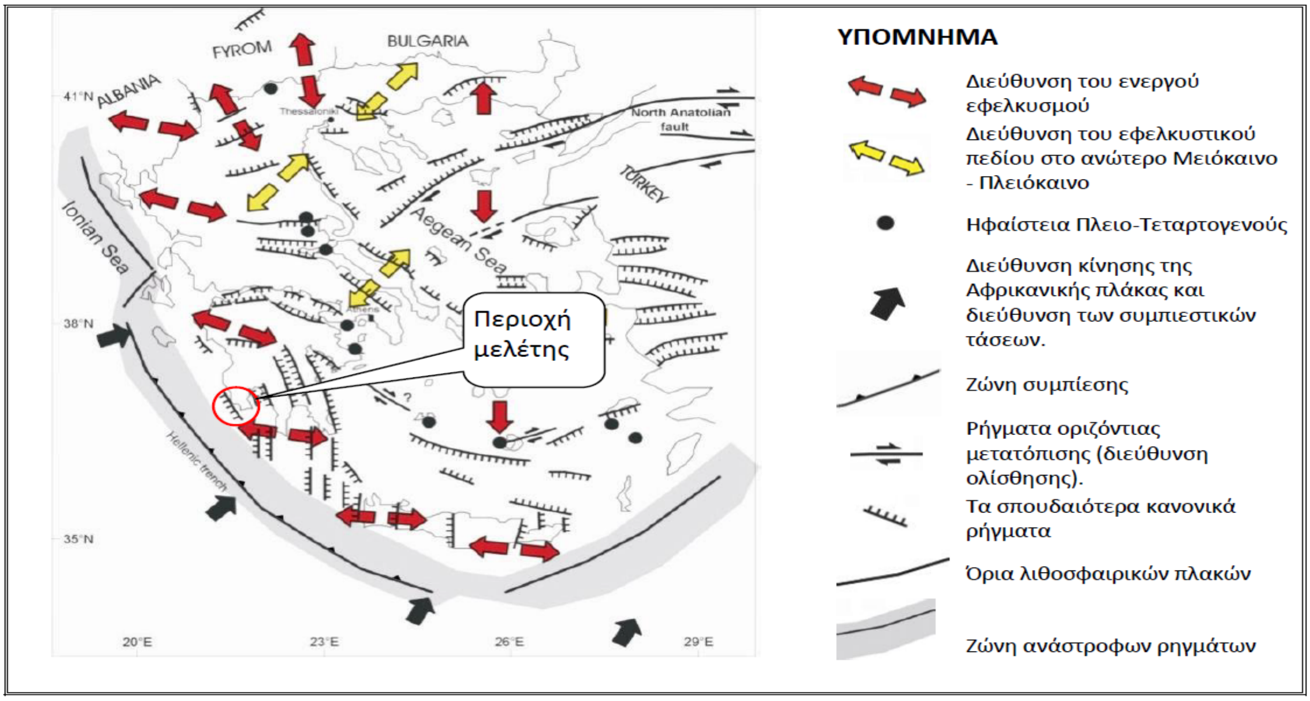


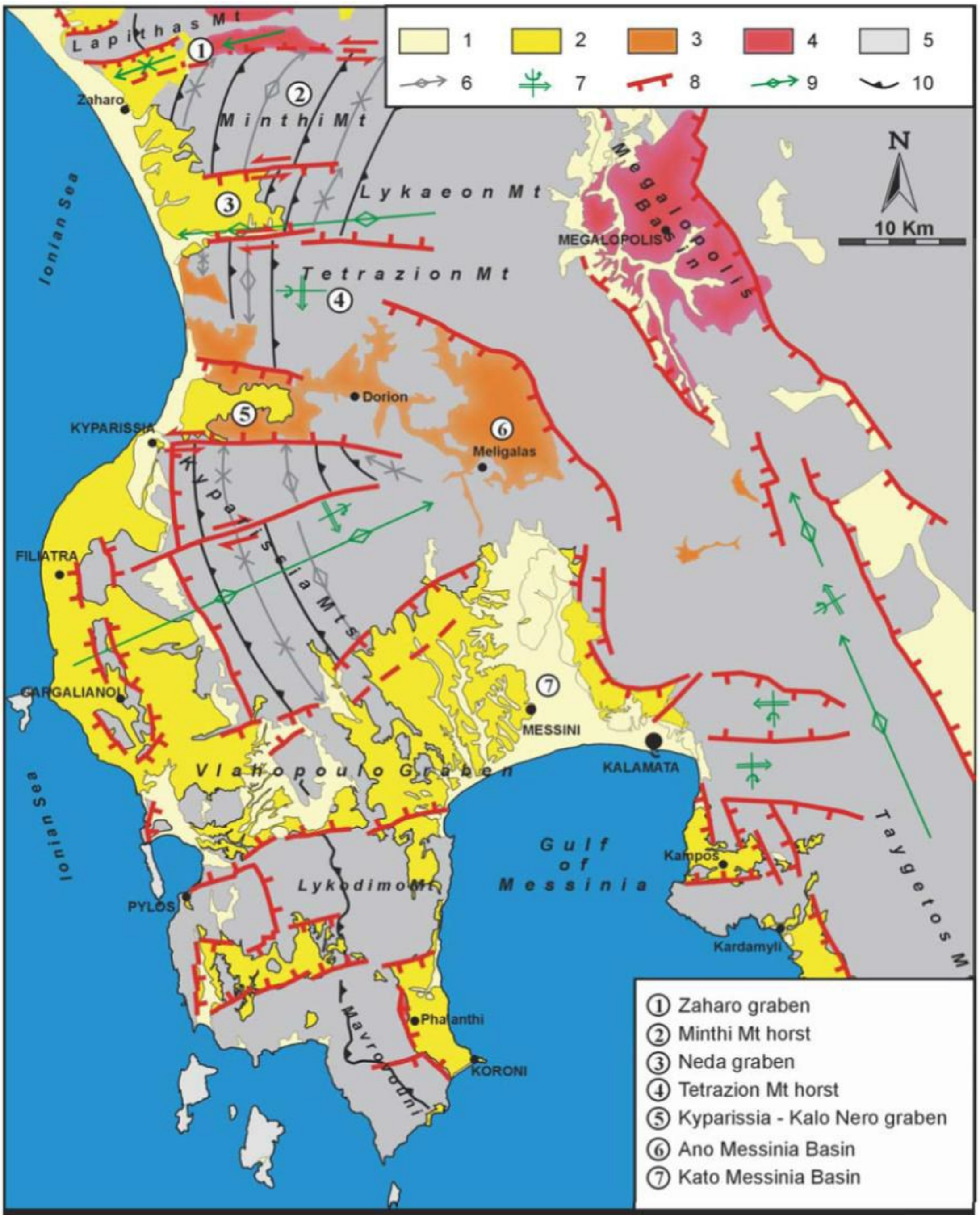

**Figure 8.13: Main seismotectonic features of the Aegean region and the surrounding areas (Mountrakis, General Geotectonic Evolution of the Wider Hellenic Area, http://www.geo.auth.gr/871/ch5/sxima_41.jpg).**

A key characteristic of the neotectonic structure of the area, according to bibliographic references, is the presence of tectonic subsidence zones and uplifted blocks (horsts), which are delimited by fault zones (Figure 8.14). The deformation that the area has undergone during the neotectonic period is both fault-related and plastically controlled, and is characterized by the presence of large-radius macroscopic folds with significant curvature.

The kinematic evolution of each macroscopic structure is rather complex, involving rotations along horizontal axes and differentiation in the rate of uplift or subsidence at the edges of the individual fault blocks.

The wider project area belongs to Seismic Zone II, with a seismic acceleration coefficient of $\alpha = 0.24g$ and an expected seismic intensity of VIII to IX degrees on the Mercalli scale. The probable maximum magnitude of an earthquake that may occur in the wider project area within the next 100 years is estimated to range between 6.8 and 7.0 on the Richter scale (Figures 8.15, 8.16, 8.17, 8.18).

**Figure 8.14: Neotectonic structures of the southwestern Peloponnese.**




(Source: *Sustainable water resource management in neotectonic basin systems*, Mariolakos I., Fountoulis I., Spyridonos E., Capourani E., Andreadakis E., 8th International Conference on Environmental Science and Technology, Lemnos Island, Greece, 8–10 September 2003).

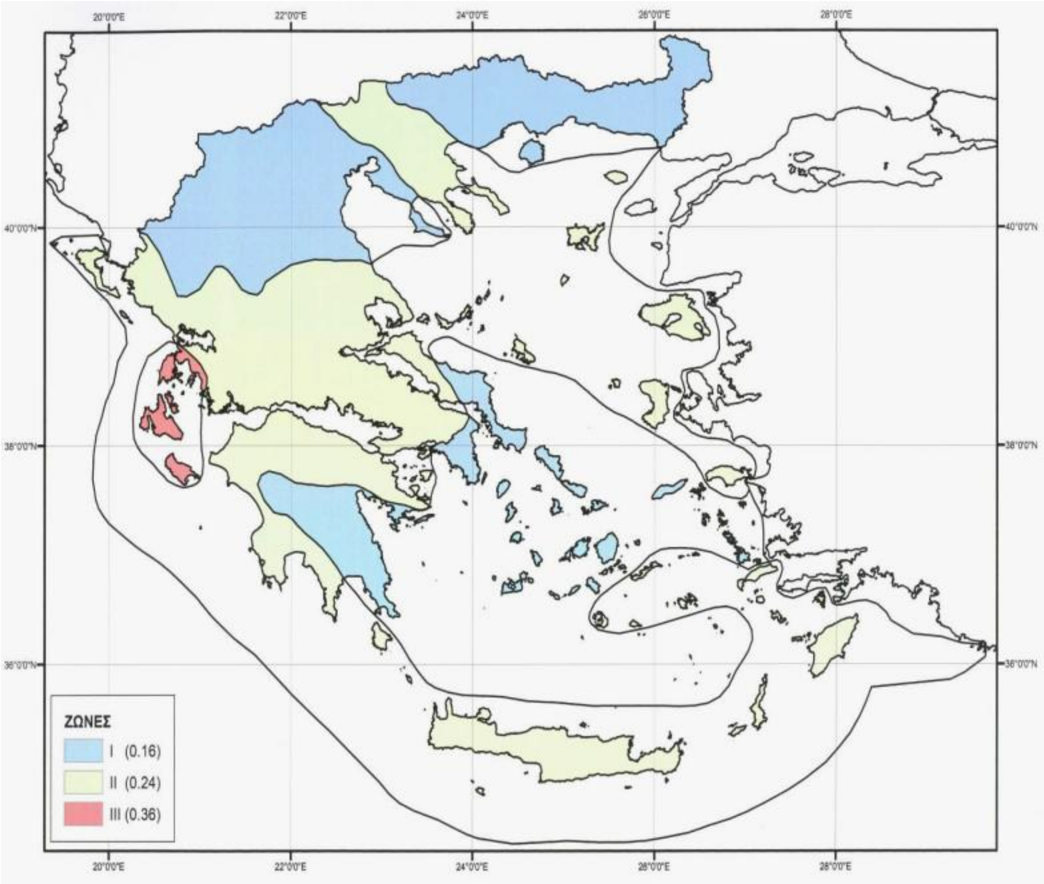



**Figure 8.15: Revised Map o Seismic Hazard Zones of Greece. (Government Gazette, Issue B 1154/12.8.2003).**

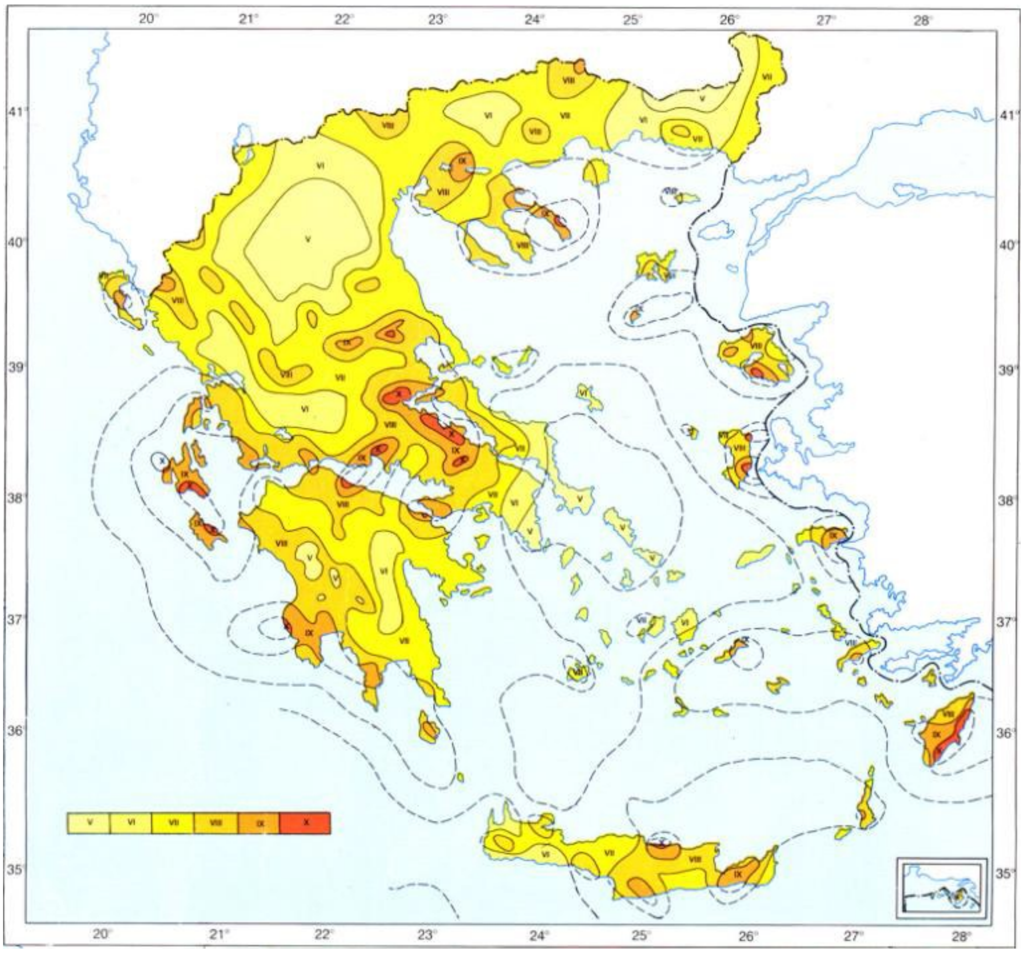



**Figure 8.16: Map of Maximum Seismic Intensities Observed in Greece During the Period 1700–1981 (after Drakopoulos I. – Makropoulos K., 1982).**

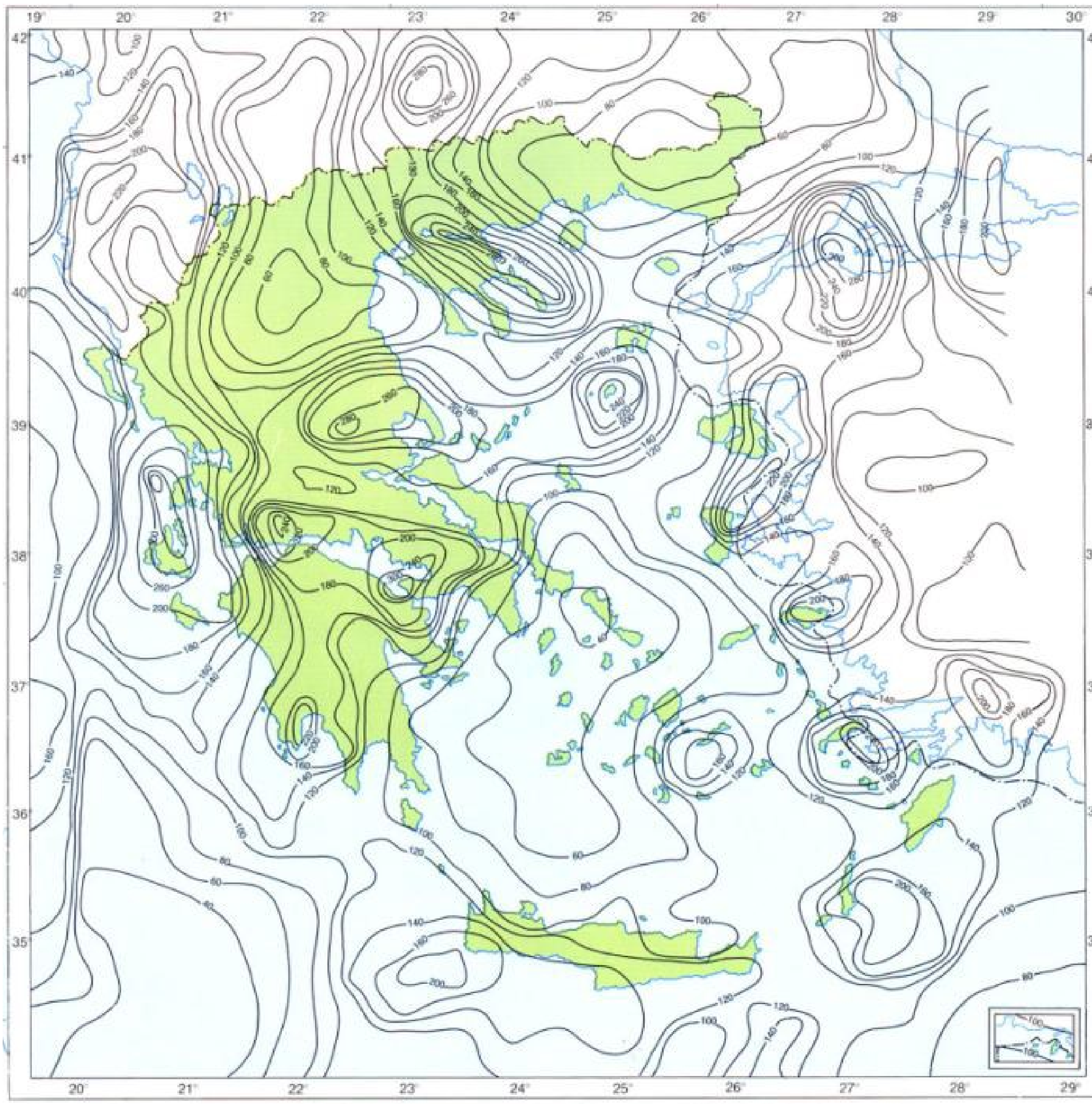



**Figure 8.17: Map of Expected Maximum Acceleration Values with a 90% Probability of Not Being Exceeded in the Next 25 Years. Recurrence Period: 238 Years (after Drakopoulos I. – Makropoulos K., 1982).**

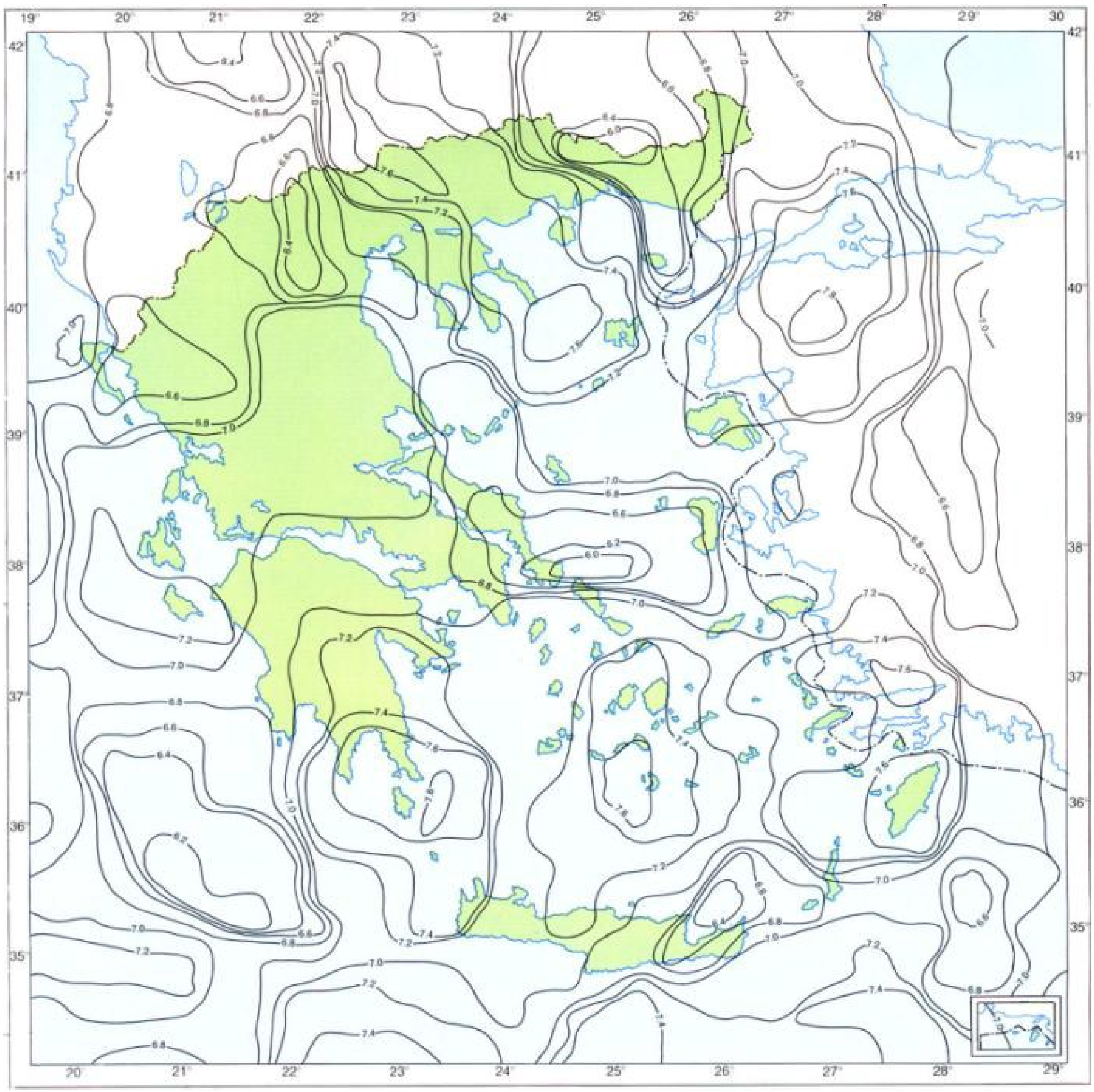


**Figure 8.18: Map of the Probable Maximum Earthquake Magnitude Expected in the Greek Territory in the Next 100 Years (after Drakopoulos I. – Makropoulos K., 1982).**

### 8.4.2. Catchment Basin

#### i) Morphology

The morphological relief of the area is complex and is characterized by intense dissection with gentle slopes and extensive flat surfaces along the course of the Minagiotiko stream and other major tributary streams, gentle slopes on the summits of local hills, and moderate to locally steep slopes in the inclined areas of the escarpments.

#### ii) Hydrographic network

The hydrographic network has an irregular dendritic/orthogonal form and consists of the main branch of the Minagiotiko stream, which has an approximately north–south flow direction, as well as other large tributary streams and a large number of smaller streams with variable flow directions.

#### iii) Geological structure

The area is composed of flysch formations (conglomerates/sandstones/marls) of the Gavrovo–Pylos geotectonic zone, which form the older geological substratum; the Messinia conglomerates and Pliocene deposits, which constitute the younger geological substratum, have been deposited in stratigraphic discordance over the heavily eroded and dissected paleomorphological relief of the flysch. The Pleistocene deposits and contemporary soil formations (alluvial deposits, colluvial material, and landslide/debris flow materials) cover to a large extent the older formations.
These flysch formations are in tectonic contact with the formations of the Olonos–Pindos geotectonic zone. This thrust has a north–south orientation and borders—almost coinciding with—the eastern boundary of the catchment basin (see Figure 8.19 below).

#### iv) Hydrogeological conditions

The hydrogeological conditions prevailing in the catchment basin area are considered favorable. This assessment is based on:

- the morphology of the escarpments around the basin,
- the prevailing geological structure of the area,
- the hydrogeological characteristics of the formations, and
- the presence of springs with periodic or permanent discharge.

Based on these data, it is estimated that the infiltrated water within the formations of the area re-emerges—after some delay—into the surface hydrographic network of the catchment basin.
Furthermore, it is also estimated that the hydrogeological basin of the Minagiotiko extends eastward beyond the watershed of the hydrological/morphological catchment basin. This estimation is based on:

- the presence of springs with high discharge and permanent flow, a phenomenon not justified by the relatively small surface area of this basin, and

- the fact that these springs are located at relatively low altitudes—exclusively—on the eastern side of the basin, i.e., towards the carbonate rocks of the Olonos–Pindos zone. These limestones are located at much higher altitudes than the spring elevations and belong to an adjacent basin.

For the calculation of the runoff volume of the basin, it is proposed—among other parameters—that the following be taken into account:

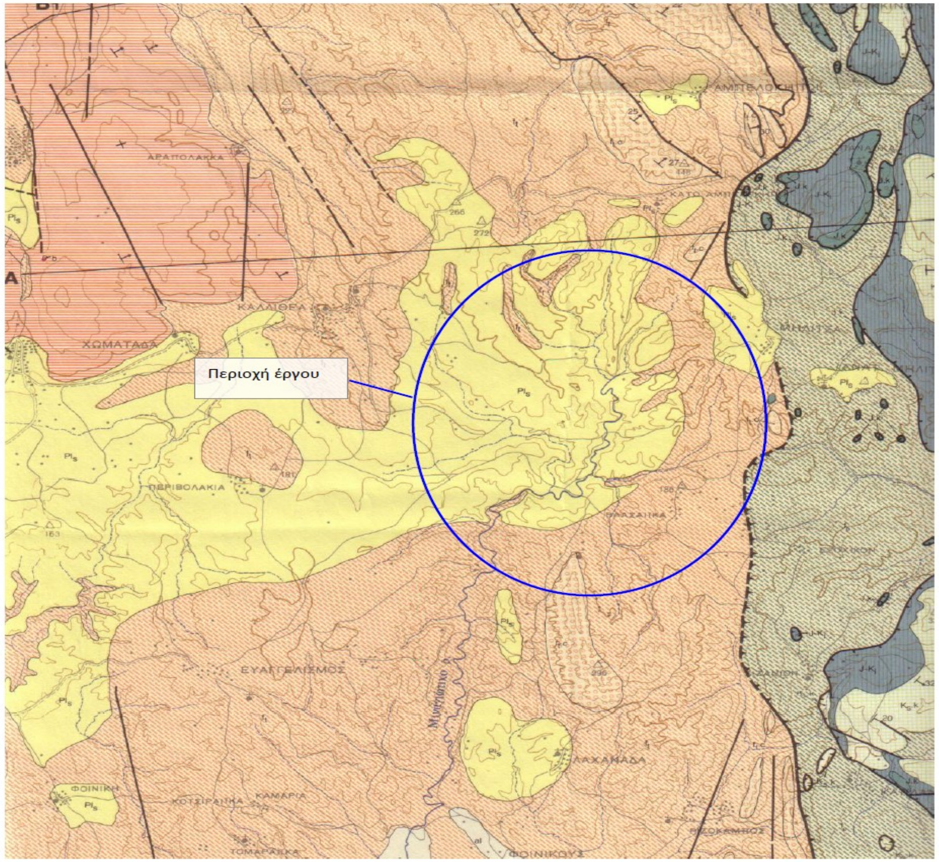
- the coefficients of effective infiltration,
- the coefficients of surface runoff, and
- the areas/percentages for each hydrological unit (I, II, III), as presented in Chapter 8.13.2, Table 8.5 of the following page, and in Plan GM-1.

| Υδρολιθολογικές ενότητες | Γεωλογικός σχηματισμός | Συμβολισμός | ΔΙΑΠΕΡΑΤΟΤΗΤΑ | | | Ανάπτυξη υδροφόρων οριζόντων | |
|---|---|---|---|---|---|---|---|
| | | | Κατηγορία | Χαρακτη-ρισμός | k m/sec | Παρατηρήσεις | Συντελεστές |
| (III) Σχηματισμοί υψηλής έως πολύ υψηλής περατότητας | Σύγχρονες αποθέσεις κοίτης, αποτελούνται από ιλυοαμμώδη υλικά, χάλικες, κροκάλες και ογκόλιθους. | Alo | $Π_1$ / $Π_2$ | Πολύ υψηλή έως υψηλή | $k>10^{-2}$ | Δεν επηρεάζουν τις υδρογεωλογικές συνθήκες καθόσον το νερό που κατεισδύει σ'αυτούς επανέρχεται με μικρή υστέρηση στο υδρογραφικό δίκτυο. Δεν απεικονίζονται στο σχέδιο ΓΜ-1, λόγω κλίμακας | Ενεργή κατείσδυση : 15-25% Επιφανειακή απορροή : 10-30% |
| | Πλειοκαινικά κροκαλοπαγή βάσης: πολύμεικτα, αγνώστου πάχους, συνεκτικής έως ημισυνεκτικής δομής, έχουν αποτεθεί επί του έντονα διαβρωμένου φλυσχικού υποβάθρου. | PPl/C | | | | Οι σχηματισμοί λειτουργούν ως μέσο ταχείας κίνησης του υπόγειου νερού καθόσον το νερό που κατεισδύει σ'αυτούς επανέρχεται στο υδρογραφικό δίκτυο με τη μορφή πηγής συνεχούς και αδιάλειπτης ροής. Αποτελούν τον κατώτερο ορίζοντα των πλειοκαινικών σχηματισμών. Η παρουσία τους πιστοποιείται στην περιοχή των πηγών ΥΔΡ-Π1 και ΥΔΡ-Π2. Στο σχέδιο ΓΜ-1 απεικονίζονται προσεγγιστικά λόγω κλίμακας. | |
| | Ενστρώσεις κροκαλοπαγούς εντός των πλειοκαινικών αποθέσεων, έχουν ημισυνεκτική έως συνεκτική δομή και πολύμεικτη λιθολογική σύσταση. | PPl/$C_b$ | | | | Οι σχηματισμοί λειτουργούν ως μέσο ταχείας κίνησης του υπόγειου νερού καθόσον το νερό που κατεισδύει σ'αυτούς εκφορτίζεται με τη μορφή μικρών πηγών και επανέρχεται στο επιφανειακό υδρογραφικό δίκτυο. Επειδή οι σχηματισμοί αυτοί συναντώνται με τη μορφή ενστρώσεων ή φακών εντός υλικών λεπτοκλαστικής δομής δηλαδή εντός στεγανών σχηματισμών, δεν επηρεάζουν τις υδρογεωλογικές συνθήκες σε μακροκλίμακα. Δεν απεικονίζονται στο σχέδιο ΓΜ-1, λόγω κλίμακας. | |
| | Ενστρώσεις φλυσχικών κροκαλοπαγών και ψαμμιτών καθώς και, κροκαλοπαγή Μεσσηνίας. | Fl/Sa, C & M/C | | | | Οι σχηματισμοί λειτουργούν ως μέσο ταχείας κίνησης του υπόγειου νερού καθόσον το νερό που κατεισδύει σ'αυτούς εκφορτίζεται με τη μορφή πηγών και επανέρχεται στο επιφανειακό υδρογραφικό δίκτυο. | |
| (II) Σχηματισμοί μέσης έως χαμηλής περατότητας | Παλαιότερες ποτάμιες αποθέσεις, πλευρικά κορήματα και σχηματισμοί σύμμεικτης φάσης : Μίγμα λεπτο- και αδροκλαστικών υλικών, αργιλοϊλύες, χάλικες, λατύπες τρόχαλοι και ογκόλιθοι. | Al | $Π_3$-$Π_4$ | Μέση έως χαμηλή | $10^{-4}$ έως $10^{-7}$ | Δεν επηρεάζουν τις υδρογεωλογικές συνθήκες καθόσον το νερό που κατεισδύει σ'αυτούς, επανέρχεται με μικρή υστέρηση στο επιφανειακό υδρογραφικό δίκτυο. Δεν απεικονίζονται στο σχέδιο ΓΜ-1 λόγω κλίμακας. | Ενεργή κατείσδυση : 7-12% Επιφανειακή απορροή : 15-35% |
| | Φλυσχικοί σχηματισμοί, οι οποίοι αποτελούνται από λεπτο-μεσοστρωματώδεις εναλλαγές ψαμμιτών, κροκαλοπαγών και ιλυολίθων. | Fl Sa SaSi SiSa | | | | Η κυκλοφορία του νερού γίνεται μέσα από ανοικτές διακλάσεις, που λειτουργούν ως μέσο αργής κίνησης του υπόγειου νερού, το οποίο κατεισδύει στους σχηματισμούς αυτούς και επανέρχεται με σημαντική υστέρηση στο επιφανειακό υδρογραφικό δίκτυο, με τη μορφή μικρών περιοδικών πηγών. Οι σχηματισμοί αυτοί εμφανίζονται με τη μορφή ενστρώσεων εντός των φλυσχικών σχηματισμών λεπτοκλαστικής δομής (ιλυόλιθοι-ψαμμούχοι, ιλυόλιθοι) δηλαδή εντός σχηματισμών χαμηλής διαπερατότητας, και ως εκ τούτου δεν επηρεάζουν τις υδρογεωλογικές συνθήκες σε μακροκλίμακα. Δεν απεικονίζονται στο σχέδιο ΓΜ-1, λόγω κλίμακας. | |
| | Φλύσχης Ωλονού - Πίνδου<br>Αποτελείται από εναλλαγές ασβεστολίθων, ραδιολαριτών, μαργών και ψαμμιτών. | Fl/P | | | | Η κυκλοφορία του νερού γίνεται μέσα από ανοικτές διακλάσεις ή μέσα από ζώνες έντονου τεκτονισμού / ρηγματογόνες δομές. Συναντώνται τοπικά στο ανατολικό όριο της λεκάνης απορροής και εκτιμάται ότι επηρεάζουν θετικά τις υδρογεωλογικές συνθήκες. | |
| (I) Σχηματισμοί χαμηλής έως πολύ χαμηλής περατότητας | Πλειστοκαινικοί και Πλειοκαινικοί σχηματισμοί **εκτός** των κροκαλοπαγών βάσης και των κροκαλοπαγών ενστρώσεων. Αποτελούνται από αργιλοϊλύες, μάργες, αδροκλαστικά αργιλώδη υλικά, σε εναλλαγές, με διασταυρούμενη στρώση και φακούς. Έχουν ημισυνεκτική έως χαλαρή δομή. | PPl-m | $Π_4$ | Χαμηλή | $<10^{-6}$ | Οι σχηματισμοί αυτοί δεν επιτρέπουν την κίνηση του υπόγειου νερού, λόγω της λεπτοκλαστικής σύστασής τους και λειτουργούν ως στεγανά διαφράγματα. | Ενεργή κατείσδυση : 3-7% Επιφανειακή απορροή : 15-45% |
| | Φλυσχικοί σχηματισμοί αποτελούμενοι από ιλυολίθους με αραιές και λεπτές ενστρώσεις ψαμμιτών. Απεικονίζονται με τον κωδικό $I_B$ | Fl Si-SiSa | | | | Οι σχηματισμοί αυτοί δεν επιτρέπουν την κίνηση του υπόγειου νερού λόγω της λεπτοκλαστικής τους σύστασης. Λειτουργούν ως στεγανά διαφράγματα καθόσον η κίνηση του υπόγειου νερού είναι πολύ αργή και – κατά συνέπεια – αμελητέα. | |

**Table 8.5:** Hydrogeological Units in the catchment basin area of the Minagiotiko stream.

**Legend – Permeability Categories (k, m/sec)**

- Π1 (Very high permeability): $k > 10^{-2}$ m/sec
- Π2 (High permeability): $10^{-2} > k \geq 10^{-4}$ m/sec
- Π3 (Medium permeability): $10^{-4} > k \geq 10^{-6}$ m/sec
- Π4 (Low permeability): $10^{-6} > k \geq 10^{-7}$ m/sec
- Π5 (Impermeable): $k < 10^{-7}$ m/sec




**Νεογενές - Πλειόκαινο (Άστιο)**

**Μάργες, ψαμμίτες, κ.λπ.:** στα κατώτερα και μεσαία στρώματα επικρατούν λευκόφαιες έως ερυθροκίτρινες μάργες, λεπτοκοκκώδεις ψαμμίτες και -τοπικά- άργιλοι. Στα ανώτερα στρώματα επικρατούν ερυθρού χρώματος μάργες, χονδρόκοκκοι ψαμμίτες και προς τα πρανή των λεκανών κροκαλοπαγή

**Ζώνη Γαβρόβου - Πύλου**

**Ηώκαινο - Ολιγόκαινο**

**Φλύσχης:**
**Κροκαλοπαγή:** Αποτελούν την ανώτερη σειρά των στρωμάτων του φλύσχη με κροκάλες που προέρχονται από πετρώματα της ζώνης Ωλονού-Πίνδου.
Στη νεώτερη βιβλιογραφία αναφέρονται ως κροκαλοπαγή Μεσσηνίας.

**Φλύσχης:** Αποτελείται στο κατώτερο τμήμα από αργιλομαργαϊκά στρώματα και στο μεσαίο από ψαμμιτομαργαϊκά στρώματα.

**Ζώνη Ωλονού Πίνδου**

**Ανώτερο Μαιστρίχτιο -Κατώτερο Ηώκαινο**

**Φλύσχης:** τα κατώτερα στρώματα αποτελούν τη μεταβατική σειρά προς το γνήσιο φλύσχη και αποτελούνται από εναλλαγές λεπτοπλακωδών ασβεστολίθων, μαύρων ραδιολαριτών, μαργών και ψαμμιτών.

**Ιουρασικό - Κρητιδικό**

**Σειρά ραδιολαριτών:** αρχίζει 80m περίπου, πάνω από τη βάση της ασβεστολιθικής σειράς του Ιουρασικού (J-$K_1$). Τα κατώτερα στρώματά της περιέχουν ασβεστολιθικούς φακούς και στρώματα ασβεστολίθων. Το ανώτερο τμήμα αποτελείται αποκλειστικά από ραδιολαρίτες, ενώ συναντώνται και πηλιτικά υλικά και ερυθροϊώδεις πυριτικοί ασβεστόλιθοι.

**Ιουρασικό**

**Ασβεστολιθική σειρά:** χαρακτηρίζεται από ανοικτότεφρους ωολιθικούς ασβεστόλιθους. Μεταξύ των ασβεστολίθων παρατηρούνται και δολομίτες ή δολομιτικοί ασβεστόλιθοι.

**Σχήμα 8.19:** Απόσπασμα γεωλογικού χάρτη ΙΓΜΕ (Φύλλο Κορώνη, κλίμακα1:50.000

**Figure 8.19: Extract of Geological Map of IGME (Sheet Koroni, scale 1:50,000)**

### 8.4.3 Reservoir Basin

The Minagiotiko reservoir, with a Normal Retention Level (NRL) at elevation +122.00 m, covers an area of 886,733 m² at NRL and has a useful storage volume of approximately 10.15 × $10^6$ m³ of water (Plan GM-2).

**i) Morphological relief and hydrographic network**

The reservoir basin area is characterized by a dense and highly dissected hydrographic network and intensely eroded and fragmented relief, with alternating steep slopes and flattened surfaces.

This morphological and hydrographic pattern of the area results from the long-term action of natural processes — erosion, transport, and deposition — and reflects the lithological characteristics of the formations and the geological conditions of the region.

**ii) Geological and tectonic structure**

The geological basement of the area consists of flysch formations (conglomerates / sandstones / shales), which are exposed only at the downstream part of the reservoir basin and in the dam site area.

The Pliocene deposits, deposited on the intensely eroded and dissected palaeomorphological flysch relief, entirely cover the upstream and middle part of the reservoir basin.
Soil formations (alluvial deposits / colluvium / scree / landslide material) cover extensive areas, both in Pliocene deposits and in flysch formations.
The flysch formations are intersected by bedding planes arranged approximately transversely to the abutments, dipping at steep to moderate angles either upstream or downstream.
The discontinuity surfaces are numerous, with varying dip directions and angles.
The tectonic fractures, which are reasonably assumed to exist in the area, could not be identified or recorded due to the extensive soil cover and dense vegetative canopy in the area.

### 8.4.4 Dam

The Minagiotiko Dam, according to the final design selection, is planned to be of the type "roller-compacted lean concrete" (RCC), with a crest at elevation +127.00 m, a height of 49.00 m from the riverbed, and a total volume of 196,000 m³.

**i) Morphology**

The dam abutments, particularly the left abutment, are characterized as narrow ridges, with low elevations and a width of 50–70 m at the left abutment and 150 m at the right abutment.

This morphology of the abutments is considered an adverse factor regarding both their impermeability conditions and the stability conditions of the left abutment, especially under reservoir impoundment and operational conditions.

**ii) Geological and tectonic structure**

The flysch formations (conglomerates / sandstones / shales), which constitute the geological basement of the area, are arranged approximately transverse to the dam abutments or sub-parallel to the dam axis, dipping at steep to moderate angles either upstream or downstream.
The Pleistocene deposits, which cover the higher parts/summits of the abutments, have a significant thickness at the left abutment area and relatively less thickness at the right abutment area.

The **colluvium/scree and landslide materials**, which extensively cover the steep areas of the abutments, consist of a mixture of fine-grained and coarse-grained materials, together with large blocks of flysch. Their thickness locally reaches **7–8 m**.

**iii) Qualitative Characteristics of the Formations – Dam Foundation Conditions**

The qualitative characteristics of the flysch formations (conglomerates / sandstones / shales) are considered very poor in the upper weathered / loosened layers, and poor in the conglomerate formations of type C1 — i.e., conglomerates with shale matrix, loosely to slightly cemented. They are moderate to good in the deeper, fresh to slightly weathered layers, particularly in the conglomerates of type C2, which contain sandstone-limestone matrix and show strong cementation, as described in Section 5.4 of the Geological Study.
As a criterion for selecting the foundation depth of the dam and spillway, the adoption of the guidelines specified in Section 5.5.2 of the Geological Study is recommended.

### 8.4.5 Geotechnical Subsurface Conditions

#### 8.4.5.1 Dam Area

Within the framework of the present contract, geotechnical investigations were conducted by the company KASTOR Ltd. – Hellenic Subsurface Research Company, a member of the Consortium. These investigations were followed by the evaluation of the results.
Presented below are data from the Phase A report, concerning the evaluation of the geotechnical boreholes and laboratory tests, carried out for the Minagiotiko Dam.
In the dam foundation zone, boreholes were drilled in the dam foundation alignment. Based on the results, the subsurface can be distinguished into the following three main strata:

- Layer I: Surface soil formation
- Layer II: Mantle of weathered flysch rocks
- Layer IV: Underlying unweathered flysch rock formations

The upper surface soil formation (Layer I) mainly consists of gravels, clays, and clayey or silty sands.

The mantle of weathered flysch (Layer II) includes sandstones, conglomerates, and shales, completely weathered to residual soils, occurring mainly as gravels, silty sands, and clays. Locally, it appears as rock outcrops of sandstone or conglomerate.

The underlying unweathered flysch formations (Layer IV) consist mainly of conglomerates and sandstones, with occasional intercalations of shales. At the base of all these sequences, bedrock formations of shale are encountered.

**Excavatability**

Based on the results of the boreholes, the subsurface is initially covered by the upper surface soil formation, which mainly consists of gravels, clays, and clayey or silty sands.

Beneath this, a mantle of weathered flysch bedrock formations was encountered, consisting mainly of completely weathered sandstones, conglomerates, and shales.
Below this layer, the flysch bedrock formation was encountered, extending down to the maximum explored depth of the boreholes.
This consists of sandstones, conglomerates, and shales, with shales forming the basal sequence of the formation.

These strata exhibit low to moderately high rock strength. No problems of bearing capacity or settlement are anticipated, since the dam foundation will be placed directly on the bedrock formations.

- Excavation of the soil materials of Layer I and the weathered materials of Layer II can be carried out using conventional mechanical means.
- Excavation of sandstones and conglomerates (Layer IV and rock outcrops within Layer II) for foundation purposes is expected to be difficult and can be achieved with the use of a hammer and prior loosening (ripping) of the formation (using bulldozer D8 or stronger). The use of explosives will accelerate the excavation process.
- Excavation of **shales** for foundation purposes is also expected to be difficult and may require prior loosening (ripping) using bulldozers D6 or D7.

These excavatability assessments were confirmed during the construction of access roads to the borehole locations, where continuous use of hammer and prior ripping was necessary in the sandstone and conglomerate rock outcrops that largely form the slope surfaces of the area.

#### 8.4.5.2 Reservoir Basin Area

Based on the borehole results conducted in the reservoir basin of the dam, the subsurface can be divided into the following three strata:

- **Layer Ia**: Surface soil formation

- **Layer III**: Pliocene formations
- **Layer IV**: Underlying flysch bedrock formations

The surface soil formation (Layer Ia) consists mainly of clays, clayey sands, or silty sands.
The Pliocene formations (Layer III) were deposited above the flysch formations and consist of marls and sandstones of semi-rocky structure.
The underlying flysch bedrock formations (Layer IV) consist mainly of conglomerates and sandstones with thin intercalations of shales.

**Excavatability**

Based on the results of the boreholes, the subsurface is initially covered by a surface soil formation consisting mainly of clays and clayey or silty sands, followed by Pliocene sediments, which comprise sandy marls, sandstones, clays, and clayey silts, and finally by the bedrock formations of conglomerates and sandstones of the flysch, which extend down to the maximum investigated depth of 40.4 m.

<u>These strata are of low to moderately high strength for rock.</u>
The permeability was generally found to be low to very low.
If excavations are carried out for the formation of permanent slopes in the reservoir basin, slope stability checks must be conducted, due to the considerable thickness of soil and semi-rocky layers.

<u>Excavation of the soil materials of Layer Ia and of the weathered materials of Layer III can be performed using conventional mechanical means.</u>

<u>Excavation of sandstone and conglomerates</u> (Layer IV and rocky outcrops of Layer II) for foundation purposes is expected to be difficult and may require the use of hammer drilling and prior loosening (ripping) of the formation (using bulldozer D8 or stronger). The use of explosives will accelerate the excavation process.

These assessments of excavatability were confirmed during the construction of access roads to the borehole locations, where continuous hammering and prior ripping were required in the sandstone and conglomerate rock outcrops, which primarily form the slope surfaces of the area.

### 8.4.6 Soil Conditions

#### 8.4.6.1 Soil Classification

According to the FAO soil classification system (Soil Map of Greece – National Committee Against Desertification – Agricultural University of Athens – compiled by N. Yassoglou), an excerpt of which is presented in the following section, the soils of Messinia Prefecture are classified into five soil categories:

- **Leptosols (LP):** Soils derived from limestone and flysch. They are fine-textured, clayey soils, with good permeability and neutral pH.
- **Regosols (RG):** Loose material layer overlying hard substrate. They are moderately clayey soils, with moderate permeability and pH > 7.
- **Fluvisols (FL):** Clayey soils, with moderate to low permeability and pH > 7.
- **Cambisols (CM):** Their composition is clayey to moderately clayey, with low permeability and neutral to slightly acidic pH.
- **Vertisols (VR):** Clayey soils, with low permeability and neutral to slightly acidic pH.

#### 8.4.6.2 Soil Characteristics of the Study Area

The study area consists of land that has been intensively cultivated over the last 35–45 years.

In the study area, the soil is clay loam, with a neutral to alkaline pH. It is highly fertile in the lowland zones, moderately permeable, with satisfactory drainage and good capacity for water and soil solution movement, resulting in the soil not retaining excessive water and not forming cracks.

There is no classification study of the soils into irrigability categories specifically for the study area. However, data from the available soil analyses carried out by the Agricultural Institute of Kalamata are presented in the following table.
The results of these analyses provide a relatively satisfactory coverage of the soil conditions in the study area.

From these data it emerges that the soils of the study area are predominantly clayey, although other soil types are also present where silt participates in high percentages (sandy clay loam, clay loam, etc.).

The soils are mostly of neutral pH, with some being slightly acidic. In the majority of cases, they are poor in organic matter and exhibit low electrical conductivity.

**Table 8.6: Soil Analysis Data**

| Site allocation | | | Soil Analysis Data | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| α/α | X | Y | SAND (%) | SILT (%) | CLAY (%) | pH | ORGANIC MATTER (%) | EC (mS/cm) | SOIL CLASSIFICATION |
| 1 | 303566 | 4084838 | 48.5 | 27.3 | 24.2 | 7.91 | 0.84 | 1.11 | L – Loam |
| 2 | 302893 | 4081979 | 46.5 | 26.3 | 27.2 | 6.20 | 1.37 | 0.74 | L – Loam |
| 3 | 303619 | 4080978 | 46.5 | 31.3 | 22.2 | 6.32 | 0.50 | 1.27 | L – Loam |
| 4 | 302141 | 4079820 | 48.5 | 23.3 | 28.2 | 5.67 | 2.61 | 1.29 | SCL – Sandy Clay Loam |
| 5 | 301721 | 4078895 | 42.5 | 35.3 | 22.2 | 7.54 | 1.31 | 0.33 | L – Loam |
| 6 | 301000 | 4076806 | 44.5 | 29.3 | 26.2 | 7.81 | 2.24 | 0.42 | L – Loam |
| 7 | 299084 | 4077985 | 35.5 | 35.3 | 28.2 | 7.97 | 2.28 | 0.48 | CL – Clay Loam |
| 8 | 301492 | 4081200 | 66.5 | 14.2 | 19.3 | 5.59 | 2.28 | 0.45 | SL – Sandy Loam |
| 9 | 300824 | 4082335 | 42.5 | 39.3 | 18.2 | 5.48 | 1.68 | 0.29 | L – Loam |
| 10 | 299457 | 4082401 | 36.5 | 34.2 | 29.3 | 6.42 | 3.08 | 0.27 | CL – Clay Loam |

## 8.5. Natural Environment

The following section presents a description of the natural environment as documented in the Special Ecological Assessment, which is included in the annex of this Environmental Impact Study (EIS).

### 8.5.1. General Information

The study area is typical of southwestern Greece, both in terms of landscape and ecosystems. The wider region belongs to the Eu-Mediterranean Vegetation Zone (Quercetalia ilicis) and the Quercion ilicis sub-zone. Characteristic plant species include the olive tree (Olea europaea), mastic tree (Pistacia lentiscus), and Spanish broom (Spartium junceum), among others. The cultivation of olive and vine thrives under the favorable climatic and soil conditions of the area.

The landscape of the region is shaped by a set of characteristic features, mainly resulting from natural factors—such as topography, water, vegetation, and fauna—and to a lesser degree by human activity and land use (predominantly agricultural). The most significant aesthetic component of the landscape is the vegetation. Within the dominant agricultural landscape, natural ecosystems are mainly composed of olive–mastic shrublands and garrigue formations typical of the Eastern Mediterranean.

The agro-ecosystems occupy the largest part of the study area, consisting primarily of cultivated lands. The tree crops are predominantly olive groves, while vineyards are also present.

The region of Messenia hosts over 700 plant species, of which 80 are endemic, and 32 are found exclusively on the high peaks of Mount Taygetos. The region's rich vegetation appears across all altitudinal zones, depending on temperature and soil morphology. In the coastal zone, one finds isolated palm clusters, lush cacti, tamarisks (Tamarix cretica), and numerous reeds. Additionally, there is an abundance of shrubs and phrygana (low Mediterranean scrub).

In the plains, olive groves dominate, showcasing the fertility of Messenia. Fig trees, vines, and currant vines coexist with smaller plots of corn, barley, and other cereals, confirming the high productivity of the area. Vegetables (grown in greenhouses or open fields), legumes, and citrus fruits are also cultivated. Alongside these crops, scattered mulberry, wild pomegranate, wild pear, almond, blackberry, broom (Spartium junceum), and prickly pear plants occur. The region's herbaceous flora includes chamomile (Chamomilla recutita), mint (Mentha spicata), poppy (Papaver rhoeas), yellow daisies, white chamomile, mallow (Malva sylvestris), and green clover, among many others, all contributing to the rich floral composition of Messenia.

In the semi-mountainous and mountainous zones, there are Judas trees (Cercis siliquastrum), acacias, junipers (Juniperus oxycedrus), and coniferous forests, with spiny broom (Calicotome villosa), asphodel, and Phlomis fruticosa being characteristic elements. Oaks appear sporadically, while many herbaceous species such as Morina persica, valerian (Valeriana officinalis), bellflowers (Campanula spatulata), asphodels, irises, and spring lilies (Ornithogalum sp., Muscari sp.) enrich the vegetation. In the ravines and gorges of Vyros, Ridomos, Nedon, and Neda, there are plane trees (Platanus orientalis), laurels (Laurus nobilis), myrtles (Myrtus communis), and a significant diversity of ferns.
Remarkable vegetation is also found on the six islands of Messenia—Schiza, Sapienza, Agia Marianí (part of the Oinousses complex), Proti, Sfaktiria, and Venetiko. On Venetiko, Agia Marianí, and Proti, the slopes are covered with mastic shrubs, maples, and junipers. Judas trees, wild pears, wild olives, carobs, and spiny brooms dominate in various parts. In the interior of Schiza, there are oak forests, while Sapienza hosts the only arbutus (strawberry tree) forest in the Mediterranean. Finally, the Vasiliki Forest, home to many rare trees, is considered one of the most important forests in Greece and Europe, while the Gialova Lagoon (Divari wetland) is an essential wetland ecosystem, dominated by reeds and shrubs, supporting rich biodiversity.

In addition to its remarkable botanical diversity, the region of Messenia is home to a wide variety of wild animals and birds, as the prevailing soil and climatic conditions make their habitation and survival relatively easy.

In the coastal zone, one can observe seagulls and numerous other bird species such as pigeons, swallows, and sparrows. The Mediterranean monk seal (Monachus monachus) and the loggerhead sea turtle (Caretta caretta) find the sandy beaches of the region to be safe breeding grounds.

The Caretta caretta turtles lay their eggs primarily on the beaches stretching from Kalo Nero (Kyparissia region) to the mouth of the Neda River, while additional breeding sites are recorded at Voidokilia, Glyfadaki, Romanos, and Mati beaches near Pylos.

The Messinian seabed hosts a rich marine ichthyofauna, making coastal areas such as Methoni, Chranoi, Nea Koroni, and Marathopoli well-known fishing grounds.

In the plains, the lush green landscapes of Messenia provide shelter for numerous bird species such as blackbirds and thrushes, while various insects — including bees, butterflies, ladybugs, beetles, and grasshoppers — are abundant during the spring and summer months. Additionally, there are significant populations of lizards, rodents, amphibians, and reptiles such as the nose-horned viper (Vipera ammodytes), house snake, and Aesculapian snake, along with several small mammals.

In the semi-mountainous and mountainous zones, carnivorous species such as the weasel (Mustela nivalis), marten (Martes foina), jackal (Canis aureus), and fox (Vulpes vulpes) are found. The forest ecosystems host both raptors and non-raptorial birds, including the golden eagle (Aquila chrysaetos), honey buzzard (Pernis apivorus), turtle doves (Streptopelia turtur), quails (Coturnix coturnix), and hoopoes (Upupa epops), coexisting with a wide range of rodents, lizards, snakes, tortoises, and insects. Also noteworthy are the white-throated dipper (Cinclus cinclus), the Greek stream frog (Rana graeca), toads, and tree frogs (Hyla arborea).

On the islet of Sapienza, herds of Cretan wild goats (Capra aegagrus cretica – kri-kri) coexist with mouflons (Ovis orientalis musimon). Within the dense tree foliage, pheasants, partridges, quails, wild pigeons, and woodcocks can also be found.

## 8.5.2. Areas of the National System of Protected Regions

### 8.5.2.1. Cartographic Representation of the Protected Area

The maps included in the annex of the Special Ecological Assessment illustrate the boundaries of the protected area of the Natura 2000 network, as well as its internal habitat mapping according to the habitats designated under the EU Habitats Directive (92/43/EEC).

**MAP 1** shows the land cover of both the directly protected area and the surrounding wider zone, according to the CORINE Land Cover Program of the European Union. The land cover data refer to the year 2000, and under this program, Greece is divided into 40 distinct land-cover categories.

**MAP 2** displays the land cover of Greece based on a nationwide mapping of main land-cover categories for the year 2007, conducted by Aristotle University of Thessaloniki in collaboration with WWF Greece.

**MAP 3** presents the habitat mapping of the area, as defined in Annex I of Directive 92/43/EEC, specifically for this Natura 2000 region, showing the distribution and typology of natural habitats within the study area.

#### 8.5.2.2. Summary Description of the Ecological Features of the Area

The site designated as a Site of Community Importance (SCI), according to the EU Habitats Directive 92/43/EEC, is named "Islands of Sapientza, Schiza, and Cape Akritas" and bears the code GR2550003, with a total area of 11,253 hectares (ha).

| Site Name | Category | Code | Area (Ha) |
|---|---|---|---|
| **Islands of Sapientza & Schiza, Cape Akritas** | SCI (Site of Community Importance) | **GR2550003** | **11,406.23** |

The specific area of the Natura 2000 network includes the coastal and inland zones extending from Methoni to Cape Akritas (southwestern Peloponnese), along with the nearby islands of Schiza (1,090 ha) and Sapientza (963 ha), as well as the smaller islands Venetiko, Agia Marianí, Avgo, and others of the Oinousses island group. The island of Sapientza is predominantly forested, while the surrounding areas are covered mainly by shrubby Mediterranean vegetation. In the southern part of the site, including the Venetiko islet and the Sapientza and Schiza islands, the dominant vegetation type is Mediterranean maquis. On Sapientza Island, there exists a 240-hectare forest of tree-shaped Mediterranean maquis, officially declared a Preserved Natural Monument due to its ecological value.

The area serves as an important resting and stopover site for migratory birds. It is also of significant ecological importance because of the presence of the Mediterranean monk seal (Monachus monachus) and its rich marine ichthyofauna. On the coastal cliffs and rocky shores, several endemic Limonium taxa are found, while two additional plant taxa endemic to the Peloponnese are also present in the region. Figure 8.20 presents the boundaries of the protected Natura 2000 area, as displayed on the Natura Map Viewer of the Ministry of Environment and Energy (Υ.Π.ΕΝ.).


**Figure 8.20. Protected Area Natura 2000 – Sapientza and Schiza Islands, Cape Akritas (GR2550003)**
***(Source: Hellenic Ministry of Environment and Energy – NATURA VIEWER MAP)***

The high zoological significance of this protected area is highlighted by the presence of 29 important vertebrate species, excluding birds, five of which are listed in Annex II of Directive 92/43/EEC. Among these, the Mediterranean monk seal (Monachus monachus) and the loggerhead sea turtle (Caretta caretta) are priority species (Field 3.2). Both species, along with the greater horseshoe bat (Rhinolophus ferrumequinum), are considered threatened in Greece and are listed in the National Red Data Book of Threatened Animals as "Endangered" (the first two) and "Vulnerable" (the third). All five Directive-listed species are also included in the Bern Convention and CITES appendices, as well as in Presidential Decree 67/1981. The remaining species have been classified as Other Important and Greek Significant Species based on the evaluation system of Fields 3.3 and 3.4. Among these, the Kefalonian slowworm (Anguis cephallonicus), the Peloponnesian wall lizard (Podarcis peloponnesiaca), and the Hellenic fox (Vulpes v. hellenica) are endemic to Greece, occurring throughout the Peloponnese and, for the first species, also on the Ionian islands of Ithaca, Kefalonia, and Zakynthos. All taxa listed in Fields 3.3 and 3.4, except for the hedgehog (Erinaceus concolor) and the fox, are marked with Criterion C, as they are protected under the Bern Convention. Moreover, the majority of species in these fields receive Criterion D, as they are included in Presidential Decree 67/1981 (exceptions include *Rana ridibunda*, *Ophisaurus apodus*, *Ablepharus kitaibelii*, *Typhlops vermicularis*, *Vipera ammodytes*, *Vulpes v. hellenica*, *Martes foina*, and *Meles meles*). The species *Bufo viridis*, *Hyla arborea*, and *Ablepharus kitaibelii* have been assessed under the CORINE-Biotopes Programme, while *Triturus vulgaris graecus*, *Podarcis taurica ionica*, and *Coluber gemonensis* are Balkan endemics.

The area is also designated as an Important Bird Area (IBA) due to its position along the western migratory route of birds across Greece, located at one of the southernmost ends of the Balkans, and owing to the presence of suitable habitat types within the site. At least three threatened species of large eagles—the greater spotted eagle (Aquila clanga) and the imperial eagle (Aquila heliaca) (“Endangered”), as well as the golden eagle (Aquila chrysaetos) (“Vulnerable”)—constitute key components of the local avifauna.

Most of the interior area of the protected site is cultivated land. Hunting represents the main threat to the fauna and avifauna of the region. In addition, tourism and residential activities by local inhabitants exert negative pressure on both the fauna and the habitats.

The habitat types include embryonic shifting dunes, coastal juniper scrub with Juniperus phoenicea, shrub formations with Euphorbia dendroides, phrygana with Sarcopoterium spinosum, grazed holm oak forests with Quercus ilex, Eastern Mediterranean calcareous cliffs of Greece, and Oriental plane forests (Platanion orientalis).

**Protection Status:**

The site is part of the European Natura 2000 network, classified as a Site of Community Importance (SCI) under Directive 92/43/EEC, with multiple species and habitats of priority conservation value protected under international and national legislation (EU Habitats Directive, Bern Convention, CITES, and Greek Presidential Decree 67/1981).

| **Level** | |
|---|---|
| **National and Regional** | Declared *Natural Monument* and *Controlled Hunting Area* |
| **International** | Recognized as a *Biosphere Reserve* |

Rare Plants: *Colchicum parlatoris* (Parlatori’s colchicum), *Pancratium maritimum* (Sea daffodil), *Allium callimischon* (Elegant onion), and *Limonium pylense* (Sea lavender of Pylos). These species are associated with coastal rocks and sandy areas, representing important indicators of the ecological integrity of Mediterranean habitats.

Rare Animals: the Mediterranean monk seal (Monachus monachus), the Bottlenose dolphin (Tursiops truncatus), the Greater horseshoe bat (Rhinolophus ferrumequinum), the Striped-neck terrapin (Mauremys rivulata), and the Loggerhead sea turtle (Caretta caretta).

Legal Protection Framework

The *“Islands of Sapientza, Schiza and Cape Akritas” (GR2550003)* site enjoys a multi-level legal protection status under **national**, **European**, and **international** law.

**According to Directive 92/43/EEC:**

- **Annex II:** Includes eight (8) species (four mammals and four reptiles), of which two (one mammal and one reptile) are *priority species*.
- **Annex IV:** Includes sixteen (16) species (three mammals, eleven reptiles, and two amphibians).

**Bern Convention:**

- **Annex II:** Nineteen (19) species (four mammals, thirteen reptiles, and two amphibians).
- **Annex III:** Seven (7) species (three mammals, three reptiles, and one amphibian).

**Bonn Convention:**

- Five (5) species (four mammals and one reptile), of which two (one mammal and one reptile) are also listed in Annex I of the same convention.

**Presidential Decree 67/1981:**

- Protects nineteen (19) species (six mammals, ten reptiles, and three amphibians).

**IUCN Red List:**

- One mammal classified as *Data Deficient (DD)*,
- One as *Critically Endangered (CR)*,
- One as *Lower Risk / Vulnerable (LR/VU)*,
- One reptile as *Endangered (EN)*,
- and one amphibian as *Near Threatened (NT)*.

**CITES Convention (Annexes I & II):**

- Protects two (2) species of mammals and two (2) species of reptiles.

**Ecological Importance**

The site exhibits high biodiversity and ecological importance, as the coastal rocks and cliffs host several endemic taxa of the *Limonium* genus, while a total of 23 significant vertebrate species (excluding birds) have been recorded.
The zoological value of the area is exceptional, as it serves as a refuge for endemic and threatened species, while also functioning as a critical stopover point for migratory birds along the western migration route of the Balkans.

**Environmental Issues:** Hunting and poaching, Unauthorized and legal construction, Touristic overdevelopment and disturbance of natural habitats.

#### 8.5.2.3 Evaluation of the Integrity of the Natura 2000 Site

The Natura 2000 site GR2550003 maintains a high degree of ecological integrity, with no signs of habitat fragmentation. The priority habitats, for which the area was declared protected, are mainly located near the coastal zone, remaining unfragmented and ecologically stable. The only habitat type potentially affected by the proposed project is that of the olive and mastic shrublands, which are widely distributed throughout the Mediterranean basin and act as transitional habitats between forest ecosystems and *garrigue* formations of the Eastern Mediterranean. The implementation of the proposed project is not expected to cause any disruption or degradation to the ecological continuity or the natural functions of the habitats within the protected area.

##### 8.5.2.3.1 Cartographic Representation of the Protected Area

The relevant cartographic coverage and documentation of the protected area are provided in Section 8.5.2.1, while the current vegetation and ecosystem status are illustrated in the accompanying maps AP-1 to AP-2 and GO-1 to GO-8 of the present Environmental Impact Study (EIS).

#### 8.5.2.3.2 Current Protection and Management Status of the Natura 2000 Site

As mentioned above, the area has been designated as a Site of Community Importance (SCI) under Directive 92/43/EEC, named *"Islands of Sapientza, Schiza and Cape Akritas"* with code GR2550003.

The institutional and regulatory framework governing the protection and management of the area includes:

- Law 1650/1986 (*Government Gazette 160/A/86*) on environmental protection,
- Joint Ministerial Decision 69269/5387/1990 and Law 2742/1999 (*Government Gazette 297/A/99*) on spatial planning and sustainable development,
- Directive 79/409/EEC and JMD 414985/1985 (*Government Gazette 757/B/1985*) on the conservation of wild birds,
- Directive 92/43/EEC and JMD 33318/3028/1998 on the conservation of natural habitats and wild fauna and flora.

The integrated implementation of these legislative instruments ensures the ecological stability, environmental management, and sustainable development of the Natura 2000 site.

- The provisions of the Greek forest legislation are also applicable, particularly those of the Legislative Decree 86/1969 "Forest Code" (Government Gazette 7/A/1969), as amended by Law 996/1971, Law 177/1975, and Law 998/1979 "On the Protection of Forests and Forest Areas in General" (Government Gazette 298/A/1979), which was further amended by Law 3208/2003 "Protection of Forest Ecosystems, Compilation of the Forest Registry, Regulation of Real Property Rights on Forests and Forest Areas, and Other Provisions". Additionally, Law 1734/1987 "On Pastures" and Presidential Decree 67/1981 "On the Protection of Native Flora and Fauna and on the Coordination and Control Procedure of Research Related Thereto" apply, as well as all other relevant forest legislation.
- International Conventions:The international conventions for the protection of endangered, rare, and endemic species of flora and fauna (such as the Bern Convention and the Bonn Convention). The international conventions for the protection of the marine environment and the Mediterranean Sea are also applicable.

##### 8.5.2.3.2.1. Provisions of the Special Environmental Study for the Examined Area

A Special Environmental Study (SES) has been carried out for the protected area, which proposes the designation of a **"Mainland Zone of Ecological Development of Akritas**" for the part of the protected area that will be affected by the construction and operation of the Minagiotiko stream dam and reservoir.

Within this Mainland Zone of Ecological Development of Akritas, the draft Presidential Decree for the protection of the area proposes that the following activities be permitted, under specific terms and restrictions set forth in the respective Administrative and Operational Regulation of the area:

- The execution of projects,
- The implementation of scientific research (limited strictly to ecological and environmental parameters),
- The exercise of traditional activities,
- and the promotion of alternative forms of tourism, provided they comply with sustainable development principles.

For areas located within the boundaries of the "Mainland Zone of Ecological Development of Akritas" but outside the Nature Protection Areas and settlement boundaries, the following regulations are proposed to ensure the preservation of the natural heritage and maintenance of the ecological balance, while allowing for traditional practices and offering opportunities for environmental education and nature-related activities for the public.

Regulations for Selected Sectors of Activity (Relevant to the Examined Projects)

**<u>Agriculture – Livestock Farming</u>**

a) <u>Maintenance and reinforcement of traditional primary-sector activities (agriculture and livestock farming) within the area.</u>
b) Extensive grazing is permitted. The terms of this activity will be defined and specified in the Administrative and Operational Regulation, following the approval of a Management Plan based on the results of a grazing capacity and carrying capacity study for the area. Until the preparation of this Management Plan, grazing will continue at current levels.
c) <u>Restructuring of agricultural crops is permitted following the preparation of a relevant study, while ecological/organic farming is encouraged. Improvement of livestock management practices is also promoted.</u>
d) Information and training programs for farmers and livestock breeders are promoted, focusing on environmental protection and sustainable land-use practices.

**<u>Protection of Vegetation, Habitats, and Plant Species</u>**

a) The collection of herbs from public forest areas is permitted only for personal use (and not for commercial purposes), in accordance with the specific terms defined in the Administrative and Operational Regulation of the area.
b) No intervention is permitted in the riparian vegetation or in the beds of rivers and streams. Exceptions are allowed only when special permits have been granted, following an approved study, for the execution of works officially certified by the competent authority.

**<u>Protection of Fauna and Landscape</u>**

a) The controlled placement of signage is permitted, strictly adhering to the relevant legal framework. Signs must be discreet, aesthetically compatible, and must not conflict with the conservation principles of the protected area. In any case, their height shall not exceed 2.5 meters. Their design will comply with the detailed specifications to be included in the Administrative and Operational Regulation of the area.
b) The collection of terrestrial invertebrates is prohibited.

<u>Other Activities – Projects</u>

a) The siting and operation of wind and photovoltaic parks for large-scale energy production are permitted only after obtaining the approval of the Area Management Authority and following an approved Environmental Impact Assessment (EIA), which must take into account, among other factors, the impact on the aesthetic value of the landscape.
b) The establishment and operation of aquaculture units are permitted after obtaining the approval of the Area Management Authority and following an approved Environmental Impact Assessment, which should place emphasis on the hydrodynamic characteristics of the area and consider cumulative environmental impacts. In particular, for their location in coastal protected areas, the impact on the visual and aesthetic quality of the landscape must also be assessed.
c) The sale of local products (food and other goods) and informational material is permitted only in specially designated open-air spaces with light constructions. The locations of these areas, as well as the technical specifications of the constructions, are defined in the Administrative and Operational Regulation of the area.
d) <u>**The construction of new forest or rural roads is permitted** only after an approved technical study, an approved Environmental Impact Assessment, and the consent of the Area Management Authority. The feasibility of each project must also take into account the adequacy of the existing road network and the Visitor Management and Organization Plan of the area.</u>
e) <u>**The maintenance and improvement of the existing road network are permitted** only after obtaining environmental approval and the consent of the Area Management Authority, which must take into account the Visitor Management and Organization Plan of the area.</u>
f) The construction of new roads of any category, as well as the widening and paving of existing ones with a permanent surface, is prohibited in the coastal zone between the settlements of Methoni and Finikounda, from the shoreline up to the connecting main road. <u>Exceptions</u> are permitted for the maintenance of existing roads, the demarcation of existing parking areas, and the construction of new roads for purposes of protection and management of the area, provided that these works are supported by approved technical studies, an approved Environmental Impact Assessment, and the consent of the Area Management Authority.
g) <u>Restoration and anti-erosion projects are permitted, provided that a special approved study has been conducted</u>
h) Only low-nuisance industrial units are permitted to be installed and operated within the area.
i) Only two-phase olive mills (which produce no liquid waste) are permitted for construction and operation. Existing and operating olive mills must comply with this requirement within five (5)

years from the issuance of this decree. This regulation also applies to a **wider area**, defined by the road starting from the National Road Pylos–Methoni and following the route through Mesochori, Pidasos, Chomatada, Kallithea, and Minagia, ending at Longa (the watershed of the eco-development zone).

j) For the establishment, modernization, or expansion of any type of productive activity within the limits of existing settlements, for which a permit is required, the interested party must obtain an Environmental Terms Approval Decision (AEPO), issued in accordance with the applicable environmental regulations.

#### 8.5.2.3.2.2. Compatibility with Current Terms and Restrictions

**As is evident from the aforementioned regulatory framework, the construction and operation of the dam and reservoir on the Minagiotiko stream are fully consistent with the permitted uses and protection goals of the region.**

**Agriculture and Livestock**

- The project is expected to contribute positively to the "maintenance and strengthening of traditional primary sector activities (agriculture and livestock farming) in the area.
- The change in cultivation patterns proposed by the regional development plan aligns with the guideline that allows "the restructuring of agricultural crops following an approved study."

**Regarding the protection of vegetation, habitats, and plant species**, any intervention in riparian vegetation and in the beds of rivers and streams is prohibited. By way of exception, such interventions are permitted only in cases where special permits have been granted following the approval of a study for the execution of works, as certified by the competent authority. Such permits are issued primarily through the environmental licensing process.

**Regarding other activities – Projects, it is noted that**

- **The maintenance of the existing road network and the construction of new forest or dirt roads is permitted.**
- **Restoration works and anti-erosion projects are permitted,** subject to an approved technical study and an approved Environmental Impact Assessment.

From the above regulations, it is evident that the nature and objectives of the project are fully aligned both with the specific provisions concerning agriculture and with the general environmental protection framework governing the implementation of technical works and road infrastructure within protected zones.

#### 8.5.2.3.2.3. Main Ecological Characteristics of the Natura 2000 Habitats

Within the Natura 2000 area, eleven (11) habitat types have been recorded. Of these, six (6) are included in Annex I of Directive 92/43/EEC, one of which is classified as a **priority habitat type (2250)**.

The following table presents each habitat type, its area coverage, representativity, relative surface, degree of conservation, and the overall site assessment.

**Table 8.7: Data on Habitat Types in the Area "Sapientza & Schiza Islands, Cape Akritas – GR2550003**

| NATURA Code | Habitat Type Description | Coverage (%) | Representativity | Relative Surface | Conservation Status | Overall Assessment |
|---|---|---|---|---|---|---|
| **(Habitat Types included in Annex I of Directive 92/43/EEC)** | | | | | | |
| A. COASTAL AND INLAND DUNES | | | | | | |
| 2110 | Embryonic shifting dunes | 0.19 | C | C | C | C |
| 2250* | Coastal dunes with Juniperus spp. (*priority habitat type*) | 0.20 | C | C | C | C |
| B. SHRUBLANDS WITH HARD-LEAVED VEGETATION | | | | | | |
| 5330 | Thermo-Mediterranean and pre-desert scrub with *Euphorbia dendroides* | 0.41 | B | B | B | B |
| C. ROCKY HABITATS AND CAVES | | | | | | |
| 8210 | Calcareous rocky slopes with chasmophytic vegetation | 0.22 | C | C | A | B |
| 8330 | Submerged or partially submerged sea caves | 0.10 | B | C | A | B |
| D. MEDITERRANEAN SCLEROPHYLL FORESTS | | | | | | |
| 9320 | Olive (*Olea europaea*) and mastic (*Pistacia lentiscus*) groves | 46.5 | B | B | B | B |
| New Habitat Types (not included in Annex I of Directive 92/43/EEC) | | | | | | |
| 21B0 | Sandy beaches without vegetation | 0.15 | B | C | B | B |
| 5340 | Hard-leaved shrublands of the Eastern Mediterranean (Garrigues) | 3.00 | B | B | B | B |
| — | Wet hollows with reeds (*Phragmites australis*) and rushes (*Juncus spp.*) | 0.10 | C | C | B | B |
| — | Forests of strawberry trees (*Arbutus unedo*) and other broad-leaved evergreen species of Sapientza Island | 3.10 | B | A | A | A |
| — | Formations of broad-leaved evergreens (*Arbutus unedo, Pistacia lentiscus, Phillyrea latifolia*, etc.) on Sapientza Island | 10.70 | B | C | B | B |

**Explanatory Notes**

**Habitat Type Description**: The terminology corresponds to the Greek translation in the relevant Presidential Decree.
NATURA Code: As defined in Annex I of Directive 92/43/EEC. Priority habitat types are marked with (*).
**Coverage (%):** The percentage of the area covered by the specific habitat type.
Representativity: The degree to which the habitat type is characteristic of the area: A = excellent, B = good, C = significant, D = present but not significant.

**Relative Surface:** The proportion of the national area covered by this habitat type compared to its total surface at the national level. A = 100–15%, B = 15–2%, C = 2–0%.
**Conservation Status**: An evaluation of the degree of conservation of the structure and functions of the habitat and the possibility of restoration: A = excellent, B = good, C = average.
**Overall Assessment:** A general evaluation of the value of the site for the conservation of the specific natural habitat type: A = excellent, B = good, C = significant.

1. **Embryonic shifting dunes (NATURA Code: 2110)**
   This habitat type includes the low sand dunes formed along the coastline. These dunes represent the first elevation front of loose sandy substrate immediately after the winter wave zone and, as they constitute the initial stage in the development of the dune system, they are also known as *"embryonic" or "incipient" dunes*. They are characterized by continuous movement and alteration of their shape, particularly during the winter season when wind intensity is high. As a result of these dynamic processes, their height remains low and the vegetation cover sparse. This habitat type occurs along the western and southern Peloponnese, the Ionian Islands, western mainland Greece, and Epirus, as well as in extensive areas along the coasts of northern Greece.

**Typical form of habitat type 2110 "Embryonic shifting dunes" in the study area**

The habitat is mainly found in the coastal area of Finikounta, on Faneromeni beach, Cape Sakouli, and Lampes beach — areas located far from the site of the dam and the proposed reservoir — as well as at one location west of it. It has been steadily retreating over the last few decades due to intense human activity within the coastal ecosystems. In particular, during the summer months when tourism peaks, characteristic sand-dune vegetation is trampled, litter is discarded, and uncontrolled camping takes place, all of which threaten this habitat type with further degradation and reduction.

Ecological conditions – Floristic composition of the study area

The habitat colonizes both the dune ridges and the wide sheltered zones formed on the leeward sides of the dune systems.

From a syntaxonomic point of view, it belongs to the class *Ammophiletea*, order *Ammophiletalia*, and alliance *Agropyrion juncei* (211010), specifically the plant association *Eryngio–Elymetum farctii* (211012). Characteristic species include: *Eryngium maritimum* (sea holly), *Medicago marina* (sea medick), *Pancratium maritimum* (sea daffodil), *Elymus farctus* (rhizomatous sand couch), and *Otanthus maritimus*.

Conservation status – Importance – Threats

The communities of primary dunes are inherently variable, being in a state of constant dynamic evolution, yet they consist of species highly resistant and well-adapted to extreme environmental conditions such as high salinity and water scarcity.
The ecological importance of this habitat lies in its role as a structural component of dune vegetation, which helps to retain sand, stabilize the shoreline, and protect the inner plant communities from erosion and sea spray. Although several areas are in excellent or good conservation condition, many others are in moderate or degraded condition, surviving only as remnants of the original psammophilous vegetation.

Protection status

This habitat type is included in Annex I of Directive 92/43/EEC.

2. **Coastal dunes with juniper thickets (Juniperus spp.) (NATURA Code: 2250) — *Priority Habitat***

This habitat type consists of shrublands growing on shifting coastal dunes, dominated by *Juniperus phoenicea* (Phoenician juniper). It occurs in coastal zones throughout the Mediterranean and in Greece is found in the western and southern Peloponnese, the Ionian Islands, and western mainland Greece. It mainly appears within the meso-Mediterranean and thermo-Mediterranean vegetation belts, characterized by approximately 100 dry days during the hot, dry summer period, a subhumid and mild winter, and in the subhumid bioclimatic zone where snowfall is almost absent.

Typical form of habitat type 2250 “Coastal dunes with juniper thickets (Juniperus spp.)” in the Finikounta area.

Ecological Conditions – Floristic Composition of the Study Area

This habitat develops on sandy substrates, located a short distance from the sea at an elevation of 0–10 meters, on gentle slopes (0–5%) with a southern exposure.

Apart from *Juniperus phoenicea*, other characteristic species found in this habitat include: *Cistus salviifolius* (sage-leaved rockrose), *Pistacia lentiscus* (mastic tree), *Quercus coccifera* (kermes oak), and *Ephedra campylopoda*.

From a syntaxonomic perspective, it belongs to the plant association *Ephedro campylopodae – Juniperetum lyciae* (225014) of the alliance *Juniperion lyciae* (225010).

Conservation Status – Importance – Threats

As part of the dune community complex, this habitat plays an important role in sand retention, shoreline stabilization, and the protection of inland plant communities. It also possesses significant aesthetic value.

However, due to its relictual (residual) character and the intense touristic development in the region, the prospects for its long-term conservation are considered unfavorable.

Protection Status

This habitat is included in Annex I of Directive 92/43/EEC and is designated as a priority habitat type.

## 3. Thermo-Mediterranean Shrublands Dominated by *Euphorbia dendroides* (NATURA Code: 5330)

This habitat type includes various shrubland communities, which are often degraded or secondary formations of the high maquis vegetation belonging to the class *Quercetea ilicis*, and more specifically to the alliance *Ceratonio–Rhamnion*. It consists of shrubby formations within the thermo-Mediterranean vegetation zone, where the dominant species is *Euphorbia dendroides* (tree spurge). It occurs sporadically and discontinuously across the warm coastal regions of southern Greece, as well as the Aegean and Ionian Islands.

The habitat develops exclusively on hard limestone substrates and is restricted to the thermo-Mediterranean vegetation belt. The bioclimatic zone in which it develops may be semi-arid with mild winters, subhumid with warm winters, or humid with warm winters.

Typical form of habitat type 5330 “Thermo-Mediterranean Shrublands”
on the island of Agia Marianí.

Ecological Conditions – Floristic Composition of the Study Area

This habitat occurs exclusively on the island of Agia Marianí, located east of Sapientza and west of Schiza. It develops on limestone substrates, with variable slopes and exposures, and at low elevations (0–100 m).
From a syntaxonomic perspective, it belongs to the plant association *Oleo–Euphorbietum dendroidis* (533122) of the alliance *Ceratonio–Rhamnion* (533120).

Apart from *Euphorbia dendroides* (tree spurge), the vegetation of the habitat in the study area is mainly composed of hard-leaved thermophilous shrubs, such as *Olea europaea* (wild olive), *Phillyrea latifolia* (mock privet), and *Pistacia lentiscus* (mastic tree).
The vegetation structure also includes phryganic species and a variety of herbaceous plants.

Conservation Status – Importance – Threats

The vegetation on Agia Marianí island is dense and in good condition. The formations of *Euphorbia dendroides* create a distinctive and visually impressive landscape, particularly in spring, which is found only in few areas of Greece.

The importance of this habitat lies mainly in its uniqueness within the region and its contribution to biodiversity. It does not currently face direct threats from human activities.

Protection Status

This habitat is included in Annex I of Directive 92/43/EEC.

**4. Calcareous Rocky Slopes with Chasmophytic Vegetation (NATURA Code: 8210)**

The chasmophytic vegetation consists of plants growing in fissures or cracks (chasms) of steep rocky cliffs with moderate to high slopes (65–100%).
This habitat type is found throughout Greece, extending from sea level up to approximately 2,500 meters in elevation.

In areas with strong continental influence, it may occur on coastal cliffs as low as 10 meters, whereas in more mountainous regions, it appears on the summits of central Greek mountains. These communities are composed of species specifically adapted to survive and grow in rock crevices, even with minimal soil availability.
It occurs across all bioclimatic zones, from semi-arid with mild winters to humid with cold winters. The rock material may be compact or stratified limestone, or even conglomerate formations derived from limestone deposits.
In the study area, this habitat was found only in small patches, on vertical limestone cliffs up to 50 meters in height, mainly along the coasts of Sapientza Island, in a small section on the eastern shores of Schiza Island, and east of Methoni.

Ecological Conditions – Floristic Composition of the Study Area

Due to its relictual nature and limited spatial extent, this habitat cannot be classified below the level of the association *Campanulion versicoloris* — the low-altitude chasmophytic assemblage occurring between 0 and 1,300–1,500 meters.
The habitat comprises chasmophytic plant communities dominated by *Piptatherum coerulescens*, *Capparis spinosa* (caper bush), and *Phagnalon graecum* (Greek cudweed), among others.

Conservation Status – Importance – Threats

This habitat is of special interest, as it frequently hosts rare, endemic, and protected taxa. However, the limited extent and low representativeness of the community in the study area do not allow it to be classified as of major importance.

Nevertheless, it contributes to the conservation of biodiversity and does not currently face significant threats.

Protection Status

This habitat is included in Annex I of Directive 92/43/EEC.

**5. Submerged or Partially Submerged Sea Caves (NATURA Code: 8330**

This habitat type consists of caves located below the sea surface or open to the sea — at least during high tide — and includes partially submerged marine caves.
The floors and walls of these caves host communities of marine invertebrates and algae. The dominant vegetation is mainly composed of shade-loving algal assemblages, particularly red algae (*Rhodophyta*), such as *Peyssonnelia spp.*, *Lithothamnion spp.*, and others (e.g. *Udoteo–Aglaothamnietum tripinati*).
This habitat is important for the preservation of marine biodiversity and demonstrates good representativeness within the Mediterranean region.

Remote caves, those far from human activities, are used by the Mediterranean monk seal (*Monachus monachus*) as resting and breeding sites.

However, in accessible areas, this habitat type is threatened by tourism, primarily due to disturbance, noise, and pollution from recreational diving and boating activities.
The habitat occurs mainly on Sapientza Island, where numerous sea caves of various depths and sizes are found, providing suitable ecological conditions for specialized marine species.

Protection Status

This habitat is included in Annex I of Directive 92/43/EEC.

Marine caves on Sapientza Island (Habitat type 8330)

6. **Olive and Mastic Shrublands (NATURA Code: 9320**

This habitat type occurs across extensive areas of both the continental part of the study region—scattered from Vasilitsi to Methoni—and the islands of Schiza and Venetiko.
It shows its widest distribution in the semi-mountainous zone of the study area, particularly around

Mount Koukoura, while to the north and west, it appears interspersed among the region's broad agricultural lands.

Ecological Conditions – Floristic Composition in the Study Area

In the study and surrounding areas, this habitat represents a typical thermo-Mediterranean formation, consisting mainly of shrublands dominated by the species *Olea europaea* (wild olive) and *Pistacia lentiscus* (mastic tree).
These shrublands develop primarily on limestone substrates, at low and medium altitudes, and under various slopes and orientations.
From a phytosociological standpoint, they belong to the order *Pistacio–Rhamnetalia* and the alliance *Ceratonio–Rhamnion* (932010), more specifically to the association *Oleo europaeae–Pistacietum lentisci* (932014).

This habitat type represents the transitional zone between forested ecosystems and the garrigue-type vegetation of the Eastern Mediterranean.
It plays a vital role in soil protection and erosion control, serves as an important refuge for Mediterranean fauna, and contributes significantly to the structural diversity and landscape value of the region.

Protection Status

The habitat is included in Annex I of Directive 92/43/EEC.

Typical Form of Habitat Type 9320 — "Olive and Carob Woodlands" in the Study Area

This habitat includes communities of varied structure and physiognomy, ranging from dense shrublands with tall shrubs or small trees to sparser formations.
Typically, there is a lower shrub layer with variable coverage, inversely proportional to the cover of taller shrubs. The herbaceous layer also varies in density and is composed mainly of therophytes and grasses.
Among the characteristic species — apart from the two dominant ones, *Pistacia lentiscus* (mastic tree) and *Olea europaea* (wild olive) — the vegetation also includes *Phillyrea latifolia* (mock privet), *Ceratonia siliqua* (carob tree), and *Quercus coccifera* (kermes oak), among others.

Conservation Status – Importance – Threats

As previously mentioned, sclerophyllous shrublands represent a highly stable vegetation type, composed of hardy species well-adapted to the Mediterranean climatic and soil conditions.
Protection Status

This habitat type is included in Annex I of Directive 92/43/EEC.

7. **Sandy Beaches without Vegetation (NATURA Code: 21B0)**

These are sandy coastal areas devoid of phanerogamic vegetation.
They are classified as "other habitat type" (i.e., not included in Annex I of Directive 92/43/EEC).
In the study area, this habitat forms a narrow strip between the sea and the land, characterized by an absence of plant species.
It occurs along the coastline in several locations — mainly from Cape Akritas to Finikounda, as well as along the coastal zone of Methoni. This zone is intensively used by tourists and bathers, and the prevailing environmental conditions do not permit the establishment of vegetation.

8. **Eastern Mediterranean Sclerophyllous Shrublands (Garrigues) (NATURA Code: 5340)**

This habitat type is widely distributed throughout Greece, encompassing a large variety of sclerophyllous shrub formations spread across different substrates, bioclimatic zones, and ecological conditions. The soils are typically warm, dry, and nutrient-poor, often calcareous, though they can also develop on flysch or schist formations. Other ecological parameters — such as slopes, aspects, and altitudes — vary considerably, with this habitat being recorded from sea level up to about 1200 meters, though it is most common at low and mid-elevations.

In many cases, these habitats represent degraded forms of forest communities.
Their composition is highly heterogeneous, since they include phytocommunities that cannot be

classified under other habitat types of thermo- or meso-Mediterranean shrublands (e.g., *Olea–Ceratonia* forests, *Sarcopoterium spinosum* phrygana, *Quercus ilex* forests).

Generally, Garrigue formations consist of evergreen sclerophyllous shrubs, with the structure and composition of the herbaceous layer depending on the density of shrub cover and human activities, such as fires and grazing.
In the study area, this habitat type occurs in scattered and limited patches, mainly in the eastern part, from Agios Georgios to Tapia, and in smaller areas at Cape Nisakoulia, Cape Akritas, near the Monastery of Chrysokellaria, east of Akritochori, and Sparthorachi.

This habitat contributes significantly to biodiversity, landscape structure, and soil protection, serving as an intermediate vegetation type between forests and phryganic communities, typical of the Eastern Mediterranean ecosystems.

Typical Form of Habitat Type 5340 – “Garrigues of the Eastern Mediterranean” in the Study Area

**Ecological Conditions – Floristic Composition of the Study Area**

The habitat is found in barren, rocky, and generally dry areas, developing mainly on flysch substrates, but also on limestone formations.In most cases, it occurs below 150 meters in altitude, while slopes and aspects vary. From a phytosociological perspective, the formations of this habitat belong to the class *Quercetea ilicis*, the order *Pistacio–Rhamnetalia*, and the alliance *Ceratonio–Rhamnion*, specifically to the phytocoenosis *Cistus salvifolius–Quercus coccifera comm.* (534022). These formations represent a successional stage of the *Oleo–Lentiscetum* association following fire events.

They consist of open shrublands dominated by *Cistus salvifolius*. Other accompanying species include typical members of the *Ceratonio–Rhamnion* alliance, such as *Quercus coccifera* (kermes oak), *Smilax aspera* (rough bindweed), *Pistacia lentiscus* (mastic tree), and *Olea europaea* (wild olive).

**Conservation Status – Importance – Threats**

These communities result from the fire–grazing cycle and represent a degraded stage of sclerophyllous shrublands. Over the years, it is expected that the shrubs will dominate, reducing the coverage of *Cistus salvifolius*.

The phytocommunity faces no major threats, except for the potential recurrence of wildfires, which could significantly alter its composition and structure. Further degradation could lead to the complete disappearance of sclerophyllous shrubs and the formation of grasslands.

**Protection Status**

This type has been classified as “other habitat type”, i.e. it is not included in Annex I of Directive 92/43/EEC.

**9. Wet Depressions with Reeds and Rushes**

This wetland habitat comprises moist depressions, mainly within dune systems, dominated by reeds and rushes. It occurs in small patches in Finikounda, Lampes Beach, and Schiza Bay in the southern part of Schiza Island.

**10. Arbutus Forest and Evergreen Broadleaf Formations**

On Sapienza Island, there is a forest of evergreen broadleaved trees, designated as a Natural Monument (GR03) under Decision No. 105497/6459/11-8-86 (Government Gazette 656/B/1986), titled *“The Forest of Evergreen Broadleaves on Sapienza Island”*.
In areas with this designation, the same prohibitions apply as in the cores of National Parks.
Additionally, under the name *“Sapienza Forest of Evergreen Broadleaves”*, it has been recognized as a Biogenetic Reserve by the Council of Europe, with the objective of ensuring its long-term preservation.
The rich vegetation of the evergreen broadleaf formation, covering almost the entire island, appears as shrubby or phryganic vegetation in rocky or degraded soil areas, while in deeper soils with adequate moisture, it develops into a tree-like formation.
The forest designated as a Natural Monument (GR03) consists of tall, dense, arboreal vegetation, reaching 8–10 meters in height and 30–40 cm in trunk diameter.
It forms a typical Mediterranean evergreen sclerophyllous broadleaf forest, covering an area of 25–30 hectares, dominated by *Arbutus unedo* (strawberry tree).
Other species contributing to the canopy include *Pistacia lentiscus* (mastic tree) and *Phillyrea latifolia* (mock privet), forming a unique Mediterranean forest of exceptional ecological and aesthetic value.

This high forest is of great scientific value for studying the history and evolution of Mediterranean vegetation. Moreover, it serves as evidence of the potential for regeneration and the development of similar forests within the Greek landscape.

Sapienza Island Arbutus Forest

The dense evergreen broadleaf forest of Sapienza Island.
At the center of the photograph, *Spartolakko* can be distinguished.


The forest species that compose the tall forest in mixed form, as well as the dense medium-height shrublands, are mainly *Arbutus unedo* (strawberry tree), *Pistacia lentiscus* (mastic tree), *Phillyrea latifolia* (mock privet), *Quercus ilex* (holm oak), *Olea europaea* (wild olive), and *Quercus coccifera* (kermes oak).

The remaining part of the island is covered by a dense, impenetrable evergreen broadleaf shrubland up to 2 meters high, composed of the aforementioned species. In the southern part of the island, this vegetation becomes sparser and lower, enriched with phrygana-type plants such as *Cistus creticus* (rockrose), *Sarcopoterium spinosum* (thorny burnet), *Coridothymus capitatus* (thyme), *Cistus incanus* (hoary rockrose), *Salvia fruticosa* (sage), and others.

The herbaceous vegetation is confined to the openings and clearings of the forested areas and consists mainly of grasses, legumes, and other broad-leaved species, several of which are of high grazing value.

Along the western and northeastern shores of the island, steep rocky cliffs host crevice vegetation, while the remaining coasts are rocky and covered by sparse or locally dense vegetation. As mentioned earlier, along the northeastern, western, and eastern shores of the island, there are marine caves used as shelters by the Mediterranean monk seal (*Monachus monachus*) and by bats.

Finally, it is important to note the presence of Spartolakka on the island — a unique geological formation resulting from the accumulation of large quantities of pollen over a long period.

This area is of great phytosociological interest, as it can provide valuable information about the vegetation succession and development of the island and the wider region of Messinia.

## 8.5.3 Forests and Forested Areas

### 8.5.3.1. Character of the Study Area – Classification at the Forest Habitat Level

Phytosociologically, the study area belongs to the Eumediterranean vegetation zone (Quercetalia ilicis).
This zone is characterized by species such as the holm oak (*Quercus ilex* L.) and, mainly in the Peloponnese, by the kermes oak (*Quercus coccifera* L. var. calliprinos).
The Oleo-ceratonion subzone is subdivided into two smaller ecological and physiognomic units:

- *Oleo-ceratonion*
- *Quercion ilicis*

Within the study area "Islands of Sapienza and Schiza, Cape Akritas," the Oleo-ceratonion subzone is identified. The climate here is sub-humid, with annual rainfall not exceeding 800 mm and a dry period lasting 4–6 months.
This subzone is further divided into two forest habitat units:

- Oleo-lentiscetum — Despite the dry climate, this habitat features remarkable stands of *Pinus halepensis* (Aleppo pine), which extend beyond the Oleo-lentiscetum boundaries. Apart from *Olea oleaster* and *Pistacia lentiscus*, other species found here include *Erica verticillata*, *Myrtus communis* (in moist areas), *Quercus coccifera*, *Lonicera etrusca*, *Rosa sempervirens*, *Smilax aspera*, *Styrax officinalis*, and *Rubia peregrina*.
  From an agricultural perspective, this zone is dominated by the cultivation of olives, citrus trees, and pistachios.
- Oleo-ceratonietum — In this habitat, the natural plant communities have long been degraded, and where the land is not cultivated, it is covered by phrygana (garrigue) formations, dominated by thorny dwarf shrubs such as *Sarcopoterium spinosum*, *Genista acanthoclada*, *Euphorbia acanthothamnos*, and others.

Various Labiatae species (Lamiaceae) also occur, such as *Coridothymus capitatus*, *Salvia officinalis*, *Salvia pomifera*, *Phlomis fruticosa*, and *Ballota acetabulosa*.

In Figure 8.21, the vegetation map of the wider study area is presented.

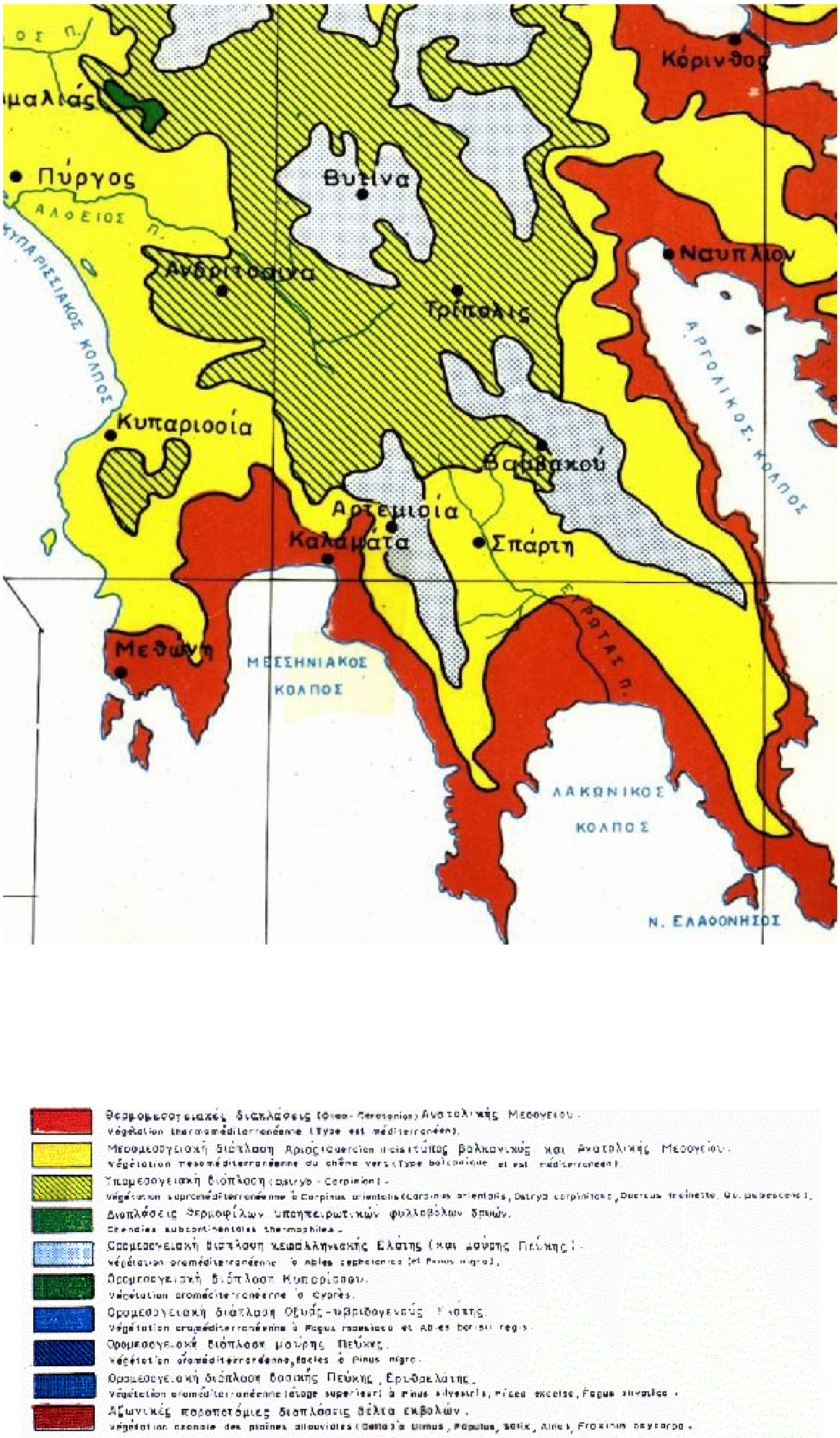



**Figure 8.21: Extract from the Vegetation Map of the Study Area (Mavromatis)**

From the classification of vegetation in the study area at the growth-site level, it is evident that there are no organized forests in the project area. Field inspections and cartographic representation confirm that within the area where the works will be implemented, no structured forest formations are present. Instead, the landscape consists mainly of olive–mastic–carob shrublands, which do not constitute an organized forest structure.

The zones to be occupied by the construction of the dam and its reservoir basin are primarily composed of agricultural lands and limited patches of macchia shrub vegetation. No forested lands of any type will be affected or occupied by the planned works.

#### 8.5.3.2. Documentation through Administrative Acts

According to the recent publication of the Forest Maps of Messinia Prefecture, as displayed on the official website of EKXA S.A. (http://gis.ktimanet.gr/wms/forestobjections/), and until their final ratification following the appeals process, all non-agricultural areas within the project's boundaries are currently classified as forest lands and are subject to the provisions of the national forest legislation.

#### 8.5.3.3. Cartographic Representation

The Annex of Maps includes the precise locations of the proposed works to facilitate their evaluation by the Forest Service.

### 8.5.4. Other Important Areas

#### 8.5.4.1. Terrestrial and Inland Water Areas

Within the project area, no additional terrestrial or inland water zones—beyond the protected areas—have been identified as environmentally significant or requiring special protection from the proposed works.

#### 8.5.4.2. Marine Areas

In the wider vicinity of the project lies the protected marine zone GR2550007 "Marine Area of Methoni Strait." Both this area and the coastal zone of Finikounda are located at a sufficient distance from the project site. Therefore, no impact is expected on these areas from either the construction or operational phases of the project.

## 8.6. Human Environment

### 8.6.1. Spatial Planning – Land Uses

#### 8.6.1.1. Spatial Planning

In Chapter 5.2.3 of the present study, the provisions and directions of the Municipal Spatial and Urban Plans (SXOOAΠ) of the municipalities within the study area are presented. Based on these plans, the examined area is mainly characterized as agricultural land, while zones for recreation and tourism, natural protection areas, and areas designated for small-scale industrial and commercial activities are also defined, particularly north of the settlement of Methoni, alongside the Methoni–Pylos national road.
From the mapping of the existing situation, as well as from the incorporation of current trends and planning directions, the spatial organization and functions of the area can be summarized as follows:

- Industrial and commercial activity zones in the Methoni area.
- Main tourist zone: the coastal front Methoni–Finikounda, extending slightly inland.
- Agricultural land with enhanced potential for agrotourism in the hinterland.
- Environmental protection zones, including forest areas and riparian protection zones along the main streams of the region.

#### 8.6.1.2. Land Uses

Regarding land uses in terms of land cover, within the studied municipal units, an assessment was carried out on three levels, corresponding to different data sources used in the context of this study.
Specifically, data from the CORINE Land Cover Programme were included, as these were used in the hydrological analysis of the works. Additionally, statistical data from the Hellenic Statistical Authority (ELSTAT) concerning the classification of municipalities and communities and the basic categories of land uses were also considered.

#### 8.6.1.3. Vegetation Characteristics According to the CORINE Land Cover Programme

The drainage basin exhibits significant vegetation cover, as indicated by the maps of the CORINE Land Cover Programme. The most important types of vegetation and land cover are:

- Mixed forests
- Olive groves
- Sclerophyllous vegetation
- Complex cultivation systems
- Agricultural areas with significant portions of natural vegetation

#### 8.6.1.4. Classification of Municipalities and Communities Based on Directive 75/268/EEC

The following table presents the classification of communities into Lowland (Π), Semi-mountainous (H), and Mountainous (O) categories. It is observed that all communities, except Kallithea, are characterized as Lowland, while Kallithea is classified as Semi-mountainous. This classification aligns with and explains the **predominantly agricultural character** of the region.

**Table 8.8: Classification of Municipalities and Communities of the Municipality of Pylos - Nestor (Directive 75/268/EEC)**

| Municipal / Local Community | Area (thousand stremmas*) | Classification (Directive 75/268/EEC)Lowland (L), Semi-Mountainous (S), Mountainous (M) |
|---|---|---|
| **Municipal Unit of Methoni** | 97.2 | - |
| Local Community of Evangelismos | 29.5 | L |
| Local Community of Kainourgio Chorio | 23.3 | L |
| Local Community of Laxanada | 12.3 | L |
| **Municipal Unit of Pylos** | 144.4 | - |
| Local Community of Methoni | 6.1 | L |
| Local Community of Finiki | 5.5 | L |
| Local Community of Finikounta | 20.5 | L |
| Local Community of Kallithea | 19.2 | S |
| Local Community of Mesochori | 6.6 | L |
| Local Community of Pidasos | 5.2 | L |
| Local Community of Chomatada | 6.7 | L |

#### 8.6.1.5. Main Categories of Land Use

The following table presents the distribution of the land areas of the Municipality of Pylos – Nestor among the main categories of land use, according to data from the Hellenic Statistical Authority (E.S.Y.E.) for the years **1999–2000**.

**Table 8.9: Main Categories of Land Use**

| Land Use Categories | Total Area (stremmas) | Percentage (%) |
|---|---|---|
| Cultivated Areas (including those currently in fallow) | 257,700 | 46.6 |
| Pastures | 104,400 | 18.9 |
| Forests | 138,500 | 25.0 |

| | | |
|---|---|---|
| Water-Covered Areas | 15,800 | 2.9 |
| Residential Areas | 21,000 | 3.8 |
| Other Areas | 15,500 | 2.8 |
| **Total** | **552,900** | **100.0** |

Source: Strategic Plan of the Municipality of Pylos–Nestor, 2015–2020.

It is evident that the examined area has a distinctly agricultural character, with cultivated land accounting for 46.6% of the total surface area, followed by pastures at 18.9%. In total, the agricultural sector covers 65.5% of the total area of the municipalities.

### 8.6.2. Structure and Functions of the Human Environment

#### 8.6.2.1. General Information

As stated in Chapter 1, the projects examined in this study—the Minagiotiko Stream Dam and the irrigation network—are located in the southwestern part of the Regional Unit of Messinia, within the Municipalities of Pylos–Nestor and Messini.
The study area is currently under the administrative jurisdiction of four (4) Municipal Units, covering cultivated areas belonging to the corresponding former Municipal Districts, as follows:

1. Municipal Unit of Methoni, including the former Municipal Districts of Evangelismos, Finikounta, Lachanada, and Finiki.
2. Municipal Unit of Pylos, including the former Municipal Districts of Pidasos, Chomatada, Kallithea, and Ampelakia.
3. Municipal Unit of Aipeia, including the former Municipal District of Militsa.
4. Municipal Unit of Koroni, including the former Municipal Districts of Exochiko and Kaplani.

Under the framework of the "Kallikratis Plan", the main administrative headquarters where the majority of municipal services have been concentrated are Pylos, serving as the seat of the Municipality of Pylos–Nestor, and Messini, for the Municipality of Messini.

#### 8.6.2.2. Elements of the Spatial and Urban Development Plan (SCHOAP)

According to the Spatial and Urban Development Plan (SCHOAP) of the Municipality of Methoni, in Chapter P.1.3 entitled *"Roles of Settlements within the Residential Network and Relations with Broader Development Axes and Growth Poles"*, the following key characteristics are presented regarding the organization of the settlement network.

The study area is an integral part of the development zone of Southwestern Messinia – Pylia, which, due to improved travel times, has become more closely connected with national, regional, and prefectural development axes and growth poles such as Kalamata, Patras, Athens, Pylos, and Koroni, as well as, through the ports of Kalamata and Patras, with transport and tourism flows to Crete, Italy, and the wider Mediterranean.

Primarily, there is a development outlook for increased urban dynamics in the settlement of Methoni, classified as a 4th-level settlement center on a regional scale. This aligns with national and European urban policies aimed at strengthening small and medium-sized towns, promoting complementary development actions with Kalamata, Pylos, and Koroni—each functioning as 3rd-level urban centers serving populations of over 20,000 inhabitants, acting as nuclei of residential units.

It is further assessed that the remaining 18 settlements within the municipal cluster will also experience upgrades, with the historic town of Methoni as its core and Finikounda as a secondary settlement center with a tourist character, given that no significant signs of urban saturation or environmental degradation have been observed to date, either in the settlement network or in natural resources.

In the spatial structure of the study area, two internal development axes can be identified, representing the spatial interrelations between the settlement network and the local production system, in connection with the geographic relief:

- The North–South axis, which connects the study area with higher-order urban centers such as Pylos and Kalamata, linking Methoni as the gateway settlement of the Municipality.
- The East–West axis, which facilitates internal communication within the settlement network and with the municipal headquarters, extending towards the coastal front and the sea, while further connecting the area to the coastal development corridor extending towards Koroni and Kalamata.

In recent years, this axis has attracted new tourism and recreation / holiday home activities, resulting in a gradual weakening of the traditional agricultural and livestock production system in the northern and intermediate inland zones of the Municipality.
The above internal development axes directly connect the study area with the secondary regional coastal development axis: Pylos – Methoni – Koroni – Kalamata – Kardamyli – Areopoli – Gytheio – Monemvasia – Neapoli.
Additionally, Methoni, dependent on the urban center of Pylos, is indirectly connected to other secondary regional development axes, including:
Kalamata – Pylos – Kyparissia, and Kalamata – Messini – Pylos – Gargalianoi – Filiatra – Kyparissia.
The national and provincial road network of the study area—namely the Methoni–Pylos national road (North–South axis), which connects Methoni with Pylos, and the two provincial coastal roads (old and new) along the East–West axis following the coastal front towards Koroni and Kalamata—constitutes the structural backbone of these two internal development axes.
Along this coastal axis, the two main settlements of Methoni and Finikounda have developed, concentrating the majority of non-residential land uses.

The settlement network of the Municipality is organized into two main spatial zones that together cover the entire municipal area:

- the Coastal Zone, with an altitude of up to 40 meters, and
- the Inland Zone, with an altitude above 40 meters and slopes of approximately 30%.

This spatial distinction is clearly visible and follows the north–south orientation of the area's geographic and developmental pattern.

The settlement of Methoni, the administrative seat of the Municipality, has developed in the southwestern part of the area, on flat to gently hilly terrain near Cape Akritas, partly surrounding the Medieval Castle of Methoni, along the Methoni stream, and at the terminus of the northbound road axis that connects it with Pylos, as well as along the coastal axis extending parallel to the shoreline. The town of Methoni will continue to constitute the main urban and functional center of the municipal area in the future.

Regarding the rest of the settlement network, comprising 18 settlements, three human-geographical sub-units of settlement clusters can be distinguished:

- Sub-unit Methoni – Kainourgio Chorio (West): Traversed longitudinally by the Pylos–Methoni national road, this cluster maintains a functional relationship with the settlement network of Pylos.
- Sub-unit Finiki – Evangelismos (Central): Formed by an intermediate group of settlements located between the two largest and most developed settlements of the Municipality, Methoni and Finikounda.
- Sub-unit Lachanada – Finikounda (East): Characterized by the activities of the coastal area of Finikounda and the mountainous zone of Lachanada.

The roles of the remaining 18 settlements correspond to their spatial and morphological typology:

The coastal settlements are suitable for the development of holiday housing, maritime tourism, and recreation, in parallel with the agricultural and livestock occupations of the residents.

The inland settlements will remain focused on the agro-pastoral sector, oriented toward integrated and organic cultivation, while combining complementary agro-tourism activities emphasizing alternative forms of ecotourism and nature-based tourism within the natural landscapes of the municipal hinterland.

As for the external relations of the settlement network, and primarily those of Methoni—a 4th-level urban center—in view of its prospective development as a dynamic historic town with international cultural and tourism appeal, special emphasis should be placed on strengthening cooperative and complementary roles with other urban centers of Messinia Prefecture and the wider national and international context:

- Methoni – Pylos (3rd-level urban center): Strengthening interdependence and partnership relations, including: the provision of 3rd-level urban services to 4th-level centers, upgrading of road transport infrastructure, development of business activities supporting agricultural production and agri-food processing, and the promotion of tourism initiatives, commercial exchange networks, and service linkages.

- Methoni – Koroni (3rd-level urban center): Reinforcing mutual interdependence and collaboration, particularly in the fields of cultural cooperation, road transport enhancement, agro-industrial development, tourism exchange, and commercial and service networking.
- Methoni – Kalamata (2nd-level urban center): Developing interdependent relationships across the entire settlement network of Messinia, including the provision of public and private administrative services, healthcare, higher education, cultural cooperation, and business and knowledge exchange.

Furthermore, the expected role of Methoni extends into two fundamental thematic fields of collaborative and complementary relations on both the national and international level, specifically concerning:
I. Monuments of culture with great historical and symbolic significance, and
II. Internationally protected natural landscapes and ecosystems.
In particular:

- Methoni – Cities and settlements with medieval castles in Greece and abroad: Development of partnership relations for the promotion and valorization of cultural heritage, through cultural and economic cooperation aimed at the promotion and utilization of the Methoni Castle within national and international networks of historic cities with castles of various periods. Activities may include conferences, cultural and musical events, tourism industry initiatives, awareness campaigns, publications, and multimedia presentations.
- Methoni – Cities and settlements with underwater archaeological sites in Greece and the Mediterranean: Development of partnership relations for the promotion and valorization of underwater cultural heritage, through cultural and economic cooperation aimed at the promotion and utilization of underwater archaeological findings of ancient shipwrecks in the Bay of Methoni, with the prospect of international networking among approximately 30 comparable regions of visible underwater antiquities in Greece — the closest being Plytra, Laconia — as well as others in the wider Mediterranean region (e.g., Cyprus, Italy). Activities include diving tourism, conferences, cultural and musical events, tourism industry development, awareness campaigns, publications, and multimedia presentations.
- Methoni – Cities and settlements within protected NATURA 2000 areas: Development of partnership relations for the promotion and protection of natural heritage, through various forms of eco-tourism, exchange of research and data between management authorities, organized excursions, outdoor sports events, conferences, cultural and musical activities, tourism industry initiatives, publications, and multimedia presentations.

Finally, attention is drawn to the international research program in experimental astrophysics and oceanography “NESTOR”, implemented by the University of Athens, which aims to detect neutrino particles through the installation of an underwater telescope at a depth of 4,000 meters in the Bay of Methoni, approximately 11 nautica**l miles from the** town. This project has the potential for international scientific utilization, attracting significant numbers of visitors in the context of conference and scientific tourism.

Summary regarding the examined projects

In relation to the studied works, three groups or settlement levels are identified:

1. Methoni, the seat of the former municipality and a settlement of significant historical importance, together with Finikounda–Lachanada, which form the main coastal front and road axis, concentrating most tourist and economic activities.
2. Finiki, Kamaria, and Evangelismos, which are small settlements but of high interest for tourism and secondary housing development.
3. Other settlements of the Municipality of Pylos–Nestor (Kallithea, Chomatada, Pidasos, Mesochori, Perivolakia), with Kallithea and Vlassaiika (Municipality of Aipeia) being the most prominent, where agricultural activity predominates.

The proposed works mainly concern the second and third groups, in terms of the total cultivated area. For the second group, the significant growth in tourism and secondary housing was taken into account, and the boundaries of the irrigation perimeters were adjusted accordingly.

Within this overall framework, at the level of settlements, the most significant roles are held by the towns of Pylos, Methoni, and Finikounda, while Finikounda demonstrates considerable dynamism with a distinctly seasonal activity profile.

These settlements function as centers of commerce, administration, public services, and education, and they concentrate almost all tourism activity. Specifically, they host the major tourist facilities (hotels, rental accommodations, and campgrounds).

In the wider Pylos–Gialova area, the largest organized tourist complexes are located, including settlements and golf facilities. A new large-scale mixed-use complex of this type is planned to be established near—but outside—the irrigated area, in the Kynigos region, west of Kallithea and north of Pidasos.

Other settlements (Finiki, Kamaria, Evangelismos, and Lachanada) of the former Municipality of Methoni show a strong interest in residential development, whereas the settlements of the former Municipality of Pylia (Mesochori, Pidasos, Chomatada, and Kallithea) exhibit a relatively stagnant profile, remaining focused on primary-sector activities.

Finally, the settlements of Vlassaiika and Militsa in the Municipality of Aipeia, located northeast of the studied area, as well as Exochi in the Municipality of Messini, are small peripheral settlements relative to their respective municipal seats.

#### 8.6.2.3. Traditional and Protected Settlements

Within the project area, there are no settlements officially designated as protected or traditional, except for the towns of Pylos and Methoni, which are located at a significant distance from the project area. Relevant reference to these is made in Section 8.3.1 of the present Environmental Impact Study.

### 8.6.3. Cultural Heritage

As stated in Section 5.1, according to the Permanent List of Monuments maintained by the Ministry of Culture, the main project (dam and reservoir) does not intersect with any known monument or archaeological site of interest, as indicated in Table 8.10 that follows.
The pipeline network for water transport and distribution may pass in proximity to certain known monuments, as it generally follows existing road alignments.
The identified monuments consist mainly of buildings (schools, churches, and an Early Christian basilica), generally located within or near the settlements inside or adjacent to the project area.

**Table 8.10: List of Monuments within the Study Area, Source: Permanent Register of Declared Archaeological Sites and Monuments — Hellenic Ministry of Culture (http://www.culture.gr/)**

| | Municipality / Community | Location | Name | Ministerial Decision No. / Government Gazette (FEK) | Description |
|---|---|---|---|---|---|
| 1 | Pylos–Nestor / Finikounta | Loutra | Early Christian Basilica | ΥΑ ΠΠΕ/Β1/Δ/30/25243/558/5-5-1982 – FEK 320/B/2-6-1982 | Declared as an Early Christian Basilica located at the site "Loutra" in the Community of Finikounta, Prefecture of Pylia, Messinia. The ruins extend to the south and west of the thermal springs of Loutra, within the property of the Spa Company. The monument lies at a distance of 100 m from the Finikounta-Methoni provincial road. |
| 2 | Pylos–Nestor / Kallithea | Kallithea | Former Primary School Building | ΥΑ ΥΠΠΟ/ΔΙΛΑΠ/Γ/7275/9399/24-10-1984 – FEK 674/B/24-10-1984 | Declared as a preserved historical monument: the building of the former Primary School of Kallithea, Messinia. The structure is a characteristic example of public architecture of the early 20th century and has significant historical and educational value for the region. |
| 3 | Pylos–Nestor / Chomatada | Chomatada | Church of Panagia Myrtidiotissa | ΥΑ ΥΠΠΟ/ΑΡΧ/Β1/30/5824/1102/14-1-1992 – FEK 88/B/14-2-1992 | The Church of Panagia Myrtidiotissa in the settlement of Chomatada, Municipality of Pylos–Nestor, is declared a listed religious monument. The church presents a typical three-aisled basilica form with interesting morphological and architectural features. |
| 4 | Pylos–Nestor / Pidasos | Pidasos | Private Building | ΥΑ ΥΠΠΟ/ΔΙΛΑΠ/Γ/1424/33838/23-6-1992 – FEK 482/B/27-7-1992 | Declared as a preserved historical building, formerly owned by Georgios Kazantinos and Ioannis Kalaitzis in Pidasos, Messinia. It constitutes a representative sample of rural architecture significant for the study of the region's building history. |
| 5 | Pylos–Nestor / Mesochori | Mesochori | Church of the Holy Apostles | ΥΑ ΥΠΠΕ/ΑΡΧ/Β1/30/16107/328/29-3-1984 | Declared as an archaeological site of the Church of the Holy Apostles, located in the Community of Mesochori, Pylia, Messinia. The church preserves important architectural elements of the post-Byzantine period and is situated on an 6elevated rocky outcrop north of the settlement. |

| | | | | | |
|---|---|---|---|---|---|
| 6 | Pylos–Nestor / Mesochori | Mesochori | Church of the Transfiguration | ΥΑ ΥΠΠΕ/ΑΡΧ/Β1/30/26894/511/29-5-1984 – ΦΕΚ 836/Β/26-11-1984 | Declar7ed as a preserved religious monument: the Church of the Transfiguration in Mesochori, Pylia, Messinia. The temple maintains original morphological and structural features representative of Byzantine ecclesiastical architecture. |
| 7 | Pylos–Nestor / Mesochori | Mesochori | Former Primary School Building | ΥΑ ΥΠΠΟ/ΔΙΛΑΠ/Γ/7870/39894/4-10-1990 – ΦΕΚ 749/Β/24-10-1990 | Declared as a listed historical building: the former Primary School of Mesochori, Pylia. It is a representative example of the early 20th-century public school architecture of the region, built with local stone and traditional techniques. |
| 8 | Pylos–Nestor / Mesochori | Mesochori | Primary School Building | ΥΑ 60586/4260/7-9-1989 – ΦΕΚ 587/Β/25-9-1989 | Declared as a listed monument: the Primary School building of Mesochori, representing a characteristic example of educational architecture of the interwar period in Messinia. |

## 8.7. Socio-economic Environment

### 8.7.1. Demographic Situation – Population Data

The following table presents, according to the data from the agroeconomic-technical study, the area of the municipal districts, the population, and the population density (inhabitants/km²).

Table 8.11. Population Density

| Municipal District | Area (km²) | Population 2011 | Inhabitants / km² |
|---|---|---|---|
| Militsa | 14,8 | 176 | 11,89 |
| Kallithea | 19,20 | 664 | 34,58 |
| Pidasos | 5,20 | 166 | 31,92 |
| Chomatada | 6,70 | 310 | 46,27 |
| Methoni | 29,50 | 1209 | 40,98 |
| Evaggelismos | 23,30 | 408 | 17,51 |
| Lachanada | 6,10 | 147 | 24,10 |
| Finiki | **5,50** | **103** | 18,73 |
| Finikouda | 20,50 | 677 | 33,02 |
| **Total** | **130,80** | **3.680,00** | **29,51** |

**Source:** Hellenic Statistical Authority (ELSTAT). Own processing

The following table presents the population of the area directly affected by the project, by local community, as officially reported by the Hellenic Statistical Authority (ELSTAT) based on the 2011 Census.

**Table 8.12: Permanent Population of the Settlements for the Years 2001 and 2011**

| Description | 2011 | 2001 |
|---|---|---|
| **Greece** | 10,816,286 | 10,934,097 |
| **Peloponnese** | 577,903 | 597,622 |
| **Messinia** | 159,954 | 166,566 |
| **Local Community of Militsa** | 176 | 215 |
| Eastern Militsa | 94 | 135 |
| Vlassaika | 11 | 14 |
| Militsa | 71 | 66 |
| **Local Community of Evangelismos** | 408 | 341 |
| Amoulaki | 11 | — |
| Dentroulia | — | 4 |

| | | |
|---|---|---|
| Evangelismos | 259 | 258 |
| Kabouriano | 24 | — |
| Kamaria | 109 | 79 |
| Palialona | 5 | — |
| **Local Community of Lachanada** | 147 | 152 |
| Astrohori | 9 | — |
| Lachanada | 138 | 146 |
| Nerantzies | — | 6 |
| **Local Community of Methoni** | 1,209 | 1,198 |
| Gefyri | 16 | — |
| Kokkinia | 13 | 23 |
| Kritika | 4 | 9 |
| Methoni | 1,103 | 1,121 |
| Sapientza (islet) | 2 | 7 |
| Tapia | 71 | 38 |
| **Local Community of Finiki** | 103 | 92 |
| Lampes | 6 | — |
| Finiki | 97 | 92 |
| **Local Community of Finikounta** | 677 | 570 |
| Agia Marina (islet) | — | — |
| Anemomylos | 22 | 10 |
| Grizokampos | 25 | 13 |
| Lousta | 13 | 7 |
| Schiza (islet) | — | 17 |
| Finikounta | 592 | 517 |
| Chounakia | 25 | 6 |
| **Local Community of Kallithea** | 664 | 620 |
| Arapolakka | 35 | 40 |
| Kallithea | 629 | 580 |
| **Local Community of Chomatada** | 310 | 305 |
| Perivolakia | 125 | 135 |
| Chomatada | 185 | 170 |
| **Local Community of Pidasos** | 166 | 146 |
| Pidasos | 166 | 146 |
| **Total Study Area** | **3,860** | **3,639** |

**Source:** Hellenic Statistical Authority (ELSTAT) – Own Processing

The following table presents the population movement during the period 2001–2011. It illustrates both the absolute and percentage changes that occurred during this decade, for the overall study area as well as for each Local Community individually. Additionally, a comparison is made with the corresponding variations at the levels of the Regional Unit, the Region, and the Country as a whole.

**Table 8.13: Population Movement (2001–2011)**

| Area | Population 2011 | Population 2001 | Change 2001–2011 | % Change 2001–2011 |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **Greece** | 10,816,286 | 10,934,097 | -117,811 | -1.08% |
| **Peloponnese** | 577,903 | 597,622 | -19,719 | -3.30% |
| **Messenia** | 159,954 | 166,566 | -6,612 | -3.97% |
| **Mnilitsa** | 176 | 215 | -39 | -18.14% |
| **Evangelismos** | 408 | 341 | +67 | +19.65% |
| **Lachanada** | 147 | 152 | -5 | -3.29% |
| **Methoni** | 1,209 | 1,198 | +11 | +0.92% |
| **Finiki** | 103 | 92 | +11 | +11.96% |
| **Finikounta** | 677 | 570 | +107 | +18.77% |
| **Kallithea** | 664 | 620 | +44 | +7.10% |
| **Chomatada** | 310 | 305 | +5 | +1.64% |
| **Pidasos** | 166 | 146 | +20 | +13.70% |
| **Total Study Area** | **3,860** | **3,639** | **+221** | **+6.07%** |

**Source:** Hellenic Statistical Authority (ELSTAT) – Own Processing

From the data presented in the above table, as well as from the following figure, it is evident that within the study area, the most populous municipal districts are Methoni, Finikounta, and Kallithea.

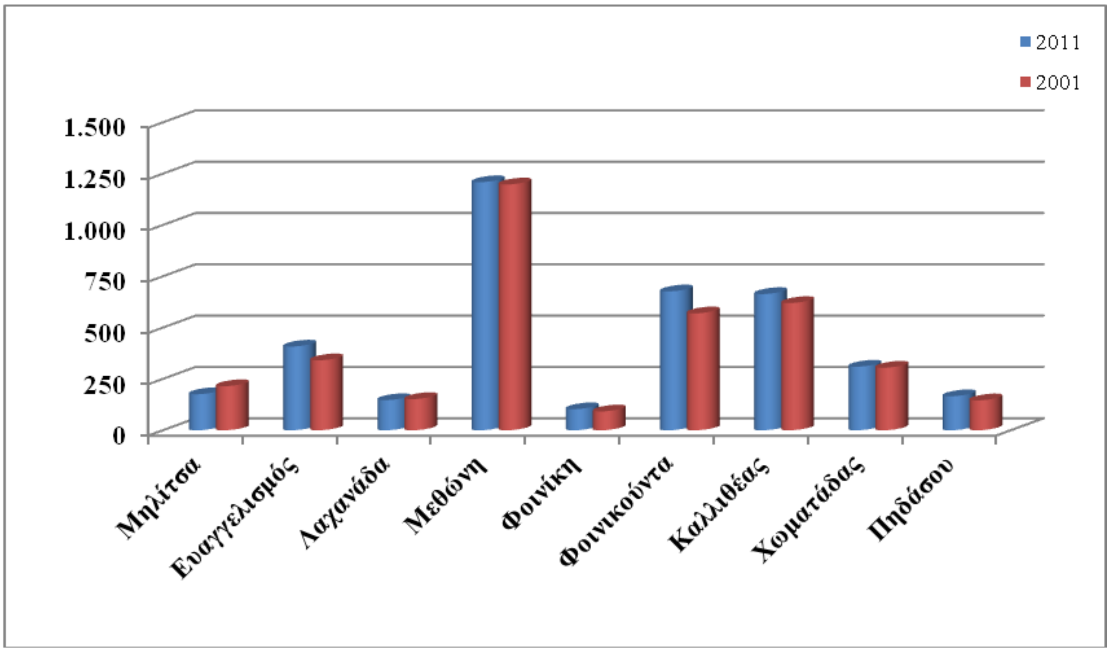
In the municipal districts of Militsa and Lachanada, a decrease in the permanent population is observed by -18.14% and -3.29%, respectively. In contrast, the municipal district of Methoni shows a slight increase in its permanent population in 2011 compared to 2001, by 0.92%, while the highest increases are recorded in Evangelismos (+19.65%) and Finikounta (+18.77%).

Overall, the study area presents a growth in permanent population of 6.07%, whereas during the same period the Regional Unit of Messenia shows a decline of -3.97%, the Region of Peloponnese a decline of -3.30%, and Greece overall a decline of -1.08%.

The retention and increase of the population in the study area during this period constitute a distinctive feature that can be attributed not only to the growth of tourism but also to the general socio-economic vitality of the region and to the ability of its residents to maintain a satisfactory to high standard of living.

This fact reflects, beyond the area's inherent dynamism, the significant differences that distinguish it from the broader regional context. The observed variations between municipal districts are attributed to the specific characteristics and socio-economic profiles of each locality.

**Figure 8.22: Population change within the study area (2001–2011)**




**Source:** Hellenic Statistical Authority (ELSTAT) – Own Processing

The improvement in living conditions that occurred in the study area included a series of positive developments, such as:

- The enhancement of the national, provincial, and rural road networks, through the implementation of corresponding infrastructure projects.
- The electrification of settlements and all residences, which facilitated everyday life by enabling the use of electrical appliances.
- The reduction of isolation through the universal availability of telephone connections in households.
- The improvement of educational and health infrastructures, ensuring access to quality services even in rural areas.
- The increase of irrigated land, made possible through the drilling of wells and boreholes.
- The over-concentration of population in urban centers and the resulting decline in living standards in these areas, which acted as a push factor for residents.
- The desire of inhabitants to remain or return to their place of origin, following the development of essential infrastructures that improved local quality of life.

The following table presents the distribution of the permanent population (both sexes) by age group for the year 2001. The table also provides a comparative presentation for the whole country, the Region of Peloponnese, and the Regional Unit of Messenia. Data from 2001 are used because they were the most recent available at the time of the study’s preparation. It is estimated that no substantial changes have occurred in the distribution among age groups in subsequent years, and therefore the analysis of the study remains unaffected by the use of these specific data.

**Table 8.14:** ***Distribution of permanent population by age group (both sexes)***

| Region | Total | 0–14 | 15–24 | 25–39 | 40–54 | 55–64 | 65–79 | ≥80 |
|---|---|---|---|---|---|---|---|---|
| **Greece** | 10,934,097 | 1,660,899 | 1,561,637 | 2,500,772 | 2,183,267 | 1,200,289 | 1,497,181 | 330,052 |
| **Peloponnese** | 597,622 | 88,704 | 75,513 | 126,700 | 113,270 | 66,170 | 100,261 | 27,004 |
| **Messenia** | 166,566 | 24,564 | 21,344 | 34,123 | 31,102 | 18,306 | 29,342 | 7,785 |
| **Municipal District of Militsa** | 215 | 17 | 8 | 30 | 27 | 36 | 69 | 28 |
| **Municipal District of Methoni** | 1,198 | 142 | 150 | 204 | 254 | 181 | 201 | 66 |
| **Municipal District of Evangelismos** | 341 | 34 | 32 | 50 | 69 | 42 | 76 | 38 |
| **Municipal District of Lahanada** | 152 | 22 | 22 | 25 | 26 | 10 | 28 | 19 |
| **Municipal District of Finiki** | 92 | 7 | 3 | 13 | 14 | 17 | 28 | 10 |
| **Municipal District of Finikounta** | 570 | 71 | 74 | 113 | 127 | 52 | 101 | 32 |
| **Municipal District of Kallithea** | 620 | 68 | 71 | 109 | 87 | 79 | 157 | 49 |
| **Municipal District of Pidasos** | 146 | 5 | 10 | 20 | 15 | 22 | 61 | 13 |
| **Municipal District of Chomatadas** | 305 | 34 | 40 | 49 | 57 | 27 | 72 | 26 |
| **Study Area (Total)** | **3,639** | **400** | **410** | **613** | **676** | **466** | **793** | **281** |

**Source:** Hellenic Statistical Authority (ELSTAT) – Own Processing

Table 8.15 below presents the analysis of the percentage share of each age group in the composition of the total population. From this table, as well as from the corresponding chart that graphically depicts these data, several observations can be drawn concerning the age structure of the population.

**Table 8.15: Percentage Distribution of Population by Age Group**

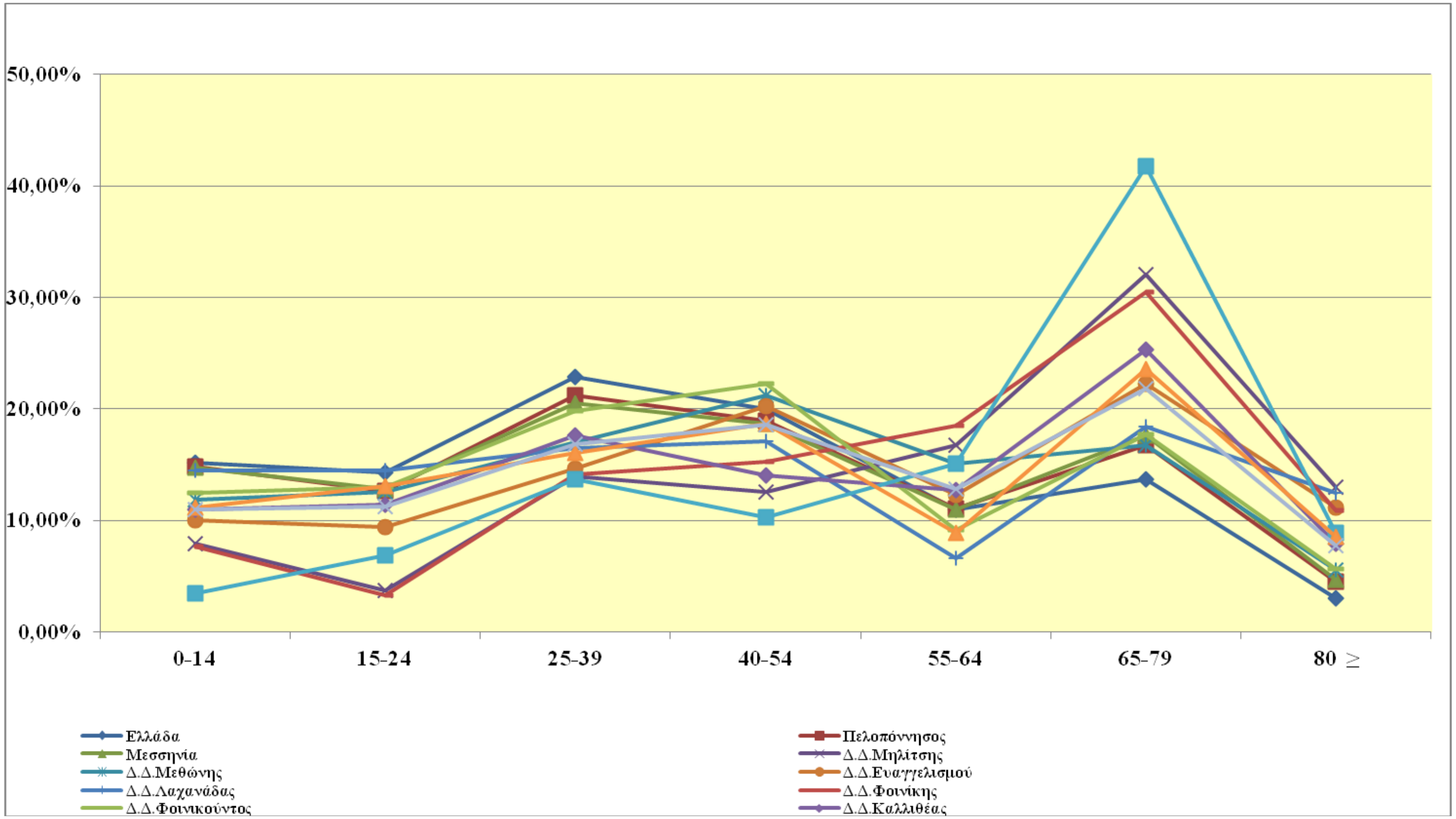
| Region | 0–14 | 15–24 | 25–39 | 40–54 | 55–64 | 65–79 | 80+ |
|---|---|---|---|---|---|---|---|
| Greece | 15.19% | 14.28% | 22.87% | 19.97% | 10.98% | 13.69% | 3.02% |
| Peloponnese | 14.84% | 12.64% | 21.20% | 18.95% | 11.07% | 16.78% | 4.52% |
| Messinia | 14.75% | 12.81% | 20.49% | 18.67% | 10.99% | 17.62% | 4.67% |
| Mnilitsa M.D. | 7.91% | 3.72% | 13.95% | 12.56% | 16.74% | 32.09% | 13.02% |
| Methoni M.D. | 11.85% | 12.52% | 17.03% | 21.20% | 15.11% | 16.78% | 5.51% |
| Evangelismos M.D. | 9.97% | 9.38% | 14.66% | 20.23% | 12.32% | 22.29% | 11.14% |
| Lachanadas M.D. | 14.47% | 14.47% | 16.45% | 17.11% | 6.58% | 18.42% | 12.50% |
| Foiniki M.D. | 7.61% | 3.26% | 14.13% | 15.22% | 18.48% | 30.43% | 10.87% |
| Foinikountas M.D. | 12.46% | 12.98% | 19.82% | 22.28% | 9.12% | 17.72% | 5.61% |
| Kallithea M.D. | 10.97% | 11.45% | 17.58% | 14.03% | 12.74% | 25.32% | 7.90% |
| Pidasos M.D. | 3.42% | 6.85% | 13.70% | 10.27% | 15.07% | 41.78% | 8.90% |
| Chomatadas M.D. | 11.15% | 13.11% | 16.07% | 18.69% | 8.85% | 23.61% | 8.52% |
| **Study Area Total** | **10.99%** | **11.27%** | **16.85%** | **18.58%** | **12.81%** | **21.79%** | **7.72%** |

**Source:** Hellenic Statistical Authority (ELSTAT) – Own Processing

***From the analysis of the aforementioned data, it is observed that:***

The Municipal District of Pidasos exhibits a very high percentage in the age category 65–79 years, with 41.78% of its population belonging to this group. It is followed by the Municipal Districts of Mnilitsa and Foiniki, with 32.09% and 30.43%, respectively. These percentages are more than double those observed at the regional and national levels.
All municipal districts within the study area, except for Methoni, show a higher proportion of residents aged 65 years and older compared to the overall figures for the country, the region, and the regional unit.
In general, within the study area, there are no significant deviations in the percentage distribution among the various age groups when compared to the national, regional, and prefectural averages.

**Figure 8.23: Percentage Distribution of Population in the Study Area**



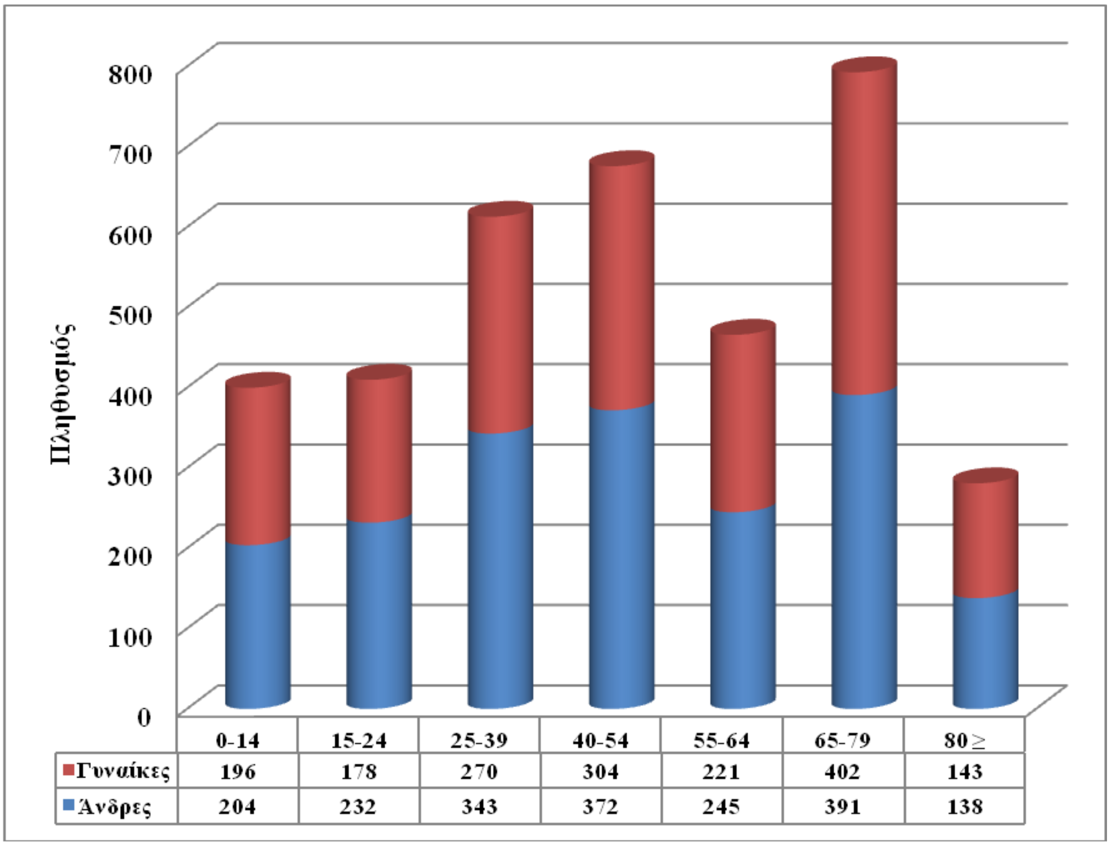

**Source:** Hellenic Statistical Authority (ELSTAT). Own processing

The total Study Area shows overall lower percentages in the 15–39 age group, the working-age population, compared to the national average. Similarly, in the 40–64 age group, the Study Area does not exhibit significant differences compared to the national, regional, or regional unit levels.

For the Study Area, we can observe that:

- In the comparison between the female and male population (see Diagram 5.3), in the age groups up to 64 years, the male population predominates, whereas in the age groups of 65 years and older, the female population exceeds the male population.
- Another characteristic observable from the analysis of Diagram 5.3 is the increasing population trend between the ages of 25–39 and 40–54. The female population decreases in the 15–24 age group, likely due to migration to urban centers for education, with women in this age group not being replaced in the Study Area.
- The increase in population in the 65–79 age group compared to the previous 55–64 age group can be explained by the possible return of residents to their place of origin after retirement from employment in other areas.
- The higher number of men in the working-age population can also be attributed to the migration of labor to the area, which is predominantly male or consists of men in a much higher proportion than women, employed as auxiliary staff in agricultural work as well as in hospitality establishments.

**Figure 8.24: Population by Age Group and Gender in the Study Area**




**Source:** Hellenic Statistical Authority (ELSTAT). Own processing

### 8.7.2. Productive Structure of the Local Economy

#### 8.7.2.1. General Structure of the Economically Active Population (E.A.P.) by Sector and Branch of Economic Activity

The economic structure of the study area in 2001, based on the three productive sectors — Primary, Secondary, and Tertiary — is presented in detail in the following tables.

The Primary Sector employed 861 workers, followed by the Secondary Sector with 127 workers, representing 8.73% of the active labor force, and finally the Tertiary Sector with 332 workers.

A total of 25 individuals did not declare a specific economic activity sector, while 109 individuals of the economically active population (permanent residents of the study area) declared themselves as unemployed.

In the study area, as of 2001:

- The Primary Sector was particularly strong due to the geomorphological characteristics of the wider area of the Municipality and the predominantly agricultural–farming nature of the local economy in previous decades, reaching 59.22% of total employment. This percentage is five times higher than the national average, double that of the prefecture, and greater than that of the Municipality of Pylos–Nestor.
- The Secondary Sector, with 8.73% of the economically active population, showed significant lag — approximately 50% lower compared to both the Prefecture and the Country. The main reason for this shortfall is the limited development of distribution networks for promoting local products, despite the fact that these are globally recognized for their high quality, particularly olive oil and raisins.
- The Tertiary Sector, representing 22.83% of the economically active population, also showed a notable lag of around 50%, both in comparison with the Prefecture and with the national level. Nevertheless, it demonstrates developmental potential and has begun, over the last decade, to evolve as a mechanism for a gradual economic shift toward services — primarily driven by tourism, one of the most promising sectors in the region due to its natural environment, extensive coastline, archaeological sites, and Natura 2000 protected areas.
- The unemployment rate was exceptionally low, at 7.50%, significantly below the corresponding rates observed at the national, regional, and municipal levels.

**Table 8.16: Economically Active, Inactive Population and Employed Population by Sector of Economic Activity**

| Region | Total Economically Active | Employed Persons | Primary Sector (NACE A–B) | Secondary Sector (NACE C–F) | Tertiary Sector (NACE G–Q) | Not Declared Sector | Unemployed | Economically Inactive |
|---|---|---|---|---|---|---|---|---|
| **Greece** | 4,615,470 | 4,102,091 | 591,666 | 892,189 | 2,401,834 | 216,402 | 513,379 | 6,318,627 |
| **Peloponnese** | 66,743 | 59,663 | 20,853 | 9,438 | 27,260 | 2,112 | 7,080 | 99,823 |
| **Messenia Prefecture** | 8,670 | 7,836 | 4,747 | 726 | 2,176 | 187 | 834 | 12,502 |
| **Study Area** | 1,454 | 1,345 | 861 | 127 | 332 | 25 | 109 | 1,970 |
| Local District of Methoni | 526 | 479 | 225 | 62 | 179 | 13 | 47 | 672 |
| Local District of Evangelismos | 136 | 130 | 109 | 11 | 8 | 2 | 6 | 205 |
| Local District of Lachanada | 57 | 52 | 38 | 3 | 10 | 1 | 5 | 95 |
| Local District of Finiki | 35 | 34 | 27 | 0 | 7 | 0 | 1 | 57 |
| Local District of Finikounta | 268 | 254 | 178 | 22 | 54 | 0 | 14 | 302 |
| Local District of Kallithea | 244 | 234 | 166 | 26 | 35 | 7 | 10 | 376 |
| Local District of Pidasos | 48 | 41 | 24 | 0 | 16 | 1 | 7 | 98 |
| Local District of Chomatada | 140 | 121 | 94 | 3 | 23 | 1 | 19 | 165 |

**Source:** Hellenic Statistical Authority (ELSTAT), own processing.

**Table 8.17: Percentage of Employment per Sector in Relation to the Economically Active Population**

| Region | Total Employment (% of E.A.P.) | Primary Sector NACE A–B (%) | Secondary Sector NACE C–F (%) | Tertiary Sector NACE G–Q (%) | Not Declared Sector (%) | Unemployment Rate (%) |
|---|---|---|---|---|---|---|
| **Greece** | 88.88 | 12.82 | 19.33 | 52.04 | 4.69 | 11.12 |
| **Messenia** | 89.39 | 31.24 | 14.14 | 40.84 | 3.16 | 10.61 |
| **Municipality of Pylos–Nestor** | 90.38 | 54.75 | 8.37 | 25.10 | 2.16 | 9.62 |
| **Study Area** | 92.50 | 59.22 | 8.73 | 22.83 | 1.72 | 7.50 |
| Local District of Methoni | 91.06 | 42.78 | 11.79 | 34.03 | 2.47 | 8.94 |
| Local District of Evangelismos | 95.59 | 80.15 | 8.09 | 5.88 | 1.47 | 4.41 |
| Local District of Lachanada | 91.23 | 66.67 | 5.26 | 17.54 | 1.75 | 8.77 |
| Local District of Finiki | 97.14 | 77.14 | 0.00 | 20.00 | 0.00 | 2.86 |
| Local District of Finikounta | 94.78 | 66.42 | 8.21 | 20.15 | 0.00 | 5.22 |
| Local District of Kallithea | 95.90 | 68.03 | 10.66 | 14.34 | 2.87 | 4.10 |
| Local District of Pidasos | 85.42 | 50.00 | 0.00 | 33.33 | 2.08 | 14.58 |
| Local District of Chomatada | 86.43 | 67.14 | 2.14 | 16.43 | 0.71 | 13.57 |

### 8.7.2.2. Agricultural Activity

#### 8.7.2.2.1. Crop Data

The data presented in this section are derived from the Agro-Economic and Technical Study and refer to the agricultural and livestock production of the Municipal Districts (M.D.) located within the project area.

The following table shows the cultivations by category, as declared by the producers in their 2014 Unified Farm Declarations, according to the data provided by OPEKEPE (Payment and Control Agency for Guidance and Guarantee Community Aid).

According to these records, the total utilized agricultural area in 2014 amounted to 50,925 stremmas within the municipal districts of the study area.
Out of this area:

- 42,971.50 stremmas were cultivated with olive groves,
- 2,789.00 stremmas were arable land (mainly non-irrigated),
- 2,597.00 stremmas were cultivated with currants, and
- 1,357.40 stremmas were in fallow.

All other cultivation categories occupied smaller areas.
In total, the cultivated land amounts to 56,876.00 stremmas, distributed as follows:

- 32.00 stremmas of nurseries,
- 1,123.00 stremmas of vineyards and currants,
- 13,947.00 stremmas of arable crops (including land in good agricultural condition and fallow), and
- 41,768.00 stremmas of tree crops.

From these data, and their percentage proportions, it is evident that tree crops occupy by far the largest share of cultivated land in the study area. As in the wider region, olive cultivation is the dominant agricultural activity, representing 84.38% of the total cultivated area and 92.88% of all tree crops. Arable crops cover 5.48% of the total cultivated area of the Municipal Districts, while fallow land accounts for 2.67%. Outdoor and greenhouse vegetables occupy only 0.11% of the total cultivated area.

Between the Municipal Districts, some variation is observed in the relative proportion of each crop type, reflecting differences in economic significance for the local population. Nevertheless, in all districts, olive cultivation remains dominant, with a minimum participation rate of 77.99% (recorded in M.D. Militsa).

**Πίνακας 8.18: Έκταση καλλιεργούμενων εκτάσεων στην περιοχή μελέτης**

| No | Municipal District | Arable Land (stremmas) | Pastures (stremmas) | RES Areas (stremmas) | Fallow Land (stremmas) | Olive Groves (stremmas) | Other Tree Crops (stremmas) | Outdoor Vegetables (stremmas) | Greenhouse Vegetables (stremmas) | Table Vineyards (stremmas) | Wine Vineyards (stremmas) | Raisins (stremmas) | Total (stremmas) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Mnilitsa | 328.00 | 396.00 | 4.00 | 192.60 | 4,684.20 | 38.00 | 0.00 | 0.00 | 14.20 | 119.90 | 229.00 | **6,005.90** |
| 2 | Methoni | 455.20 | 9.10 | 0.00 | 161.90 | 5,638.90 | 5.00 | 5.00 | 18.00 | 0.00 | 12.40 | 215.40 | **6,520.90** |
| 3 | Evangelismos | 782.80 | 7.00 | 2.60 | 204.30 | 8,275.60 | 7.10 | 3.20 | 7.60 | 0.00 | 33.70 | 457.90 | **9,781.80** |
| 4 | Lachanada | 0.00 | 0.00 | 0.00 | 0.00 | 2,397.40 | 0.00 | 0.00 | 0.00 | 0.00 | 6.70 | 32.20 | **2,436.30** |
| 5 | Finiki | 130.50 | 0.00 | 0.00 | 143.40 | 2,403.60 | 0.00 | 2.50 | 0.00 | 0.00 | 6.80 | 3.40 | **2,690.20** |
| 6 | Finikounta | 61.10 | 0.00 | 0.00 | 41.20 | 2,053.80 | 1.00 | 2.30 | 2.70 | 0.00 | 9.30 | 96.00 | **2,267.40** |
| 7 | Kallithea | 845.30 | 40.00 | 0.00 | 487.10 | 11,122.50 | 2.50 | 1.70 | 0.00 | 231.00 | 0.00 | 961.00 | **13,691.10** |
| 8 | Pidasos | 11.60 | 0.00 | 0.00 | 19.40 | 3,413.70 | 0.00 | 2.20 | 0.00 | 0.00 | 80.30 | 193.50 | **3,720.70** |
| 9 | Chomatadas | 174.40 | 0.00 | 0.00 | 107.50 | 2,981.80 | 0.00 | 7.00 | 2.50 | 8.10 | 120.20 | 409.20 | **3,810.70** |
| **Total Study Area** | **2,788.90** | **452.10** | **6.60** | **1,357.40** | **42,971.50** | **53.60** | **23.90** | **30.80** | **253.30** | **389.30** | **2,597.60** | **50,925.00** | |

**Πίνακας 8.19: Ποσοστιαία αναλογία καλλιεργούμενων εκτάσεων**

| No | Municipal District | Arable Land | Pastures | RES Areas | Fallow Land | Olive Groves | Other Tree Crops | Outdoor Vegetables | Greenhouse Vegetables | Table Vineyards | Wine Vineyards | Raisins | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Mnilitsa | 5.46% | 6.59% | 0.07% | 3.21% | 77.99% | 0.63% | 0.00% | 0.00% | 0.24% | 2.00% | 3.81% | **100.00%** |
| 2 | Methoni | 6.98% | 0.14% | 0.00% | 2.48% | 86.47% | 0.08% | 0.08% | 0.28% | 0.00% | 0.19% | 3.30% | **100.00%** |
| 3 | Evangelismos | 8.00% | 0.07% | 0.03% | 2.09% | 84.60% | 0.07% | 0.03% | 0.08% | 0.00% | 0.34% | 4.68% | **100.00%** |
| 4 | Lachanada | 0.00% | 0.00% | 0.00% | 0.00% | 98.40% | 0.00% | 0.00% | 0.00% | 0.00% | 0.28% | 1.32% | **100.00%** |
| 5 | Finiki | 4.85% | 0.00% | 0.00% | 5.33% | 89.35% | 0.00% | 0.09% | 0.00% | 0.00% | 0.25% | 0.13% | **100.00%** |
| 6 | Finikounta | 2.69% | 0.00% | 0.00% | 1.82% | 90.58% | 0.04% | 0.10% | 0.12% | 0.00% | 0.41% | 4.23% | **100.00%** |
| 7 | Kallithea | 6.17% | 0.29% | 0.00% | 3.56% | 81.24% | 0.02% | 0.01% | 0.00% | 1.69% | 0.00% | 7.02% | **100.00%** |
| 8 | Pidasos | 0.31% | 0.00% | 0.00% | 0.52% | 91.75% | 0.00% | 0.06% | 0.00% | 0.00% | 2.16% | 5.20% | **100.00%** |
| 9 | Chomatadas | 4.58% | 0.00% | 0.00% | 2.82% | 78.25% | 0.00% | 0.18% | 0.07% | 0.21% | 3.15% | 10.74% | **100.00%** |
| **Total Study Area** | **5.48%** | **0.89%** | **0.01%** | **2.67%** | **84.38%** | **0.11%** | **0.05%** | **0.06%** | **0.50%** | **0.76%** | **5.10%** | **100.00%** | |

As mentioned, the data referred to in the previous paragraph concern the total cultivated area for the year 2014, according to the information provided by OPEKEPE.

The data to be used for the preparation of the initial Development Plan are as follows:

**Table 8.20: Crop Areas within the Project Perimeter**

| No | Crop Type | Project Perimeter (stremmas) |
|---|---|---|
| 1 | Arable Crops | 1,839.7 |
| 2 | Pastures | 349.2 |
| 3 | Fallow Land | 942.4 |
| 4 | Olive Trees for Oil Production (Irrigated) | 1,576.7 |
| 5 | Olive Trees for Oil Production (Rainfed) | 26,805.2 |
| 6 | Table Olives (Irrigated) | 59.0 |
| 7 | Table Olives (Rainfed) | 590.0 |
| 8 | Other Tree Crops | 38.0 |
| 9 | Outdoor Vegetables | 14.9 |
| 10 | Greenhouse Vegetables | 10.1 |
| 11 | Vineyards (Table Grapes) | 17.6 |
| 12 | Vineyards (Wine Grapes) | 388.6 |
| 13 | Raisins | 1,968.6 |
| 14 | Fallow Land (Repeated Entry) | 400.0 |
| **Total** | | **35,000.0** |

#### 8.7.2.2.2. Animal Production

In the study area, the livestock population is very limited. The main sector concerns the breeding of sheep and goats, which accounts for **91.93%** of total livestock. The production yields are quite low.

The type and number of animals raised in the study area, according to data from OPEKEPE for the year **2014**, are presented in the table below.

Based on these data, it is evident that within the entire study area, the **main form of livestock farming is sheep and goat breeding**, which in its various forms represents **63.08%** of the total livestock units (LU). The **cattle sector** holds a **secondary importance**, accounting for **34.75%** of the LU.

Within the project perimeter, there is **no organized form of livestock farming**, and the existing animals are raised **nomadically**.

After the construction and operation of the irrigation network, **no increase is expected** in either the number or the size of livestock farms within the project area.

**Table 8.21: Livestock Population Raised in the Study Area**

| Municipal District | Sheep & Goats (Number) | Sheep & Goats (LU) | Cattle (Number) | Cattle (LU) | Equines (Number) | Equines (LU) | Beehives (No.) |
|---|---|---|---|---|---|---|---|
| Evangelismos | – | – | 9 | 9 | – | – | 1,186 |
| Kallithea | 275 | 41.25 | – | – | – | – | – |
| Lachanada | – | – | – | – | – | – | – |
| Methoni | 979 | 146.85 | 33 | 33 | 1 | 1 | – |
| Mnlitsa | 275 | 41.25 | 87 | 87 | – | – | 350 |
| Pidasos | 32 | 4.80 | 7 | 7 | – | – | – |
| Foiniki | – | – | – | – | – | – | – |
| Foinikounta | – | – | – | – | – | – | – |
| Chomatada | – | – | – | – | – | – | – |
| **Total** | **1,561** | **234.15** | **129** | **129** | **8** | **8** | **1,536** |

### 8.7.3. Employment – Unemployment

The data used in the analysis of economic parameters include assumptions regarding the size of other animal species, which mainly concern household-level farming operations and have no significant contribution to the local economy.

The employment data for the study area are presented in the following tables. These figures refer exclusively to the areas belonging to the Municipality of Pylos–Nestor, as it is estimated that these specific areas will benefit the most from the construction of the project and will be directly affected by its operation.

Within the individual municipal districts, there are substantial variations, which can be explained both by the composition of the population and by the level of development of tourism activities in each area. The shift toward modern agricultural practices, which has increased mechanization and consequently reduced the demand for manual labor, may—and certainly does—affect employment levels, particularly in regions with a high degree of dependence on agriculture, such as the study area.

From the analysis of the available data, it is observed that the Economically Active Population (EAP) in the entire study area between 1991 and 2001 increased only slightly compared to the growth observed in the Regional Unit and the country as a whole. Within the individual districts, Methoni, Lachanada, and Foinikounta show an increase in the total EAP, while a decrease is recorded in the remaining districts.
This finding highlights the need to support the area through developmental initiatives that will strengthen and attract new ideas and capital so that the region's growth potential can be used as a tool for continuous progress and the attraction of economically active individuals.

Specifically, in 2001, the Economically Active Population in the study area amounted to 1,601 individuals, compared to 71,625 individuals in the Regional Unit as a whole, representing 2.23% of the total for the Prefecture.

Compared to 1991, a slight upward trend of 10 individuals or 0.62 percentage points was observed. Additionally, in 1991 and 2001, the Economically Inactive Population of the study area represented 2.03% and 2.01%, respectively, of the total economically inactive population of the Regional Unit of Messenia.

It is also noteworthy that the unemployment rates—although small in absolute numbers (ranging between 9 and 19 individuals)—showed a significant percentage increase, reaching levels between 20% and 95%, reflecting the vulnerability of employment structures in small rural economies.

**Table 8.22: Economically Active Population in 2001 and 1991**

| Description | Total 1991 | | | | | Total 2001 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Economically Active | | | | Economically Inactive | Economically Active | | | | Economically Inactive |
| | Total | Employed | Unemployed | | | Total | Employed | Unemployed | | |
| | | | Total | Of which "young" | | | | Total | Of which "young" | |
| **Greece** | **3,886,157** | **3,571,957** | **314,200** | **168,416** | **5,048,005** | **4,621,848** | **4,108,083** | **513,765** | **247,155** | **5,265,889** |
| **Messinia** | **63,817** | **59,072** | **4,745** | **2,637** | **83,277** | **71,625** | **64,283** | **7,387** | **4,246** | **89,075** |
| **Study Area** | **1,591** | **1,547** | **44** | **31** | **1,688** | **1,601** | **1,428** | **119** | **59** | **1,793** |
| Municipal District of Methoni | 423 | 402 | 21 | 16 | 621 | 553 | 505 | 48 | 26 | 594 |
| Municipal District of Evangelismos | 207 | 205 | 2 | 1 | 234 | 163 | 155 | 8 | 3 | 204 |
| Municipal District of Lachanada | 52 | 50 | 2 | 1 | 88 | 66 | 61 | 5 | 3 | 86 |
| Municipal District of Finiki | 46 | 44 | 2 | 2 | 53 | 40 | 40 | 0 | 0 | 59 |
| Municipal District of Foinikounta | 304 | 302 | 2 | 1 | 260 | 313 | 294 | 19 | 15 | 270 |
| Municipal District of Kalithea | 334 | 327 | 7 | 5 | 223 | 263 | 252 | 11 | 2 | 340 |
| Municipal District of Pidasos | 73 | 66 | 7 | 4 | 97 | 51 | 42 | 9 | 7 | 91 |
| Municipal District of Chomatadas | 152 | 151 | 1 | 1 | 112 | 152 | 133 | 19 | 3 | 149 |

**Table 8.23: Changes in the Economically Active Population between 2001 and 1991**

| Description | Difference 2001 - 1991 | | | | | % Change 2001 - 1991 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Economically Active | | | | Economically Inactive | Economically Active | | | | Economically Inactive |
| | Total | Employed | Unemployed | | | Total | Employed | Unemployed | | |
| | | | Total | Of which "young" | | | | Total | Of which "young" | |
| **Greece** | 735,691 | 536,126 | 199,565 | 78,739 | 217,884 | 15.92% | 13.05% | 38.84% | 31.86% | 4.14% |
| **Messinia** | 7,808 | 5,166 | 2,642 | 1,609 | 5,798 | 10.90% | 8.04% | 35.77% | 37.89% | 6.51% |
| **Study Area** | 10 | -65 | 75 | 28 | 105 | 0.62% | -4.39% | 63.03% | 47.46% | 5.86% |
| Municipal District of Methoni | 130 | 103 | 27 | 10 | -27 | 23.51% | 20.40% | 56.25% | 38.46% | -4.55% |
| Municipal District of Evangelismos | -44 | -50 | 6 | 2 | -30 | -26.99% | -32.26% | 75.00% | 66.67% | -14.71% |
| Municipal District of Lachanada | 14 | 11 | 3 | 2 | -2 | 21.21% | 18.03% | 60.00% | 66.67% | -2.33% |
| Municipal District of Finiki | -6 | -4 | -2 | -2 | 6 | -15.00% | -10.00% | 0.00% | 0.00% | 10.17% |
| Municipal District of Foinikounta | 9 | -8 | 17 | 14 | 10 | 2.88% | -2.72% | 89.47% | 93.33% | 3.70% |
| Municipal District of Kalithea | -71 | -75 | 4 | -3 | 117 | -27.00% | -29.76% | 36.36% | -150.00% | 34.41% |
| Municipal District of Pidasos | -22 | -24 | 2 | 3 | -6 | -43.14% | -57.14% | 22.22% | 42.86% | -6.59% |
| Municipal District of Chomatadas | 0 | -18 | 18 | 2 | 37 | 0.00% | -13.53% | 94.74% | 66.67% | 24.83% |

The distribution of the agricultural population by gender, age, number of full working days, and Agricultural Holding Units (A.E.M.) within the study area is presented in the following table.

**Table 8.24: Distribution of the Agricultural Population within the Project Perimeter**

| Gender | Age Group | Number of Individuals | Days of Outdoor Work | Conversion Coefficient | Equivalent Full Days | Full Daily Work Units (FDWU) | Full Annual Work Units (FAWU) |
|---|---|---|---|---|---|---|---|
| Men | 15–17 | 45 | 250 | 0.5 | 125 | 23 | 5,625 |
| Men | 18–64 | 727 | 250 | 1.0 | 250 | 727 | 181,750 |
| Men | 65–79 | 253 | 250 | 0.5 | 125 | 127 | 31,625 |
| Women | 15–17 | 35 | 250 | 0.3 | 75 | 11 | 2,625 |
| Women | 18–64 | 596 | 250 | 0.6 | 150 | 358 | 89,400 |
| Women | 65–79 | 260 | 250 | 0.3 | 75 | 78 | 19,500 |
| **Total** | | **1,916** | **250** | | | **1,322** | **330,525** |

From the data presented in the above table, it is evident that within the study area there are 330,525 Full Annual Work Units (FAWU) and 1,322 Full Daily Work Units (FDWU) available from the local population.

The following table presents the monthly and seasonal distribution of the available labor force, revealing an almost uniform distribution throughout all months of the year.

In the calculations, the participation of the agricultural population in employment has been taken into account. However, for the sake of simplification, possible agricultural work performed by professionals of other sectors and their families has not been included. Similarly, residents of municipal districts who live outside the study area but commute to work within it—either on their own farmland or as laborers—have not been considered, as such an estimation would not be precise with the available data.
The study area constitutes a subsection of a broader region, where there is the potential for labor mobility toward agricultural holdings, involving workers who travel to the project area solely for employment purposes.

Due to the seasonality and type of crops cultivated, as well as the need for timely implementation of agricultural activities, non-resident seasonal workers are often employed, and consequently, they have not been included in the current calculations.

**Table 8.25: Distribution of Workdays per Month and Season**

| No. | Month | Working Days | Share (%) | Full Workdays | Season | Full Workdays | Share (%) |
|---|---|---|---|---|---|---|---|
| **1** | December | 20 | 8.00% | 26,440 | Winter | 76,676.00 | 23.20% |
| **2** | January | 20 | 8.00% | 26,440 | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **3** | February | 18 | 7.20% | 23,796 | | | |
| **4** | March | 21 | 8.40% | 27,762 | Spring | 83,286.00 | 25.20% |
| **5** | April | 20 | 8.00% | 26,440 | | | |
| **6** | May | 22 | 8.80% | 29,084 | | | |
| **7** | June | 22 | 8.80% | 29,084 | Summer | 87,252.00 | 26.40% |
| **8** | July | 22 | 8.80% | 29,084 | | | |
| **9** | August | 22 | 8.80% | 29,084 | | | |
| **10** | September | 22 | 8.80% | 29,084 | Autumn | 83,286.00 | 25.20% |
| **11** | October | 21 | 8.40% | 27,762 | | | |
| **12** | November | 20 | 8.00% | 26,440 | | | |
| **Total** | | **250** | **100** | **330,500** | **Total** | **330,500.00** | **100.00%** |

### 8.7.4. Per Capita Income (GDP) Based on ELSTAT Indicators

Based on the available data from ELSTAT, presented in the following table and referring to regions and prefectures, the following observations can be made:

At the regional level, the Peloponnese shows

- a steady increase in per capita GDP from €10,889 thousand in 2000 to €17,224 thousand in 2008,
- followed by a steady decline reaching €13,134 in 2014, during the economic crisis period.

This trend in GDP evolution mirrors that of the national economy, as well as other regions with a similar economic structure, such as Western Greece and Thessaly.

At the prefectural level, the Prefecture of Messinia exhibits

- a steady increase in per capita GDP from €9,198 thousand in 2000 to €15,480 thousand in 2008,
- followed by a similar decline, reaching €12,155 in 2014, which corresponds approximately to the levels of 2005.

This profile of GDP evolution is consistent with that observed in the other prefectures of the Peloponnese Region. Furthermore, it is noted that from 2006 onwards, Messinia surpassed the Prefecture of Laconia in per capita GDP.

**Table 8.26: Per Capita Gross Domestic Product by Region and Prefecture**

*(in euros, current prices — Hellenic Statistical Authority, updated 17/01/2017)*

| Region / Prefecture | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011* | 2012* | 2013* | 2014* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Greece** | 13,071 | 14,011 | 14,994 | 16,371 | 17,683 | 18,734 | 19,760 | 21,061 | 21,845 | 21,386 | 20,324 | 18,643 | 17,311 | 16,475 | 16,336 |
| **Attica** | 16,514 | 17,701 | 19,310 | 21,032 | 23,026 | 23,694 | 24,223 | 26,011 | 29,215 | 28,091 | 25,652 | 23,530 | 22,540 | 22,062 | 22,377 |
| **Aegean Islands & Crete** | 13,537 | 14,795 | 15,686 | 16,453 | 17,562 | 18,479 | 19,183 | 20,513 | 19,521 | 19,362 | 18,367 | 16,362 | 15,117 | 14,705 | 14,814 |
| **Northern Greece** | 10,619 | 11,408 | 12,068 | 13,055 | 13,957 | 14,139 | 15,162 | 16,211 | 16,743 | 16,398 | 15,616 | 14,422 | 14,034 | 12,603 | 12,460 |
| Eastern Macedonia & Thrace | 10,075 | 10,701 | 11,316 | 12,176 | 12,772 | 13,142 | 13,535 | 14,741 | 15,568 | 15,272 | 15,057 | 13,320 | 13,403 | 11,498 | 11,366 |
| Central Macedonia | 10,797 | 11,624 | 12,170 | 13,229 | 14,229 | 14,626 | 15,509 | 16,374 | 17,437 | 16,913 | 15,776 | 14,600 | 13,458 | 12,669 | 12,524 |
| Western Macedonia | 11,320 | 11,680 | 12,590 | 13,746 | 14,576 | 15,159 | 16,037 | 17,362 | 17,437 | 16,913 | 15,776 | 14,600 | 13,458 | 12,669 | 12,524 |
| Epirus | 10,427 | 10,864 | 11,581 | 12,578 | 12,919 | 13,171 | 13,594 | 14,619 | 14,960 | 14,540 | 14,230 | 13,122 | 11,612 | 11,662 | 11,606 |
| Thessaly | 10,085 | 10,884 | 11,660 | 13,010 | 13,793 | 13,953 | 14,563 | 15,704 | 16,363 | 15,831 | 14,499 | 13,328 | 12,796 | 12,246 | 12,237 |
| Ionian Islands | 9,754 | 10,459 | 11,350 | 12,321 | 12,870 | 13,253 | 13,949 | 14,890 | 15,731 | 15,150 | 13,936 | 12,606 | 12,014 | 11,746 | 11,342 |
| Western Greece | 9,743 | 10,496 | 11,563 | 12,543 | 13,198 | 13,882 | 14,652 | 15,603 | 15,822 | 15,083 | 14,163 | 13,430 | 13,060 | 12,716 | 12,414 |
| Central Greece | 13,954 | 14,894 | 15,978 | 17,197 | 18,269 | 18,823 | 19,593 | 20,919 | 19,552 | 18,631 | 17,663 | 15,810 | 15,384 | 13,874 | 13,514 |
| **Peloponnese (Region)** | 10,889 | 11,687 | 12,322 | 13,198 | 14,281 | 15,588 | 16,715 | 16,862 | 16,009 | 14,942 | 14,066 | 13,390 | 13,134 | | |
| Argolis | 11,558 | 12,592 | 13,871 | 14,635 | 14,994 | 16,661 | 19,187 | 19,787 | 19,309 | 18,310 | 16,440 | 15,097 | 14,574 | 14,656 | |
| Arcadia | 11,376 | 12,482 | 12,990 | 13,711 | 14,482 | 15,615 | 16,978 | 18,382 | 18,805 | 17,543 | 15,843 | 14,770 | 13,291 | 12,270 | |
| Corinthia | 12,213 | 12,900 | 13,994 | 14,275 | 14,618 | 15,879 | 16,980 | 18,011 | 18,805 | 17,543 | 15,843 | 14,770 | 13,291 | 12,270 | |
| Laconia | 9,751 | 10,462 | 11,676 | 13,021 | 13,671 | 13,961 | 14,930 | 15,125 | 15,158 | 14,183 | 13,118 | 12,078 | 11,375 | 11,996 | |
| **Messinia** | 9,198 | 9,926 | 10,354 | 11,165 | 11,808 | 12,696 | 14,008 | 15,107 | 15,480 | 15,182 | 14,652 | 13,771 | 13,037 | 11,971 | 12,155 |

**Source:** Hellenic Statistical Authority (ELSTAT), *Gross Domestic Product at Current Prices — Regional Data*.

**Note:** Temporary data. The population used for the calculation refers to June 30 of each year, estimated based on the 2011 census.

## 8.8 Technical Infrastructure

### 8.8.1 Land, Marine and Air Transport Infrastructure

The study area is relatively isolated and located at a considerable distance from the main transportation axes, highways, and railway lines — the latter being currently inactive throughout the Peloponnese network.
The Tripoli–Kalamata Motorway is situated approximately **60 km** away (distance between Methoni and Messini), while the **Kalamata International Airport** lies at a similar distance.

The main road network of the area is classified according to the provisions of the Presidential Decree of 6/2/1956 (Government Gazette 47/A/8-2-56), as amended by Decision DMEO/ε/O/266/95 (Government Gazette 293/B/17-4-95), and consists of the following:

- Section of National Road EO 9 (Pyrgos – Methoni) — classified as a *secondary national road*.
- Section of National Road EO 82 (Sparti – Kalamata – Messini – Velika – Chatzi – Pylos) — also a *secondary national road*.
- Provincial Road No.13: *Methoni – Evangelismos – Finikous – Kaplani – Yameia – Akritochori – Falanthi – Petrades – Koroni — primary provincial road*.
- Provincial Road Pylos – Agios Andreas — *secondary provincial road*.
- Provincial Road Methoni – Falanthi — *secondary provincial road*.
- Local Road Chomatada – Evangelismos.
- Local Road Finiki – Exochiko.

In the wider area, there exists a dense network of rural roads — the majority of which are accessible — ensuring connectivity between settlements and agricultural plots.

### 8.8.2 Environmental Infrastructure Systems

#### 8.8.2.1 Solid Waste Management

The Regional Waste Management Plan (RWMP) of the Peloponnese Region is overseen by the Regional Association of Solid Waste Management Agencies (FODSA Peloponnese). The plan was initially developed in 2004, revised in 2010, and most recently updated in 2016. Specifically, the Joint Ministerial Decision 63935/30.12.2016 approved the Strategic Environmental Impact Assessment (SEIA) of the updated plan titled *"Regional Solid Waste Management Plan of the Peloponnese Region."*

This plan constitutes a revision of the original RWMP in line with the provisions of Directive 2008/98/EC on waste, Law 4042/2012 (Government Gazette 24/A/2012), as well as the National Waste Management Plan (NWMP) and the National Strategic Plan for Waste Prevention (NSPWP) approved under Cabinet Act 49/15-12-2015.

The RWMP covers the entire Peloponnese Region, including the Regional Units of Corinthia, Argolis, Arcadia, Laconia, and Messinia.

For planning purposes, the entire Region is considered as one Integrated Management Unit. The plan establishes a comprehensive framework for the management of all waste generated within the region, consistent with Law 4042/2012 and the national strategies. It defines the general principles of waste management and promotes, in a hierarchical and integrated manner:

- Waste generation prevention,
- Preparation for reuse,
- Recycling,
- Other recovery processes (including energy recovery), and
- Safe final disposal at regional level.

It also includes a Waste Prevention Plan component.
According to the RWMP, the Region is divided into three Management Units, each implementing integrated waste management measures.
The Regional Unit of Messinia belongs to the 2nd Management Unit, together with the Municipalities of Megalopoli and Gortynia (Arcadia).
To achieve the plan's objectives, significant technical infrastructure development is required, including:

- Gradual closure and restoration of all uncontrolled waste disposal sites (landfills),
- Establishment of one Sanitary Landfill for Residual Waste (SLRW), and
- Construction of three Waste Transfer Stations (WTS) located in Pylos–Nestor, Kalamata, and Gortynia.

Furthermore, targeted programs for source separation of packaging materials and organic waste, along with a network of Green Points for recyclable materials and special waste, are being implemented.
The three former uncontrolled landfills (ΧΑΔΑ) of the Municipality of Pylos–Nestor are scheduled for environmental restoration under the responsibility of the Peloponnese Regional Authority.

The municipality also participates in the Unified Association for Solid Waste Management of Messinia (FODSA), which oversees the integrated waste management system of the Regional Unit.
Currently, waste collection and transport are carried out by municipal services using refuse trucks, which transfer waste to the Agios Nikolaos area (Municipal Unit of Pylos), where a baling unit is in operation.

#### 8.8.2.2 Wastewater Collection and Treatment

The Municipality of Pylos–Nestor operates two Wastewater Treatment Plants (WWTPs) since mid-2009:

- WWTP Pylos, with a capacity of 14,000 population equivalents (PE), and
- WWTP Methoni, with a capacity of 7,500 PE.

Only the three largest settlements — Pylos, Methoni, and Finikounda — are equipped with sewage networks that feed into these WWTPs.
Sewage from these towns is conveyed through dedicated pipelines to the treatment facilities. The layout plans AP-2 of this study illustrate the route of the existing sewer collector (KAA) from Finikounda to Methoni, as well as the designed but not yet constructed collector sewers serving Finiki, Kamaria, and Evangelismos.
The towns of Koroni, Chora, and the local communities of Mesochori, Vasilitsi, and Chrysochoriaria have combined (mixed) sewer systems, while all other settlements rely on sealed cesspits.
In particular, the Municipal Unit of Methoni has an organized sewer network covering approximately 60% of Methoni and 80% of Finikounda.
The remaining areas, as well as all smaller settlements, use sealed septic tanks.
The internal sewer network of Methoni extends over 6.7 km, serving the two main roads, the coastal zone, and several peripheral streets adjacent to the central area.

### 8.8.3 Water Supply – Sources and Networks

#### 8.8.3.1 Water Sources

According to the Geological Study (Plan GM-1), several water points have been recorded in the southern part of the catchment area.
In the northern part, water points coded HYD-P3 to HYD-P6 have been identified — all of which correspond to natural springs.

Specifically, HYD-P3 is a high-yield spring, and together with sources HYD-P4, HYD-P5, and HYD-P6, forms a continuous spring front through which the main volume of the conglomerate aquifer discharges.
HYD-P4: Kato Ampelokipoi Springs

These are high-discharge springs located at the contact zone between conglomerates and Pleistocene deposits. The conglomerate formations are clearly visible on the existing slopes. Historically, these springs supplied water to the settlements of Kallithea, Arapolaka, Chomatada, Perivolaki, Pidasos, Kynigos, and others.
HYD-P5:
A low-discharge spring emerging from conglomerates with a sandy (psammitic) cementing matrix.
HYD-P6:
A minor spring that appears within the materials of the loose surface cover, with no conglomerate formations identified.

Its location to the west of the alignment of HYD-P4 and HYD-P5 indicates that it is fed by the same hydrogeological mechanism, extending westward as part of the same spring front.

**Central Part of the Catchment Area**

In the central section of the catchment, the HYD-B1 borehole was recorded. This borehole serves as the main water supply source for the settlements of Kallithea, Ampelakia, Chomatada, and surrounding areas.
According to verbal information (coded GM-18 / IGME), the borehole depth is estimated between 80 and 100 meters.
At the excavation slopes of the access road leading to the borehole site, tilted flysch formations are observed, along with scattered conglomerate boulders.
It is also reported that approximately 10 to 15 meters lower, there exists a secondary low-discharge spring that is not currently captured or utilized.

Southern Part of the Catchment Area
In the southern section of the catchment, the following hydrological points have been identified:
HYD-P1: Vlassis Mill Springs (Lachanada Springs)

These are high-yield springs, located at an elevation of +99.60 meters, emerging from conglomerates with a psammitic cementing matrix.

According to verbal data from the Municipal Authority of Pylos–Methoni, the spring discharge, based on a 1965 hydrological study, is approximately 490 $m^3$/hour in July and 691 $m^3$/hour in May.

The spring is used both for domestic water supply of the settlement of Lachanada and for irrigation purposes.
HYD-P2: Pumping Station Site

This facility draws water from nearby natural springs and is used to supply the settlements of Vlassaika and Militsa.

The stream at which the pumping station is constructed is known as Kryovrysi (or Kryorema).
Large conglomerate boulders are exposed along both the excavation slopes and the natural slopes of the stream banks.
HYD-B2: Private Borehole

A very low-discharge borehole, reportedly drilled within Pliocene deposits, according to verbal accounts.
It should be noted that HYD-P1 and HYD-P2 are located within the inundation zone of the Minagiotiko Dam reservoir, as shown in Plan GM-1.

#### 8.8.3.2 Water Supply

In most settlements, water supply is provided through natural springs and boreholes. Although the quality of water is generally good, the Municipality has undertaken specific efforts both to optimize the operation of the network by reducing losses and to promote the

rational use of potable water — limiting its use for irrigation — while also ensuring the coverage of the increased seasonal demand in the coastal zone (mainly Methoni–Finikounda) during the tourist season.
Efforts are being made both at the management level and through network and source interconnections between the former municipalities (now Municipal Units), as well as by increasing available water quantities through new boreholes, particularly in the Kato Ampelokipoi area.
Detailed information for the Municipal Units whose territories are included in the study area is presented below.

**Water Supply of the Municipal Unit of Methoni**

The water supply conditions in the settlements of the Municipal Unit of Methoni are generally satisfactory.

All settlements are equipped with water supply networks, which are primarily fed by springs and boreholes. The distribution network extends throughout the entire Municipal Unit, while additional boreholes have been drilled to serve some remote settlements.
In certain cases, especially for isolated residences outside settlement boundaries, private boreholes have been constructed to fully meet domestic water needs.
The Methoni water supply network includes approximately 3,000 water meters, and the total length of pipelines exceeds 200,000 meters.
Water is supplied from twelve (12) boreholes located within the local communities of the Municipal Unit, as well as from springs situated in:

- the Local Community of Ampelokipoi, which supplies part of Methoni and the settlements of Evangelismos, Kamaria, and Finiki, and
- the Local Community of Lachanada, which supplies the settlements of Lachanada and Finikounda.

The existing water supply network within the project area is shown in Plans AP-1 and AP-2 of the present study.
Within the project area, particularly at the dam and reservoir site, the water intake system serving the settlements of Lachanada and Finikounda is located, consisting of springs and a water collection tank.

According to data from the Municipality of Methoni and the Technical Report of TYDK Messinia (1967),
"…the community purchased the water rights of the Vlassis Mill Spring…".
These installations were developed over an area of approximately 2.5 stremmas (0.25 hectares), which was also purchased by the Community of Lachanada.
According to the same technical report, the spring discharge was measured at 590 $m^3$ per 24 hours (approximately 25 $m^3$/hour).
Based on more recent municipal information, improvement works carried out in 1985 enhanced the spring tapping infrastructure, and the current discharge reaches 50–55 cubic meters per hour, covering approximately 50% of the water demand of the Finikounda settlement.

These springs and facilities are located within the territory of the Municipality of Messini, are listed under section 8.8.3.1 – Water Sources, and contribute a critical volume to the network, particularly important during the summer period.

A portion of this water is directed through overflow to an irrigation storage tank, while the secondary overflow from that tank also supplies the settlement of Finikounda.
The locations of these installations are indicated in Plans GM-1, GO-4, and in the Photographs F.4 included in this study.
Since these springs and water supply installations will be located within the inundation area of the Minagiotiko Dam reservoir, they will need to be replaced by a new water source and corresponding water supply infrastructure.
Water Supply of the Municipal Unit of Pylos
The Pylos Water and Sewerage Company (DEYAP) is responsible for the water supply of the Municipal Unit of Pylos.

The water distributed through the DEYAP network originates primarily from natural springs and boreholes. During peak demand periods, the system is reinforced by five additional boreholes.
The network serves approximately 5,500 customers, with a total pipeline length of about 145,000 meters.

The water quality is suitable for drinking purposes and is regularly monitored by DEYAP. The annual water volume supplied to consumers reaches approximately 450,000 cubic meters.
The DEYAP network comprises two main distribution systems:

1. One extending from the Koube–Chandrino springs to Pylos, and
2. Another extending from the Ampelokipoi springs to the Local Community of Mesochori.

The physicochemical and microbiological quality of the spring and borehole water supplying the network is excellent.
The water is of moderate hardness, with low concentrations of undesirable substances such as nitrates, nitrites, ammonia, and heavy metals, all well below regulatory limits, and with very good microbiological quality.
For preventive purposes, continuous chlorination is applied both at the boreholes and storage tanks, ensuring that the distributed water remains free from microbiological contamination.
In addition to routine residual chlorine checks carried out by DEYAP’s technical staff, regular microbiological and chemical analyses are also conducted by an accredited laboratory.
The upgrading of the DEYAP water supply system includes major infrastructure works, such as the expansion of the external water network of Pylos and the replacement of internal networks within local communities.

These projects are integrated into the Operational Program of the NSRF (ESPA). Specifically, studies have been completed for the replacement of the water pipeline from Ampelokipoi to Kynigos, Mesochori, and Perivolakia.

Currently, construction works are in progress for the replacement of the internal water distribution network in the Local Community of Kallithea.

Water Supply of the Militsa Community (Municipality of Messini)
Within the project area, particularly at the location of the dam and reservoir construction, there are also territories belonging to the Municipality of Messini and the Community of Militsa.
As mentioned in Section 8.8.3.1 (Water Sources), several springs and installations are located in these areas, supplying the water system of Militsa and nearby settlements.
These installations fall under the jurisdiction of DEYA Messinis (Messini Water and Sewerage Company) and contribute to the network with a flow rate of approximately 10 cubic meters per hour, a critical quantity especially during the summer period.
The installations are depicted in Plans GM-1 and GO-4, as well as in Photographs F.5 and F.6 of this study.
A few meters downstream from the water supply facilities, there is an agricultural-use storage tank, which is fed by the overflow from the water supply installations.
Since these springs and facilities will be located within the inundation area of the reservoir, they will need to be replaced by a new water source and corresponding infrastructure.
As part of the present study, the existing water supply infrastructure was examined to ensure that it would be taken into account during the planning phase of the proposed works.
The positions of the springs, pumping stations, and main water supply pipelines for the project sites are shown in Plans GO-1 to GO-8.

## 8.9. Human-Induced Pressures on the Environment

### 8.9.1 Existing Sources of Pollution and Other Environmental Pressures

#### 8.9.1.1 Data from the Water Management Plan for Water District 01

According to the **River Basin Management Plan (RBMP)**, the **addition of a surveillance monitoring station** for rivers (for water bodies not classified as “at risk”) was proposed under the **Water Body (WB) code GR0132R000500004N**, corresponding to the **Minagiotiko Stream**, as it is located within a **protected natural area (GR2550003)**.
This station was also included in the revised monitoring network proposed in the updated RBMP, where its status is listed as unknown.
Within the National Monitoring Network for the Status of Water Bodies, it is clarified that the identified station refers to the Methoni Bay water system, rather than the Minagiotiko stream.

In the context of the 1st Revision of the River Basin Management Plans (RBMPs) of Greece, carried out pursuant to Article 14(c) of the Water Framework Directive (2000/60/EC), the documentation for the Western Peloponnese River Basin District (EL01) does not make any reference to this particular station or to any other located within the study area. The relevant reference text and the map of the river monitoring stations are presented below.
Results for the Western Peloponnese Water District (EL01)
The Western Peloponnese River Basin District (RBD 01) includes 36 monitoring stations, of which 17 are surveillance stations and 19 are operational stations.

- The physicochemical quality for the period 2012–2014, based on concentrations of nutrients and dissolved oxygen, ranged from Poor to High. Approximately 70% of the stations in the RBD exhibited Good to High physicochemical quality.
  About 8% of the sampling stations showed quality levels ranging from Bad to Moderate (3POTAMO, KYPARISSIA, THOKNA), while 5% (MATESI, VLAXORARIS) consistently exhibited Moderate quality throughout all sampling seasons. An additional 8% of the stations showed quality variation between Poor and Good (APIDITSA, KARYTAINA, TZIROREMA).
- The biological quality, assessed through benthic macroinvertebrates during 2012–2014, ranged from Poor to High. Specifically, 37.5% of stations demonstrated Good to High quality (ANTHOXORI, ELISSON, FIGALIA, PELOPION, EPITALION, FOLOI, LADON_FRAGMA, LUSIOS_C, SPILIA, TRAGOS, DEH_3POTAMOS, LUSIOS_S). 6.25% (NEDON, ARIS) showed Poor to Moderate quality, while another 6.25% exhibited Moderate quality throughout all seasons. In 50% of the stations (THOKNA, TROPAIA, 3POTAMO, APIDITSA, ARIOXORI, ELIA, KALONERO, KARYTAINA, KYPARISSIA, LAGADIOTIKO, MESSINI, NEDA, OLYMPIA, PAMISSOS, TZIROREMA, AG_FLOROS, MAVRIA), the quality ranged between Poor and Good.
  One station (MATESI) was dry during the sampling periods.
- Regarding hydromorphological quality, based on the Hydromorphological Monitoring System (HMS), among the stations assessed in the Western Peloponnese RBD, 40% showed Good to High quality, while 60% were classified as Moderate or lower. More specifically:
  - 19% exhibited High hydromorphological quality (ELISSON, FOLOI, LADON_FRAGMA, MATESI, MAVRIA, TROPAIA),
  - 21% exhibited Good hydromorphological quality (ARIS, EPITALION, FIGALIA, KYPARISSIA, LUSIOS_S, PELOPION, VALYRA),
  - 36% exhibited Moderate hydromorphological quality (ANTHOXORI, ARIOXORI, ELIA, KALONERO, LAGADIOTIKO, LUSIOS_C, NEDA, OLYMPIA, TRAGOS, VELIKA, XIROKAMBOS),
  - 19% exhibited Poor hydromorphological quality (3POTAMO, DEH_3POTAMOS, MESSINI, SPILIA, THOKNA, TZIROREMA),
  - and 6% exhibited Bad hydromorphological quality (AG_FLOROS, PAMISSOS).

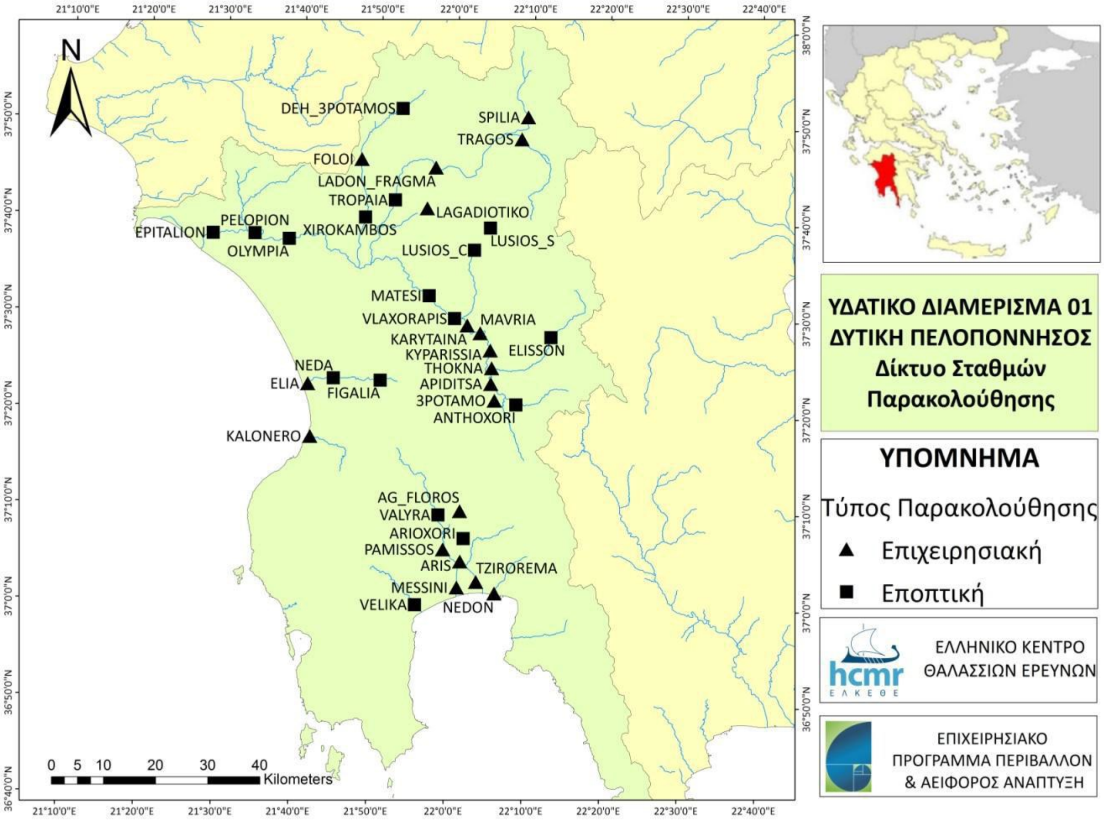



**Figure 8.25: Map of River Monitoring Stations in the Western Peloponnese River Basin District (01)**

**Status of Groundwater Systems for the Western Peloponnese RBD (EL01)**

According to the evaluation of the Methoni Groundwater Body (GWB), designated as GR0100120, the main issues regarding its quantitative and/or chemical status due to anthropogenic pressures are limited to localized impacts from agricultural activities. The overall status of this groundwater system is classified as Good.

Regarding groundwater abstraction and potential overexploitation, the average annual withdrawal for the Methoni system is estimated at $1.5 \times 10^6$ m³, and the quantitative status of the groundwater body is assessed as Good.

Furthermore, the Methoni Groundwater Body is not included among those groundwater systems identified as having significant pollution problems.

Assessment of Groundwater Quality Status

As part of the revision of the River Basin Management Plan (RBMP), each Groundwater Body (GWB) was assessed in terms of its chemical and quantitative status, as well as the existing trends related to pollution or declining groundwater levels due to overexploitation. For the Methoni GWB, the evaluation results are as follows:

| Parameter | Assessment |
|---|---|
| **Quantitative Status** | Good |
| **Chemical Status** | Good |

| | |
|---|---|
| **Trend in Water Level Decline** | No |
| **Trend in Pollutant Increase** | No |
| **Local Trace Element Exceedances** | Fe (Iron) |

Thus, both the quantitative and chemical conditions of the Methoni groundwater system are considered favorable, with no significant pressures or negative trends observed.

#### 8.9.1.2 Industrial Waste

Within the project area, no significant or specific pollution sources have been reported. However, due to the intensive agricultural activity, particularly olive cultivation, a number of small-scale olive mills operate in the area.

These units function under a defined licensing framework and approved Environmental Terms, and no pollution incidents related to their operation have been recorded.
According to data provided by the Directorate of Agricultural Economy and Veterinary Services (DAOK) of the Regional Unit of Messinia, there are nine olive mills within the project area, distributed as follows:

| Location | Number of Olive Mills |
|---|---|
| Kallithea | 4 |
| Finikounda | 2 |
| Pidasos | 1 |
| Chomatada | 1 |
| Militsa | 1 |
| | |

All facilities are small-scale, locally owned, and environmentally regulated according to national and regional environmental legislation.

#### 8.9.1.3 Liquid Waste – Solid Waste

As noted in Section 8.8.2, within the project area, the larger settlements are equipped with sewage collection and wastewater treatment systems, resulting in no recorded pollution events from urban wastewater discharges.

The smaller settlements, which lack organized sewer networks, represent low-density populations and do not exhibit pollution-related issues.
Regarding solid waste management, centralized collection and disposal are conducted by the respective Municipal Authorities.

No illegal dumping sites or significant sources of environmental degradation have been identified in the area.

### 8.9.2. Exploitation of Natural Resources

#### 8.9.2.1 Quarrying Zones

According to data provided by the Regional Unit of Messinia, the following designated quarrying areas have been officially established within the Prefecture.

**Table 8.27: Quarrying Zones of the Prefecture of Messinia**

| Location | Area (stremmas) | Government Gazette (FEK) |
|---|---|---|
| 1. Kokkinovrachos, Municipal Unit of Thouria, Municipality of Kalamata | 4,286 | 690B'/30-11-83, 231B'/22-4-88 |
| 2. Agkinara, Municipal Unit of Filiatra, Municipality of Trifylia | 484 | 690B'/30-11-83, 231B'/22-4-88 |
| 3. Tsouka, Municipal Unit of Gargalianoi, Municipality of Trifylia | 339 | 690B'/30-11-83 |
| 4. Kotronia, Municipal Unit of Thouria, Municipality of Kalamata | 578 | 80D'/6-3-2007 |
| 5. Prosilia, Municipal Unit of Thouria, Municipality of Kalamata | 283 | 80D'/6-3-2007 |

All the aforementioned quarrying zones are located at a considerable distance from the project site, making it impractical to use materials from them. No other suitable quarrying area exists in proximity to the project, and therefore, alternative locations were investigated as described in Section 6.4, since they are considered ancillary and supportive works to the main project.

#### 8.9.2.2 Agricultural Land

The wider reference area of this study primarily encompasses territories within the Municipality of Methoni, characterized by two main types of activities: agricultural and touristic. Tourism, at an extensive level, acts competitively against agriculture, as it continually seeks land for the development of new tourist facilities and residential structures. This constant demand exerts significant pressure on agricultural land, since it represents a profitable economic activity compared to farming.

This trend has been considered during the preparation of the Local Spatial and Urban Planning Framework (SCHOAP), where specific residential expansions have been designated. However, this planning effort appears insufficient to contain or redirect these pressures within designated settlement zones, as land development continues outside urban plans, primarily because the value of agricultural land per stremma—calculated based on agricultural yield—remains low.

It is expected that, by their very nature, the planned works will enhance agricultural productivity and increase agricultural income, thus reducing the pressure on farmland. As agricultural profitability improves, farmers will find renewed motivation to sustain agricultural activities, while land value will also rise, further discouraging land conversion to non-agricultural uses.

Within the former Municipality of Methoni, during the drafting of the SCHOAP, an area north of Methoni and near the settlement (but far from the project area) was designated as High Productivity Agricultural Land. Aside from this area, no other officially designated high-productivity zone has been identified within the project's vicinity.

Furthermore, due to the dominance of olive cultivation, which is practiced extensively rather than intensively, no strong environmental pressures have been recorded in the area.

#### 8.9.2.3 Irrigation

As previously discussed, the agricultural activity in the study area is mainly extensive in nature. Under current conditions, irrigation is limited, relying primarily on water extraction from private boreholes.

According to data provided by the Directorate of Agricultural Economy and Veterinary Services (DAOK) of Messinia, there are 89 declared boreholes in the wider area. The distribution of these boreholes among the municipal districts is presented in the following table.

**Table 8.28: Boreholes per Municipal District**

| Municipal District | Number of Boreholes |
|---|---|
| Evangelismos | 20 |
| Lachanada | 1 |
| Methoni | 27 |
| Foiniki | 8 |
| Foinikounta | 21 |
| Mnilitsa | 1 |
| Kalithea | 2 |
| Pidasos | 5 |
| Chomatada | 4 |
| **Total** | **89** |

The discharge rate of the boreholes is not uniform and varies depending on the specific area. The exploitable yields range between 5–40 $m^3$/hour, depending on the geological characteristics and the depth of the borehole.

In the study area, the dominant irrigation method is the use of localized drip irrigation systems, which are widespread due to their efficiency in water conservation and suitability for olive cultivation, the main agricultural activity in the region.

There have been no officially recorded incidents of over-extraction or degradation of available groundwater resources. However, localized tendencies of water quality decline may occur in certain areas, though such phenomena have not been systematically studied or documented to date.

## 8.10 Atmospheric Environment – Air Quality

In the wider study area, no polluting activities have been identified, and no significant sources of air pollutant emissions have been reported. The region is characterized by low industrial activity, limited vehicular traffic, and prevalent agricultural use, all of which contribute to maintaining good air quality conditions.

## 8.11 Acoustic Environment and Vibrations

Within both the immediate and the broader project area, no disturbing activities are present, and no significant sources of environmental noise or vibrations have been recorded. The region is predominantly rural, consisting of small settlements and agricultural landscapes, where the acoustic environment remains naturally quiet.
Specifically, at the dam construction site and at the proposed borrow pit locations, no residential areas or settlements are located nearby. The nearest settlement, Vlassaika, is situated at approximately 1,700 meters from the dam site. Similarly, the nearest residential areas from Borrow Pit L2 are about 1,500 meters away, while for Borrow Pit L1, the villages of Arapolakka, Kalithea, and Chomatada are at a safe distance of around 1,000 meters, depending on the precise placement of the pit on the hill.

## 8.12 Electromagnetic Fields

In the wider study area, no disturbing activities have been recorded, and no notable sources of electromagnetic radiation have been identified. The absence of large-scale power transmission infrastructure, industrial facilities, or communication towers near the project area ensures that electromagnetic field levels remain well below any threshold of environmental or public concern.

## 8.13 Waters

### 8.13.1 Management Plans

#### 8.13.1.1 Compatibility Check with the Water Management Plan Provisions

The data concerning the forecasts and evaluations of the Water Management Plan (WMP) are presented in Chapter 5.2.4 of this study.

The project under consideration is listed in the WMP as a planned development, and due to its positive environmental characteristics, it is considered fully compatible with the Water Management Plan of the River Basin District (RBD) 32.

The project contributes to the rational use and management of water resources, the improvement of irrigation efficiency, and the enhancement of agricultural productivity, in accordance with the objectives of the plan for the sustainable management of surface and groundwater bodies in the region.

#### 8.13.1.2 Compatibility Check with the Flood Risk Management Plan Provisions

The following information was obtained from the Preliminary Flood Risk Assessment Report for the Water District EL01 “Western Peloponnese”.

These plans identify areas that have historically experienced significant flood events, designated as Potentially High Flood Risk Zones.
The main hydrological basins of this district are:

- the Alfeios River Basin (GR29), and
- the Pamisos–Nedon–Neda Basins (GR32), as defined by Decision No. 706/16.07.2010 of the National Water Committee (Government Gazette 1383/B’/02.09.2010), as amended and currently in force. The total surface areas of these basins are 3,810 km² and 3,425 km², respectively.

The Alfeios River originates from the Arcadian plateaus, formed by three tributaries — the Upper Alfeios, Erymanthos, and Ladon Rivers — which merge in the semi-mountainous region of Ilia (Middle Alfeios) and flow into the Kyparissiakos Gulf (Lower Alfeios). The Alfeios is the largest river of the Peloponnese, with a natural length of 119.5 km (plus 7.5 km of diversion near Megalopolis), and the fifth longest river in Greece among those flowing entirely within national territory.
Within the Pamisos–Nedon–Neda basin, the main rivers are the Pamisos, Nedas, and Nedon, with Pamisos and Nedas maintaining perennial flow throughout the year, while Nedon is characterized as a seasonal (torrent-type) river.

- The Pamisos River is the largest river in Messenia, with a length of 44 km and a drainage basin of 568 km². It originates from the mountains of Upper Messenia and from the karstic springs of Agios Floros and Pidima, which discharge groundwater from Northern Taygetos, and flows southwards through the prefecture, emptying into the Messenian Gulf between Messini and Kalamata.
- The Neda River, 31 km long with a drainage basin of 278 km², springs from the Minthi, Lykaio, and Tetratio mountains, flows westwards, and discharges into the Ionian Sea between Kyparissia and Zacharo.
- The Nedon River, 22 km long with a drainage basin of 146 km², originates from Western Taygetos and flows into the Messenian Gulf near Kalamata.

In Water District EL01, there are also smaller watercourses, such as the Aris, Kalo Nero, Velika, Myloi, Selas, Kleisouraiiko, Filiatrino, Giannouzagas, Langouvardos, and Minagiotiko streams.
Within the Alfeios River Basin, the artificial lake of Ladon is located, with a reservoir surface area of 3.03 km² and a catchment area of 767 km².
In the Pamisos–Nedon–Neda basin, the Filiatrino artificial reservoir is found, with a catchment area of 27.30 km² and a water surface area of 0.5 km².

The Minagiotiko dam and irrigation network, the subject of this study, is therefore fully consistent with both the Water Management and Flood Risk Management Plans, as it contributes to:

- flood risk reduction through controlled water retention and storage,
- sustainable irrigation supply for agricultural development, and
- the balanced management of surface and groundwater resources in the western Peloponnese.

Historical Flood Data and Interpretation

Based on the analysis of historical flood events, the areas most affected by significant floods in the past include:

- the low-lying regions of the Neda River basin,
- the urban area of Kalamata,
- and the plains of Alfeios River, along with the Meligalas and Megalopoli regions. Additionally, Kalamata–Messini has recorded recurring flood events, primarily during intense rainfall periods and due to temporary overflow of local streams.

These findings were derived from the Preliminary Flood Risk Assessment for the Western Peloponnese (EL01), which highlights that approximately 8.3% of the total area of the district has been classified as Potentially High Flood Risk Zones (ΖΔΥΚΠ).

The project area (Minagiotiko Dam and irrigation network) is not included among the designated high-risk zones, as it is located outside the historical flood-prone regions, ensuring hydrological safety and compatibility with the Flood Risk Management Plan.

Table 8.29: Potentially High Flood Risk Zones (Western Peloponnese Water District – EL01)

| **No.** | **Name of Zone** | **Code** | **Area ($km^2$)** |
|---|---|---|---|
| 1 | Low-lying areas of the Alfeios River and coastal torrent zones from the city of Krestena to Filiatra (areas of the Neda River, Kalo Nero stream, Filiatrino stream, and other torrents) | GR01RAK0004 | 298 |
| 2 | Meligalas plain area | GR01RAK0002 | 78 |
| 3 | Plain area of the Kalamata–Messini streams (Pamisos, Aris, Velikas rivers) | GR01RAK0001 | 170 |
| 4 | Megalopoli plateau | GR01RAK0003 | 90 |
| **Total** | | | **637** |

From the data presented above, no form of incompatibility arises regarding the examined projects.

### 8.13.2 Surface Waters

The data in this section are derived from the Geological Study prepared specifically for the project.
The hydrographic network of a region is closely linked with its hydrogeological characteristics, the extent and boundaries of its hydrological and hydrogeological basin, as well as with parameters such as runoff and infiltration coefficients and the discharge points of the underlying aquifer system.
Within the framework of the geological investigation, the morphological–geological structure and the hydrolithological / hydrogeological conditions prevailing in the drainage basin of the Minagiotiko Dam were examined.

The basin has a north–south orientation and covers an area of approximately 29.0 km² up to the dam site.
To study these conditions, the Hydrolithological Map (Plan GM-1) was compiled at a scale of 1:20,000. This map was based on the IGME Geological Map (scale 1:50,000, Koroni sheet), relevant bibliographic sources, and on-site geological observations and measurements.

#### 8.13.2.1 Morphological Characteristics

The morphological relief of the drainage basin is complex, characterized by intense dissection and moderately low altitudes.

Specifically, the relief can be described as follows:

- Gentle, with wide flattenings along the Minagiotiko stream and the main tributaries. These flattenings are the result of strong fluvial erosion processes along the main channel and adjacent valleys.
- Moderate to locally steep in the sloping flanks, primarily due to the erosive susceptibility of the geological formations.
- Gentle with extended flat zones in the upper portions of the basin, particularly in the areas of Pliocene deposits, which exhibit elongated surfaces oriented north–south to northwest–southeast.

The combination of these morphological elements contributes to the diverse hydrological behavior of the basin and affects both runoff rates and groundwater recharge capacity.

#### 8.13.2.2 Hydrographic Network

The hydrographic network of the study area exhibits a complex configuration, combining rectangular and dendritic drainage patterns.

The main stream, the Minagiotiko, flows predominantly north to south, bifurcating into two major branches near the central part of the basin, draining most of its northern section.
Two large lateral branches, each comprising two distinct streams, drain the eastern and western portions of the basin respectively.

A large number of smaller tributaries complement the network, feeding into the main watercourse and its sub-basins.
A characteristic feature of the Minagiotiko stream and its branches is the strongly meandering morphology of their channels, with alternating N–S, E–W, NW–SE, and NE–SW flow directions.

The flood terraces are wide, whereas the modern active channel remains narrow and shallow, indicative of episodic surface runoff and seasonal flow variability.

#### 8.13.2.3 Hydrolithological Characteristics and Hydrogeological Conditions

The Pliocene and flysch formations, together with the Messinian conglomerates that form the geological substratum of the basin, as well as the younger and recent deposits covering the area, display diverse hydrolithological properties and, consequently, varying hydrogeological behavior.
These differences stem from the variation in primary and secondary porosity of the lithological units, which depend on:

- the degree of diagenesis,
- grain size, and
- the degree of fracturing (density and geometry of discontinuities).

Hydrogeological conditions are directly influenced by the morphological configuration, the hydrolithological nature of formations, and the succession of impermeable and permeable strata.
This stratigraphic alternation defines the potential recharge areas, percolation zones, and discharge points of the local aquifer system.

##### 8.13.2.3.1 Hydrolithological Units

The formations composing the drainage basin can be grouped into three (3) Hydrolithological Units (I, II, III) with similar lithological and hydrogeological properties:

- Unit I: Highly permeable formations, mainly conglomerates and coarse-grained alluvial deposits, characterized by high infiltration capacity and direct hydraulic connectivity with the surface water network.
- Unit II: Semi-permeable formations, consisting of Pliocene marls, sandstones, and alternating clayey layers, allowing limited infiltration and partial groundwater flow.
- Unit III: Impermeable formations, composed primarily of flysch and clayey sequences, acting as aquicludes that control the recharge–discharge regime of the basin.

The interplay between these three hydrolithological units governs the surface and subsurface hydrodynamics of the Minagiotiko basin, defining the water balance and storage potential critical to the dam’s hydrological performance.

Hydrolithological Unit III – Formations of High to Very High Permeability (Π1–Π2)
This unit includes formations of various origins and lithological compositions, all sharing the common feature of high to very high permeability, which favors rapid infiltration and fast subsurface runoff.

The active infiltration coefficient ranges from 15 to 25%, while the surface runoff coefficient ranges from 10 to 30%.
The formations included in this unit are as follows:

- Recent Alluvial Deposits (Alo): These formations consist of sandy, silty, and gravelly materials of loose structure and small thickness, located along the active stream channels.
  The water that infiltrates within these deposits returns rapidly to the surface hydrographic system, without contributing significantly to the groundwater regime.
- Pliocene Basal Conglomerates (PPl/Cb): Semi-consolidated to consolidated formations of mixed lithology, representing the lower horizon of the Pliocene deposits. They are deposited unconformably over the strongly eroded flysch relief and act as a medium of rapid groundwater flow toward lower elevations. The infiltrated water is discharged as springs of considerable yield and continuous flow, re-entering the surface hydrographic network with a slight delay.
- Pliocene Conglomeratic Interbeds: Thin interbeds or lenses within Pliocene marls, which are generally impermeable formations. These lenses function as local conduits for rapid subsurface flow, discharging quickly into the drainage system. They are not depicted on Plan GM-1 due to scale limitations.
- Messinia Conglomerates (M-C): Consolidated to rock-like formations of mixed composition, consisting of gravels and boulders, forming elongated zones resting on the flysch formations of the Gavrovo–Pylos zone. They act as media for rapid groundwater movement, with the water being discharged as periodic springs, re-entering the hydrographic network with minimal delay. These formations are shown on Plan GM-1 with the code (III/M-C).
- Flysch Conglomerates (Fl/C, Sa): Rock formations of considerable thickness and mixed composition, functioning as pathways for rapid groundwater flow.

Infiltrated water is discharged as periodic springs that return to the surface system with slight time lag. They are depicted on Plan GM-1 with the code (III-Fl/C, Sa).

Overall, Unit III plays a crucial role in the hydrogeological cycle of the region, allowing direct recharge and interconnection between groundwater and surface water, thus contributing to the sustained flow of the Minagiotiko stream and its tributaries.

**Hydrolithological Unit II – Formations of Medium to Low Permeability (Π3–Π4)**

This unit consists of formations with intermediate hydrogeological behavior, exhibiting medium to low permeability. The active infiltration coefficient ranges from 7 to 12%, while the surface runoff coefficient varies between 15 and 35%.
The following formations are included:

- Older Alluvial Deposits, Colluvium / Weathered Materials (Al, T, T/Al): Composed of heterogeneous mixtures of fine-grained and coarse-grained materials (clayey-silts, sandy-silts, gravels, cobbles, and angular rock fragments). These formations have low cohesion and small thickness. The infiltrated water returns to the surface hydrographic network with some delay.

- Flysch Siltstone and Sandstone Formations (Fl/Sa, SaSi, SiSa): Alternations of siltstones and sandstones, fine- to medium-grained, of variable thickness.
  They act as media of slow groundwater flow, discharging as small periodic springs and re-entering the surface system with significant delay.
  They are not shown on Plan GM-1 due to scale.
- Flysch Formations of Olonos–Pindos (II/Fl-P):
  Composed of alternations of limestones, radiolarites, marls, and sandstones. Groundwater circulates through open fractures and fault zones, locally enhancing the aquifer system.
  Depicted on Plan GM-1 with the code (II/Fl-P).

Unit II acts as a regulating layer between the high- and low-permeability formations, contributing moderately but steadily to the groundwater replenishment of the basin.

**Hydrolithological Unit I – Formations of Low to Very Low Permeability (Π5–Π6)**

The formations of this unit behave as impermeable or semi-impermeable layers, acting as barriers to both surface and subsurface water flow.

The active infiltration coefficient ranges from 3 to 7%, and the surface runoff coefficient from 15 to 45%.
They consist mainly of clayey and marly sequences, which prevent significant infiltration, leading to surface runoff concentration along morphological depressions or fault zones. These formations govern the surface hydrology of the area and play a decisive role in limiting infiltration and maintaining surface water flow during heavy rainfall events.

**Overall Assessment**

The coexistence of the three hydrolithological units forms a complex hydrogeological system, where:

- High-permeability formations (Unit III) ensure rapid infiltration and subsurface drainage,
- Medium-permeability formations (Unit II) provide buffering and partial storage capacity,
- Low-permeability formations (Unit I) act as hydraulic barriers that stabilize the hydrological balance.

Understanding this hydrolithological structure is essential for the optimal siting of the works and for the management of both groundwater and surface water resources within the area of the Minagiotiko Dam project.
This unit includes the Pliocene marls, which locally and intermittently contain thin sandy interbeds, as well as flysch formations consisting of thinly bedded alternations of siltstones and sandstones (Fl / Si–SiSa).

These formations are characterized by low permeability and play an important role in controlling the subsurface water flow in the catchment area.

**Pliocene Deposits (PPl / m)**

These formations consist of marls of grey to whitish-grey color, containing intercalations of sand and gravel layers of varying thickness, while in the upper horizons, red clays and clayey sand-gravel mixtures are observed.

Fossil-bearing horizons of small thickness are frequently found, along with cross-bedding and lenticular intercalations, leading to rapid changes in grain size both horizontally and vertically. These formations act as impermeable barriers to groundwater movement and occupy a large portion of the drainage basin, including most of the reservoir area.
On Map GM-1, they are represented with the code I / PPl-m.

**Flysch Formations (Si – SiSa)**

These formations consist mainly of siltstones with intercalated sandstone beds of variable thickness, with a clear predominance of the siltstone fraction (over 80–90%).
They act as subsurface impermeable barriers to groundwater flow and have very low hydraulic conductivity.

On Map GM-1, they are represented with the code I / Fl-(Si–SiSa).

#### 8.13.2.3.2 Inventory of Hydrogeological Points

As part of the geological mapping process, all springs and water wells identified within the catchment area were recorded.

The hydrogeological points are distributed as follows:

**i) Northern Section of the Catchment**

In this area, hydrogeological points coded HYD-P3 to HYD-P6 were identified — all of them springs. Specifically:

- HYD-P3: A spring of significant discharge. Together with points HYD-P4, HYD-P5, and HYD-P6, it forms a continuous spring front through which the main water volume of the conglomerate formations is discharged.
- HYD-P4 (Springs of Kato Ampelokipoi):
Springs of high discharge capacity, located at the contact between the conglomerates and Pleistocene deposits.
The conglomerates are visible on the existing slopes.
These springs previously supplied water to the settlements of Kallithea, Arapolaka, Chomatada, Perivolaki, Pidasos, Kynigos, and others.
- HYD-P5:
A spring of low discharge, emerging within conglomerates with a sandstone matrix.

- HYD-P6:
  A spring of low discharge, occurring within loose surface deposits where conglomerates are not visible.
  Its position on the western extension of the alignment connecting HYD-P4 and HYD-P5 supports the view that it is fed by the same hydrogeological mechanism.

**Probable Mechanism of the Northern Springs:** All hydrogeological points HYD-P3 to HYD-P6 are located at the southern edge of the Messinia conglomerates, in contact either with flysch siltstone formations or with Pliocene marls. Since the volume of the Messinia conglomerates alone does not justify the large discharge observed, it is estimated that the spring flow is enhanced by the Olonos–Pindos formations, through a tectonic fault zone of general ENE–WSW orientation. This structural feature allows subsurface water transfer from deeper aquifers, thereby augmenting the discharge of the northern spring front and contributing to the continuous outflow of the Minagiotiko hydrological system.

**ii) Central Section of the Catchment Area**

**In the central part** of the catchment, the location of borehole HYD-G1 was recorded. This borehole constitutes the main water supply source for the settlements of Kallithea, Ambelakia, Chomatada, and other nearby villages.
According to oral information, the depth of this borehole (code GM-18 / IGME) is approximately 80 to 100 meters. Along the excavation slopes of the construction access road leading to the borehole site, tilted flysch formations and scattered boulders of conglomerates were observed.

Furthermore, it was reported that about 10 to 15 meters lower, there is a secondary spring of low discharge, which has not been developed or utilized.

**Probable mechanism of the central hydrogeological points:** The feeding mechanism of the above borehole cannot be investigated in detail within the scope of this study. However, it is likely connected to tectonic fractures trending NW–SE and NE–SW, which facilitate localized groundwater flow within the flysch formations.

**iii) Southern Section of the Catchment Area**

In the southern part of the catchment, the following hydrogeological points were recorded:

- HYD-P1 – Vlassis Mill Springs (Lachanada Springs):
  Springs of significant discharge, located at an elevation of +99.60 m, emerging through conglomerates with a sandstone matrix.
  According to oral information from the Municipality of Pylos–Methoni, the discharge rate of the spring (based on a 1965 study) is approximately 490 $m^3$/hour in July and 691 $m^3$/hour in May.
  The spring is used for the water supply of the Lachanada settlement as well as for irrigation purposes.

- HYD-P2 – Pumping Station Site:
  A pumping facility that draws water from nearby springs, supplying the Vlassaika and Militsa settlements.
  The stream where the pumping station is located is known as Kryovrysi or Kryorema. Large conglomerate boulders are visible along the excavated access slopes and natural embankments of the area.
- HYD-G2 – Private Borehole:
  A privately owned borehole of very low discharge, reportedly drilled within the Pliocene deposits, according to local accounts.

**Probable mechanism of the southern hydrogeological points:** The hydrogeological points HYD-P1 and HYD-P2 are associated with the presence of conglomerate formations, which are likely to represent the basal conglomerates of the Pliocene series.

Since the significant discharge rates of the springs cannot be explained solely by recharge from the Pliocene formations, it is estimated that their flow is substantially enhanced by the Olonos–Pindos formations, through a tectonic fault zone trending ENE–WSW.

**It is important to note that both hydrogeological points (HYD-P1 and HYD-P2)** are located within the inundation area of the Minagiotiko Dam reservoir.

#### 8.13.2.3.3 Hydrogeological Conditions

The hydrogeological conditions of a catchment basin are determined by the hydrolithological characteristics of the formations, the geological and tectonic structure of the area, and the morphology of the surrounding slopes.
These parameters jointly define the distribution, movement, and recharge potential of both surface and subsurface waters within the Minagiotiko basin.
Based on these criteria and field observations, it has been determined that the hydrogeological conditions of the Minagiotiko Dam catchment area are favorable for both the construction and operation of the project.
This conclusion is supported by the following findings:

- Within the catchment area, numerous scattered springs have been identified. The discharge of the larger springs is used for the domestic water supply of nearby settlements, while the excess flow and smaller springs contribute to the surface hydrographic network.
- The surface water flows naturally from the watershed divide toward lower elevations, with no evidence of groundwater leakage into adjacent hydrological basins.
- The aquifers that develop within high-permeability formations (such as conglomerates and sandstones of the flysch, Pliocene conglomerates, and Messinia conglomerates) discharge at lower elevations within the same basin, since these permeable formations overlie or are enclosed by impermeable flysch formations.
- The groundwater flow may also be partly recharged by the limestone and other formations of the Olonos–Pindos zone, which occur at higher elevations and relatively short distances east of the catchment area.

It is estimated that this subsurface water movement may occur through tectonic fractures trending approximately E–W, which cut across both the Olonos–Pindos formations and the Gavrovo–Pylos formations located along the eastern (left) ridge of the catchment basin.
If this interpretation is correct, it follows that the hydrogeological basin of the Minagiotiko stream extends beyond the morphological boundaries of its surface drainage area. This explains the presence of springs and aquifers found exclusively along the eastern (left) slopes of the catchment.

### 8.13.3 Groundwater Systems

The previous section presented a detailed analysis of the morphological and geological structure, as well as the hydrolithological and hydrogeological conditions prevailing within the catchment area of the Minagiotiko Dam.
It also described the groundwater recharge mechanisms and discharge points as documented in the Geological Study prepared under the current dam design contract.

#### 8.13.3.1 Groundwater Systems – Data from the Water Management Plan

The following information is drawn from the Water Management Plan (WMP) concerning the identification of groundwater systems within Water District 01 (Western Peloponnese).
Under the implementation framework of Directive 2000/60/EC, groundwater resources are divided into distinct groundwater bodies, and their uses and anthropogenic pressures are identified, with the objective of assessing the risk of failing to meet the Directive's environmental objectives (Article 5, Annex II).
According to the Directive, the delineation of groundwater bodies is based on geological and hydrogeological characteristics (Articles 2.2 and 2.12).
Furthermore, the initial classification of these groundwater bodies was carried out according to Paragraph 2.1 of Annex II of Directive 2000/60/EC.
The primary criterion for the differentiation of groundwater bodies is the hydrolithological behavior of the formations that host the aquifers.
On this basis, the following categories are distinguished:

- Karstic Groundwater Systems

In these systems, the movement of groundwater occurs through secondary porosity—that is, through fractures, joints, and karstic voids created primarily by the dissolution of carbonate rocks.
This category includes aquifers hosted in limestones and marbles, where the permeability is controlled mainly by the extent of karstification and the density of fractures.

- Granular Groundwater Systems

In this type of system, groundwater circulation occurs through primary porosity (intergranular pore spaces).

These aquifers are typically hosted within recent and Neogene deposits, where porous sedimentary materials such as sands, gravels, and silts allow the free flow and storage of groundwater.

- Fractured Groundwater Systems

In these systems, groundwater movement occurs through secondary porosity (fractures, joints, and tectonically disturbed zones).
They include weak, locally developed aquifers found within the weathered mantle and fault zones of flysch formations, phyllites–quartzites, schists, and Tyros-type strata. Such aquifers usually have limited water-bearing capacity and local hydrological importance.

Groundwater Systems in the Western Peloponnese Water District (WD01)
Within Water District 01 – Western Peloponnese, a total of 26 groundwater systems have been delineated across the two major basins.
The study area belongs to Groundwater System No. 5 (GR0100120 – Methoni System), characterized as a fractured–granular aquifer with a total area of 224.0 km².

#### 8.13.3.2 Uses of Groundwater Resources

As noted in Chapter 5.2.4, the total annual water demand in the entire Water District for all activities and uses is estimated at approximately 234.5 million m³.
Of this amount, agriculture (irrigated areas)—the primary water consumer—accounts for roughly 77% (around 180 million m³).
For the Pamisos–Nedon–Neda River Basin (OK32), the total annual water demand across all sectors is approximately 114.0 million m³, of which about 80% (roughly 91.0 million m³) is used for agricultural irrigation.
In the study area, there is currently no organized irrigation system serving agricultural land. Irrigation is conducted primarily through private wells, which are operated individually by farmers.
According to data from the Directorate of Agricultural Economy and Veterinary Services of Messenia (DAOK), as presented in Section 8.9.2.3, there are 89 registered wells in the wider area.
Additionally, as mentioned in Section 8.8.3, several water-supply boreholes exist to serve local settlements.
Upon implementation of the project, the use of water resources and infrastructure will be formally licensed, while the establishment of a Management Authority will ensure the proper and planned utilization of these resources.

### 8.13.4 Sediment Load Data of the Dam Catchment

As part of the dam design studies, and specifically within the hydrology study, an assessment of sediment yield and dead storage volume was conducted.
These findings, to maintain coherence within the document, are presented in Section 6.6.3 of this Environmental Impact Assessment (EIA).

## 8.14 Environmental Evolution Trends (Without the Project)

From the analysis of the environmental data of the study area, it becomes evident that the implementation of the project has the potential to positively influence the local economy, human activities, and, to some extent, the agro-environmental identity of the region. Without the project, these sectors would likely continue to face limitations due to water scarcity, fragmented agricultural practices, and insufficient infrastructure, underscoring the importance of the Minagiotiko Dam for regional development and sustainable resource management.

Specifically, by improving agricultural efficiency and enhancing farmers' income, the project is expected to strengthen engagement in agricultural activities and help retain the rural population in the area. Moreover, the local economy will be stimulated not only in the primary agricultural sector but also in the secondary and tertiary sectors that are directly or indirectly related to agriculture.

These positive outcomes are also anticipated to counterbalance the spatial pressures exerted by the increasing demand for residential and tourist development, helping to preserve agricultural land and the region's productive identity.

Additionally, the construction of the dam will lead to a significant improvement in the management of both surface and groundwater resources, due to the recharge of aquifers through infiltration and the reduction of groundwater abstraction from wells.

The aforementioned benefits, discussed in greater detail in Chapter 4 (Objectives and Rationale of the Project), Chapter 5 (Project Compatibility), and Section 6.5 (Agricultural Development Plan), would not be realized in the absence of the project. Without the implementation of these works, the region would remain in its current state, with limited utilization of its substantial natural potential—its fertile land and favorable climatic conditions—due to the lack of irrigation infrastructure.

In the absence of irrigation, agricultural activity will continue to be fully exposed to climatic variations and increasingly frequent droughts, which have a decisive impact on both production levels and farmers' income.

Furthermore, without irrigation, there can be no advancement of cultivation practices, no introduction of new crops, and no development of entrepreneurial organization or restructuring of agricultural holdings, thereby hindering innovation and sustainable growth in the agricultural sector.

# 9. ASSESSMENT AND EVALUATION OF ENVIRONMENTAL IMPACTS

## 9.1. Methodological Approach

For the purpose of project licensing, the assessment is conducted based on the available technical data and project characteristics, as recorded during the preparation stage of the relevant technical studies, namely the *Preliminary Design of the Dam* and the *Technical Report for the Irrigation Networks*, including preliminary design data for the main water conveyance pipelines, reservoirs, and the irrigated zone.

As the technical studies for the projects progress — specifically the *Final Designs of the Dam and Networks* — certain project characteristics are expected to be more precisely defined or modified. In accordance with the legislation governing Environmental Licensing, an *Amendment File of the Environmental Terms Approval (AEPO)* and an *Environmental Impact Monitoring Report (SEPEM)* must be prepared, thereby adequately supplementing the AEPO and ensuring the proper implementation of the project.

The impacts of the examined projects are evaluated based on the following characteristics:

- **Mechanism of occurrence:** classified as *direct* or *indirect* (A, E)
- **Geographical extent:** defined as *local* or *general* (T/G)
- **Intensity:** divided into three categories — *low*, *medium*, and *high* (1, 2, 3)
- **Time of occurrence and duration:** characterized as *permanent* (operational phase) or *temporary* (construction phase)
-

Furthermore, the negative impacts are categorized into five subcategories, which are presented and explained in **Table 9.1** below.

**Table 9.1: Categories of Impacts**

| | |
|---|---|
| Reversible (N) | The system can recover, either naturally or artificially. |
| Irreversible (O) | Natural or artificial recovery of the system is not possible for long periods of time. |
| Manageable (N) | With appropriate measures, the impact can be mitigated or prevented from occurring. |
| Partially Manageable (M) | With appropriate measures, the impact can be partially mitigated or its manifestation limited. |

| | |
|---|---|
| Unmanageable (O) | It is practically impossible to take effective mitigation measures. |

At the end of this chapter, the overall evaluated impacts of the project are presented in matrix form, classified according to the construction and operation phases.

## 9.2. Impacts on Climatic and Bioclimatic Characteristics

The type and scale of the examined projects are not expected to constitute a significant factor capable of causing alterations in the climatic and bioclimatic characteristics of the area. However, a minor localized differentiation in humidity levels may occur due to the presence of the water reservoir. This effect depends on the extent of the reservoir's surface area as well as on the duration of water storage.

Given the relatively small surface area of the reservoir and the fact that no year-round water storage will take place—thus causing significant fluctuations in water levels—it is estimated that no substantial negative impacts will occur in the area.

Any potential increase in humidity may be considered beneficial for the natural environment of the region.

In any case, no significant adverse impacts are expected during either the construction or the operation phase of the projects.

## 9.3. Impacts on Morphological and Landscape Characteristics

### 9.3.1. Construction Phase

As recorded in Section 8.3 of this report, no particular or significant landscape types are identified in the area of the dam, which is considered a positive factor. Consequently, since the location of the dam and the reservoir lies at a distance and out of visual range — both upstream and downstream — from nearby settlements and major road networks, no alterations or negative impacts are expected on the visible landscape of the construction site.

Furthermore, the presence of a water body is always a positive element for the environment and the landscape, even when it is man-made, as evidenced by the example of artificial lakes such as Kerkini and Ladonas, etc.

During the construction phase of the project, a noticeable alteration in the landscape characteristics usually occurs, particularly at excavation sites for the dam, reservoirs, networks, and material borrow pits. In this phase, the area is temporarily disturbed in zones due to construction activities, and low-aesthetic-value areas (such as construction sites, borrow pits, and spoil disposal areas) are developed out of necessity.

However, this stage is both unavoidable and temporary. With the implementation of appropriate mitigation measures, the disturbance can be significantly controlled and subsequently restored, so that the final outcome is integrated into the natural environment as harmoniously as possible. The restoration of these areas upon completion of the works will return the landscape to its original condition.

At the dam site, the completion of works will produce a final result that will not require further restoration, while for the construction sites, borrow pits, and spoil disposal areas, restoration measures will be proposed in the following chapter.

**The impacts on the aesthetic value of the landscape during the construction phase relate to the operation of construction sites and borrow pits and are assessed as negative, direct, local in scale, of moderate intensity, irreversible, and manageable**.

### 9.3.2. Operation Phase

As noted in Section 8.3 of this report, no distinctive or significant landscape types are identified in the dam area, which is initially a positive factor. Consequently, since the location of the dam and the reservoir lies far from view — both upstream and downstream — from nearby settlements and major roads, no visual alterations or negative impacts are expected on the surrounding landscape.

On the contrary, the presence of a water surface is generally considered a positive feature in the environment and landscape, even when it results from human intervention, as shown by existing artificial lakes such as Kerkini and Ladonas, etc.

Among all examined components — the dam, networks, and associated facilities (reservoirs, pumping stations, and underground pipelines) — only the dam and the main reservoirs could potentially influence the landscape during the operation phase.

Due to the geomorphology of the area and the fact that the dam will not be visible from settlements or main roadways, no adverse visual impacts are anticipated. On the contrary, the formation of the reservoir is regarded as a positive impact, evaluated as positive, direct, local in scale, of low intensity, irreversible, and manageable.

The balancing reservoirs required for the efficient operation of the irrigation network are four (4), one of which has a relatively large capacity of 17,325 cubic meters, with indicative dimensions of 70 × 45 × 5.5 meters. For this reason, it was decided at the design stage to locate it away from settlements and in harmony with the natural terrain, rather than on a ridge line, to minimize visual disturbance. In addition, a peripheral embankment will be constructed around the sides of the reservoirs, where feasible, to reduce visible concrete surfaces along their height. Under these conditions, the impacts are assessed as direct, local in scale, of low intensity, irreversible, and manageable.

A key aspect of the examined project is that no land reallocation will be required, and therefore, the current image of the agricultural landscape across the 35,000-stremma irrigated area will remain unaffected.
In conclusion, no adverse landscape impacts are expected during the operational phase of the project.

## 9.4. Impacts on Geological, Tectonic, and Soil Characteristics

### 9.4.1. Construction Phase

The main construction activities that may cause impacts consist of the following:

#### 9.4.1.1. Construction of the Dam – Required and Surplus Materials

For the construction of the dam, the necessary access roads will be opened at the construction site, and works will be carried out for the soil stabilization and the foundation of the dam.

By selecting the RCC (Roller-Compacted Concrete) type dam instead of an earthen dam with a clay core, the quantities of surplus excavation materials available for disposal are already reduced by approximately half, amounting to about 80,600 $m^3$ of soil materials and approximately 155,200 $m^3$ of rock materials, giving a total surplus of about 212,300 $m^3$. These surplus materials can be utilized in several ways, the soil materials may be used for the rehabilitation of barren lands (agricultural, forest, or pasture areas) after obtaining the necessary permits. They may also serve for the restoration of borrow pits associated with the project or for the reclamation of inactive quarries.

The construction of a dam is directly related to the availability, at the shortest possible distance, of the necessary materials (soil or rock), which are naturally located.

Regarding the borrow pits**, two areas have been proposed that have adequate and suitable** rock materials for the dam's construction. At the current stage — the preliminary design of the dam and the advanced design proposal for the networks — it is considered appropriate to approve both sites (L1 and L2), while the final selection will be made in the next stage of the technical studies, i.e., the final design phase, when more detailed information about the project will be available.

From the evaluation of the present Environmental Impact Study (EIS), it is estimated that the L2 site, located south of the dam, would best serve construction purposes since it is situated at a much shorter distance from the dam. This would significantly reduce costs and be more environmentally friendly, as it minimizes transportation distances and avoids crossing inhabited areas. Conversely, the L1 site, located closer to the irrigated area, would be more suitable for supplying materials required for the backfilling of irrigation pipelines.

In the context of the present EIS, the licensing of both suitable locations identified through the geological survey is proposed. The first near the Arapolakka area (L1) and the second south of the dam, west of the settlement of Vlasaiika (L2), with L2 being the initially preferred site for the dam and L1 located closer to the irrigation network area. The locations of the borrow and spoil areas are shown in Drawing GM-11 of this EIS.

In addition to the aforementioned borrow pits for rock materials (L1 and L2), within the reservoir basin, suitable sites D1 to D10 (Drawings GM-12.1 and GM-12.2) have been identified for the extraction of borrow materials. These will primarily be used for reinforcing the left abutment of the dam, and their approval is also requested.

The earthworks balance is presented in the corresponding table of Section 6.4, and it is highly favorable, as the total surplus materials for disposal amount to 212,300 $m^3$, along with approximately 330,000 $m^3$ of aggregates — quantities that are particularly low compared to similar projects.

The surplus materials can be used for:

- Rural road construction, which will be implemented under the project,
- Maintenance and improvement of existing agricultural roads, which require annual repair and rehabilitation,
- Construction of the new perimeter road around the reservoir,
- And any remaining quantities for the restoration of borrow pits L1 and L2 or other inactive quarry sites.

In terms of the earthworks quantitative balance (as presented in Chapter 6), the estimated dam quantities demonstrate that all surplus materials will be effectively absorbed through the aforementioned uses.

The impacts on geology and soil resulting from the construction of the dam and borrow pits are assessed as: negative, direct, temporary, of moderate intensity, local in scale, and manageable.

#### 9.4.1.2. Construction of the Underground Network of Main Pipelines and Reservoirs

For the construction of the network, trenches of small width (< 2.00 m, depending on the pipe cross-section) will be excavated, with a total length corresponding to that of the irrigation pipelines. The pipelines will be installed underground at a depth of 1.20–2.00 m (depending on the diameter). Typical trench cross-sections are shown in the relevant plan (S.S.) of this report. The excavation materials (approximately 315,000 $m^3$) will be deposited alongside the trenches, and a large portion of them (about 182,700 $m^3$) will be reused for the backfilling of the pipelines.

At this stage, no further data are available for the reservoirs, and thus an accurate estimation of the earthworks cannot yet be performed. These details will be determined at a later stage, during the final design of the networks. In general terms, no significant quantity of surplus materials is expected to arise, and any small amount will be managed in the same manner as previously described.

The corresponding balance of materials from the construction of the irrigation network indicates surplus materials of approximately **167,300 $m^3$**, consisting mostly of agricultural soil. These materials can also be used according to the options mentioned above and, upon appropriate coordination, may be **spread over agricultural lands** for soil improvement.

**The impacts on the soil from the construction of the underground pipeline network are assessed as:negative, direct, of low intensity, local in scale, reversible, and manageable.**

#### 9.4.1.3. Implementation of Project Support Facilities — Construction Sites, Borrow Pits, and Spoil Disposal Areas

*Before any intervention at the project sites, the competent forestry authority must be informed, and a site installation permit must be issued for each construction site or borrow pit.*

**Construction Sites**

Within the project area, one or more construction sites are planned to be established. The earthworks required for site formation will be relatively minor, mainly involving limited-depth excavations and embankments (< 1.00 m) and gravel surfacing.

At this stage, detailed information is not available, and therefore a complete assessment of these impacts cannot yet be performed. In the next stage — after completion of the technical studies and before the commencement of construction — a Technical Environmental Study (T.E.M.) will be submitted, as required by legislation, prepared by the project contractor for the licensing of these facilities. This study will include detailed provisions regarding the establishment and operation of the construction sites.

The construction site facilities are expected to include:

- Reinforced perimeter fencing
- Internal water supply network from the municipality or a licensed borehole
- Medium/low-voltage electricity network and transformer
- Wastewater network and/or chemical toilets
- Prefabricated office units on concrete flooring
- Material storage areas, machinery and vehicle maintenance workshops, and material testing laboratories
- Parking areas for machinery and vehicles
- Vehicle washing stations
- Concrete batching plant

- Pre-treatment/treatment units for liquid waste (e.g., sealed septic tanks, sedimentation tanks, oil-water separators, etc.)
- Access to and from the construction sites will take place through the existing road network. Any temporary construction or access roads built for the execution of the works will be **strictly temporary** in nature.
- Typical disturbances expected from the operation of the construction sites include:
    - Increase in noise levels
    - Increase in dust emissions
    - Increase in heavy vehicle traffic
    - Increase in waste and wastewater production
- The construction sites will **not include significant polluting facilities** (e.g., asphalt plants).

**The impacts from the establishment and operation of the construction sites are assessed as: negative, direct, of low intensity, local in scale, reversible, and manageable.**

<u>**Borrow Pits – Spoil Disposal Areas**</u>

The establishment and operation of borrow pits are regulated by Decision Δ7/A/12050/2223/2011 (Government Gazette 1227/B/2011), which constitutes the *Regulation of Mining and Quarrying Operations (KMLE)*. Specifically, for the present case, the provisions of Chapter IX apply, concerning the *Siting of Mining and Quarrying Works*, *Environmental Protection from Vibrations, Blast Pressure Waves, and Noise*, as well as the *General Provisions* and *Specific Protection and Restoration Measures*.

The most significant issue related to such installations concerns the dust emissions generated during rock fragmentation, as well as potential disturbances from noise and vibrations if explosives are used in the extraction process.

Regarding dust control, it can be effectively managed through the implementation of appropriate and proven mitigation measures derived from the exploitation study, including continuous wetting of materials and enclosure of conveyor belts, as described in the following chapter. Thus, it is expected that, from the very beginning of operations, there will be effective containment of dust emissions during the extraction of aggregates and rock materials.

As for vibrations, the proposed locations for the borrow pits are situated at sufficient distances from settlements and residences, in accordance with the legal limits — 500 meters for the use of explosives — a distance which may be reduced if safety is not compromised, provided this is duly justified.

For the proposed L1 and L2 locations, this criterion is already met, and therefore, no significant impacts are anticipated.

At the current stage of technical studies, no further detailed information is available regarding these matters. In the next phase, when more data become available, a detailed assessment will be required, including the proposal of additional mitigation measures and conditions. In Chapter 10 of this report, general measures are proposed in line with current legislation.

Based on the above and provided that the terms and conditions of Article 85 of the KMLE concerning safety in quarrying operations involving the use of explosives are met — particularly regarding the required distances from buildings, infrastructure, pylons, and roads — no significant impacts are expected.

**Overall, during the construction phase, the project's impacts on the soil and subsoil are characterized as temporary, direct, local, of low intensity, reversible, and partially manageable.**

#### 9.4.2. Operation Phase

No impacts are expected from the operation of the project on the geological or soil characteristics of the area.

## 9.5. Impacts on the Natural Environment

### 9.5.1. Combined Consideration of Impacts on the Natural Environment

#### 9.5.1.1. Construction Phase

During the construction phase, the following impacts are expected on the flora and fauna of the project area:

During the construction period, the area will be disturbed in zones, according to the spatial scheduling of the construction works — beginning with the dam and followed by the pipelines and the irrigation network. Disturbances are expected in the ecosystems and vegetation due to the removal of surface soil layers and natural vegetation at the dam site and the reservoir basin.

For the construction of the dam and the transmission pipeline, clearing of natural vegetation will be required over an area of approximately 887 stremmas (about 88.7 hectares) within the project footprint.
The area to be occupied by the reservoir, located within the streambed, mainly consists of cultivated land with olive trees and areas covered with maquis vegetation, composed of evergreen broadleaf species and riparian vegetation within the stream channel.

Therefore, the natural vegetation is mainly low shrub vegetation located on the stream slopes. This reduction in vegetation cannot be considered a significant ecological degradation, as it concerns a very limited section of the Minagiotiko stream bed, even though part of the reservoir basin lies within the Natura 2000 protected area (code GR2550003). However, it does not affect priority habitats, which are the reason for the area's designation as protected.

This spatially and quantitatively limited loss of vegetation and cultivation will not significantly impact bird nesting or foraging activities in the area. The local mammals will not be greatly affected either — they are expected to temporarily move away due to construction noise and return once works are completed.

Impact assessment: Negative impact — direct, local, of moderate intensity, due to the relatively small area cleared and flooded; irreversible.

**The establishment of the construction site** will also cause clearing of existing vegetation within its boundaries, of a similar nature but of much smaller scale compared to that of the reservoir area. Although the exact location of the construction site is not yet known — as it will be determined by the contractor — it is expected to be situated near or within the reservoir area, where agricultural lands already exist.

Impact assessment: Negative, direct, local, of low intensity and limited extent, temporary and reversible after the application of appropriate measures and short-term, as full restoration of the landscape is foreseen once construction is completed.

**The establishment of borrow pits** will also lead to clearing of existing vegetation within their boundaries, of a similar magnitude to that of the reservoir basin. These interventions will temporarily alter the ecosystem and destroy habitats of local fauna. Two borrow pit sites (L1 and L2) have been proposed, both suitable and adequate for supplying materials for dam construction. The second site (L2) lies within the Natura 2000 area, but far from core protected zones. Both proposed sites are located in areas covered by olive shrub and mastic bush habitats, which, however, are not priority habitats. The areas used as borrow pits must be restored after the completion of works, through revegetation with native species, ensuring their reintegration into the landscape and the ecological functions of the area.

Impact assessment: Negative, direct, local, of low intensity and limited extent, temporary and reversible after the application of appropriate measures, short-term and fully manageable, as the restoration of the landscape is foreseen following project completion.

**Intense Human Presence and Noise in the Reservoir Area.** The construction of the project is not expected to alter the species composition or population size of the local fauna. The area to be occupied by the dam's reservoir will flood habitats currently used by fauna, forcing them to relocate to similar habitats nearby. This impact is not significant, as the reservoir area is relatively small, and the habitats to be inundated are not rare in the broader region. Moreover, the construction period will be sufficiently long to allow wildlife to gradually relocate to equivalent habitats around the dam area.
The animal species inhabiting the project area will temporarily abandon the site during construction, disturbed by the increased human presence and the noise produced by excavators, trucks, and other construction machinery. It should be noted that the wider area has an agricultural character, dominated by olive cultivation. The only existing artificial noise sources are those produced by farm vehicles and machinery, used occasionally for soil

cultivation (once or twice per year) and for spraying to control potential plant diseases (also once or twice per year). These current noise levels are significantly lower than those that will occur during construction due to the operation of heavy machinery.

In the immediate vicinity of the dam and the reservoir basin, no protected, endangered, or threatened fauna species have been recorded. Nevertheless, appropriate mitigation measures must be taken to reduce noise emissions from construction machinery in order to minimize disturbance to fauna near the project area.

Overall, the fauna of the region, and particularly the avian fauna found in the semi-mountainous and mountainous areas, will not be significantly affected by the construction of the dam and its associated works. The impacts are expected to be reversible after the completion of construction.

<u>Impact assessment: Negative, direct, local, of low intensity and limited extent, temporary, reversible, short-term, and fully manageable through the adoption of appropriate measures to limit noise emissions from construction machinery.</u>

During the construction of the dam, **dust levels** in the area will increase — both within the dam site and in the areas where aggregate borrow pits will be developed, as well as along the material transport routes and within the construction site itself. Dust has a negative effect on plant physiology, as it deposits on leaves and limits photosynthesis, respiration, and transpiration, which occur through the leaf surface and stomata located on the lower side of leaves. As a result, plants may fail to develop normally and may eventually wither. To prevent such problems during the construction phase, appropriate dust suppression measures must be implemented.

<u>Impact assessment: Negative, direct, local, of low intensity and limited extent, temporary, reversible, short-term, and fully manageable through the implementation of dust control measures during construction.</u>

**Overall Assessment of Impacts on Flora and Fauna from Dam Construction**

As indicated above, the construction phase of the dam will have negative impacts on the ecosystem, its functions, and the flora and fauna of the area. However, these impacts are expected to be localized, not fragment priority or critical habitats, and short-term, lasting only for the duration of the dam's construction.
Most impacts will be direct, while some — such as the inundation of vegetation and the permanent alteration of habitat types due to flooding — will be irreversible.
Finally, several impacts are manageable through appropriate mitigation measures, such as restoration and revegetation of construction sites and borrow pits for aggregates, ensuring reintegration of the affected areas into the surrounding landscape after project completion.

#### 9.5.1.2. Operation Phase

During the operation phase of the project, the following impacts are expected:

**Impacts on fauna and flora** due to the reduction of freshwater flow downstream of the water intake points. The Minagiotiko stream is characterized by its clearly torrential regime, exhibiting significant flow mainly during rainy periods. Thus, the main water discharge is observed during the winter months, whereas in summer, the stream often displays very low or even zero flow for extended periods. Based on these hydrological characteristics, it can be safely assessed that the existing fauna (both terrestrial and aquatic) in the immediate area is already adapted to seasonal flow variations and to periods of zero discharge. Following the project's implementation, the expected changes will concern the reduction of discharge volumes during the winter months, when currently the stream conveys the entirety of flood flows. Conversely, during dry periods — when the flow is already minimal or nonexistent — the dam will ensure the maintenance of an ecological flow, distributed evenly throughout the year. As a result, the period with guaranteed flow conditions will be significantly extended across all months due to the ecological discharge. Consequently, although some pressure may occur on riparian microfauna, no significant impacts are anticipated on the fauna of either the immediate or wider area, stemming from the reduced flow during the winter months. Likewise, during the summer, the fauna — already adapted to low or zero flow conditions — will benefit from the continuous ecological flow maintained by the dam.

<u>Impact regarding the reduction of water downstream of the dam: Negative, not significant, direct, long-term, of low intensity, partially reversible.</u>

**Increase of water surface area (reservoir),** which will ultimately attract a significant number of fauna and avifauna species.

The creation of a water body in the area is expected to enhance the habitats of aquatic and semi-aquatic fauna species, while also attracting waterfowl species. The artificial wetland will act as a positive factor for certain fauna species that depend directly on water for their survival, feeding, and — in some cases — nesting (e.g., amphibians). In particular, for **avian** fauna, an increase in the frequency of occurrence of certain species is expected — especially of those that are currently only transient visitors. Simultaneously, the presence of raptors will also increase, as the new environment will provide an ideal area for foraging within close proximity.

It should also be noted that the project does not affect the habitats of terrestrial wildlife in the immediate or wider area. On the contrary, it offers a permanent source of water for these species.

<u>Impact regarding the permanent presence of water in the area: Positive, direct, local, of moderate scale and permanent duration.</u>

**Hunting.** Hunting in the area has been a centuries-old tradition, still practiced today. Due to the creation of the new water surface, various aquatic and semi-aquatic bird species are expected to be attracted to the area — species that will be particularly vulnerable to illegal or uncontrolled hunting. Therefore, protection measures must be implemented to safeguard the avian fauna that will congregate around the reservoir and to prevent poaching or excessive hunting activities.
Impact: Indirect, negative, of low intensity, reversible following the implementation of appropriate mitigation measures.

**Impacts on Aquatic Ecosystems from the Reduction of Downstream Flow.** Ensuring a minimum ecological flow downstream of a reservoir is a standard practice applied in many operating dams worldwide. The primary purpose of maintaining this flow is to sustain the ecosystems located along the riverbed and riparian zones, which depend on a minimum water supply. In some cases, maintaining continuous flow in the riverbed also contributes to recharging groundwater aquifers and preventing seawater intrusion into the underground horizon near river estuaries. Finally, downstream water releases may also be required for irrigation purposes, depending on local needs. However, this operational condition for reservoirs is usually applied only when significant downstream habitats are present that require freshwater input and typically concerns large dams constructed in the beds of major rivers with continuous flow, where aquatic ecosystems and fish populations could be affected. In the case of the Minagiotiko stream, no such issue arises, as no fish populations are found in it. The stream’s discharge is very low and intermittent, with long periods of negligible or zero flow.

Consequently, the impacts on the downstream ecosystems of the stream are not expected to be significant, since part of the discharge will still be maintained during winter from the downstream catchment, and the alteration in flow will be relatively small. Therefore, it is estimated that the impacts on the riparian flora and fauna downstream of the reservoir will be minor and not significant. Nevertheless, some monitoring measures should be implemented, and if, despite these assessments, significant ecological degradation is observed, additional corrective measures should be taken.

Regarding the marine environment near the estuary of the Minagiotiko stream, which is located within a Natura 2000 protected area, the project will not have an impact. The stream’s contribution to the supply of nutrients to the coastal zone is already very limited, as it rarely (except during flood events) exhibits significant surface runoff to the sea. Therefore, the reduction of part of the stream’s discharge will not affect nutrient inflows to the marine environment or the fauna within the wetland zone near the estuary.

Impact: Negative, direct, of local extent, low intensity, reversible after the application of mitigation measures, if required.

**Intensification of Agriculture.** The primary objective of the proposed dam is to irrigate 35,000 stremmas (3,500 hectares) of agricultural land and, secondarily, to supply water to nearby settlements. The availability of additional water will create favorable conditions for the intensification of agriculture, contributing to economic development. However, in the absence of specific control measures, this may lead to an increase in the use of fertilizers and pesticides. The intensification of agricultural activity represents a human-induced pressure on the environment. The environmental burden arises from the use of agrochemicals (fertilizers, pesticides, herbicides, growth regulators), the performance of cultivation practices (plowing, hoeing), irrigation, the generation of agricultural by-products, and the establishment of monoculture systems.

Regarding fertilizer use, intensive agriculture typically requires high nutrient inputs, both in the form of inorganic fertilizers and organic matter, which can result in increased nutrient runoff to the soil and potentially to surface and groundwater systems, if not properly managed.
From fertilizers, Nitrogen and phosphorus are the main essential nutrients for plant growth and play a decisive role in the success or failure of agricultural production. However, these two elements are also primarily responsible for the adverse environmental impacts associated with agricultural activity, unlike most other macro- and micronutrients required by plants, with a few exceptions. Excess nitrogen from fertilization acts in the form of ammonia ($NH_3$), nitrogen oxides ($NO_x$), or nitrates ($NO_3^-$). Ammonia emissions contribute to nitrate enrichment of soil water, thus promoting eutrophication in receiving water bodies. Nitrogen oxides ($N_2O$ and NO) result from microbial processes in the soil, and the use of nitrogen-based fertilizers increases nitrification and the production and emission of nitrogen oxides. Elevated nitrate concentrations in aquatic ecosystems constitute a pollutant and simultaneously pose public-health risks. Together with phosphorus, nitrates trigger eutrophication phenomena in aquatic receptors such as ditches, lakes, and seas.
Excess nitrogen in soils also has negative effects on biodiversity, degrading the natural flora and, consequently, the fauna, while also influencing the quality of agricultural products. Pesticides, in turn, have detrimental effects on certain fauna species, especially birds, where high doses may even cause mortality.

However, in the olive cultivation that predominates in the region, the input of fertilizers and pesticides is limited. Consequently, nitrate leaching into the groundwater is not expected to occur, and pollution of the aquifer is considered unlikely. The use of pesticides in olive farming is minimal, since diseases (e.g., olive fruit fly, prays) are few and are typically controlled through bait traps and limited spraying. Likewise, weed control in olive groves is mainly mechanical, without the use of chemical herbicides. In any case, it is necessary to implement good agricultural practices regarding the use of fertilizers and chemical substances by farmers.

Impacts from Agricultural Intensification:

- For humans: Positive, direct, local, of moderate intensity.
- For avifauna, water, and soil: Negative, local, of low intensity, reversible, and manageable after implementing appropriate mitigation measures.

**Biodiversity.** Intensive agriculture poses a significant threat to numerous species of flora and fauna. One of the main factors contributing to biodiversity loss is the expansion of cultivated land and its technical improvement at the expense of forest areas, pastures, and wetlands.

The result is a reduction of natural habitats, which are essential for species survival and for maintaining biodiversity.

The objective of the dam's construction and operation is to supply irrigation water to improve the productivity of existing crops. Based on the post-operation cultivation plan, no changes are expected in either the extent of cultivated areas or the type and nature of crops. Therefore, no biodiversity reduction is anticipated in the area.

Impact: Negative, direct, of local extent, low intensity, reversible after the implementation of appropriate measures, if required.

**In conclusion as shown above, the impacts on the natural environment <u>during the operation</u> phase of the dam and reservoir are expected to be as follows:**

**Positive** for the fauna of the area, since the creation of a water body will attract aquatic and semi-aquatic species, as well as waterfowl.
Negative for the ecosystems and biodiversity downstream of the dam, due to the reduction of the stream's discharge. Negative impacts may also arise from the intensification of agriculture in the region. All negative impacts are expected to be of low intensity, local in scope, and manageable through the adoption of appropriate mitigation measures.

### 9.5.2. Impacts on Areas of the National Network of Protected Sites

Both the construction and operation phases of the project do not affect any areas, habitats, or priority ecosystems for which the region was designated as a protected area. The area to be occupied by the reservoir basin includes olive–mastic shrub habitats and cultivated land with olive trees, which are not priority habitats and are common throughout Greece and the Mediterranean basin.

The irrigated lands consist entirely of agricultural areas, while the pipelines will pass through existing rural roads and cultivated lands, meaning that no pressure will be exerted on any protected ecosystems.

The areas and habitats for which the region was declared protected are located at a considerable distance from the dam site and the flooded zone, and will not be affected by the project's construction or operation.

### 9.5.3. Impacts on Forests and Forest Areas

As noted in Section 8.5.3, the project is expected to occupy existing agricultural areas and land covered by olive–mastic shrub habitats, which, under Greek forest legislation, are classified as forest lands. The total area to be occupied by the project is 887 stremmas, a relatively small extent that cannot cause significant adverse effects on a habitat type that is common in Greece and the wider Mediterranean region.

The establishment of borrow pits, which will be located entirely within areas legally designated as forest land, is expected to have negative impacts on the local area. However, the proposed restoration plan, including reforestation with native tree species and grazing exclusion during the initial years, is expected to reverse the adverse effects caused by their creation.

Finally, the water transmission pipelines will be constructed mainly along existing roads crossing agricultural areas. Only a short section, mainly of the main pipeline from the dam to the downstream Pumping Station A1, may pass through forest land, the exact extent of which will be determined at later stages of the design process.

### 9.5.4. Impacts on Other Significant Areas

#### 9.5.4.1. Important Terrestrial and Inland Water Areas

As previously mentioned, no other significant terrestrial or inland water areas exist within the study region that could potentially be affected by the construction or operation of the dam and its reservoir.

#### 9.5.4.2. Important Marine Areas

The Minagiotiko stream, characterized by its torrential profile, flows into the coastal area of Finikounta. Its runoff does not influence the marine biology of the region and does not sustain any protected habitats at its estuary. Both the dam and its reservoir are located at a significant distance from the coastline, and their construction and operation are not expected to affect pelagic or benthic organisms, nor any other species dependent upon them.

No changes are anticipated in the marine environmental parameters of the study area as a result of the dam’s construction or operation.

Finally, the project is not expected to alter the ecological balance of the broader marine environment within the study area.

## 9.6. Impacts on the Anthropogenic Environment

### 9.6.1. Impacts on Spatial Planning and Land Use

As mentioned in previous chapters, the examined projects are fully compatible with the existing spatial planning framework at all levels — Regional, Municipal (ΣΧΟΟΑΠ), and other Special Plans — both in terms of their development objectives and their planning directions.

The examined projects are located within an agricultural area and do not directly affect settlements, population, or residential environments. During the spatial planning of the project — specifically, the determination of the irrigated perimeter — all areas within or adjacent to settlement boundaries were excluded, as well as a southern transitional zone bordering the touristically developed coastal area, which was also excluded due to already significant dispersed construction activity.

The project is therefore expected to have no negative effects; on the contrary, it is anticipated to support regional planning objectives, improving agricultural productivity and contributing to population retention in rural areas. This will serve as a counterbalance to the growing development pressures observed in unplanned zones, particularly from tourism, which often expands at the expense of agricultural land.

In terms of land use, the projects are located entirely within areas designated as agricultural and are fully compatible with the existing spatial and urban planning framework.

The small-scale expropriations required for the dam, reservoir, and auxiliary irrigation infrastructure (tanks, pipelines) will not alter the agricultural character of the region. The dam site and basin are located within the streambed, which is covered by natural vegetation that will be removed, and logging products will be managed according to the instructions of the competent Forestry Service.

The majority of the main pipelines will be laid underground, following existing public, municipal, or rural roads, and in some sections, along newly planned alignments. The construction and operation of the project thus enhance planned land uses in the area and do not generate any negative impacts.

**Conclusion: The impacts from the construction and operation of the projects are positive, indirect, cover the entire study area, and are of moderate intensity.**

### 9.6.2. Impacts on the Structure and Functions of the Anthropogenic Environment

As previously mentioned, the examined projects are entirely compatible with the functions of the anthropogenic environment, both in terms of planning forecasts and developmental directions.

Their implementation is expected to strengthen the existing social and economic structure by enhancing agricultural production and retaining population in the area, acting as a counterbalance to the strong pressures recorded in unplanned areas for residential and tourist development, often at the expense of agricultural land.

Conclusion: The impacts from the construction and operation of the projects are positive, indirect, affect the entire area, and are of moderate intensity.

### 9.6.3. Impacts on Cultural Heritage

According to the cultural heritage records, no declared monuments or archaeological sites have been identified within the project area, apart from those mentioned in Section 8.6.3, which concern churches or buildings within settlement limits.

However, the possibility of archaeological finds cannot be excluded, especially during excavation works for the dam. Therefore, the recommendations of the Ephorate of Antiquities of Messinia must be strictly followed during the construction phase.

Based on the above, **no significant impacts** are expected on known monuments or archaeological sites from the construction or operation of the projects, and the cultural heritage of the area is not anticipated to be adversely affected.

## 9.7. Socio-Economic Impacts

### 9.7.1. Impacts on Population and Housing

**Construction and Operation Phase**

The examined projects are located in an agricultural area and do not directly affect the population or the residential environment. Indirectly, however, the improvement in the efficiency of agricultural activities can be considered a positive factor for population development and demographic stability, by promoting the retention of the younger population in the area and potentially attracting new residents, given that the distances from major urban centers are relatively small.

Positive impacts on the population size are expected to result indirectly from the strengthening of the productive base of the region due to the implementation of the projects.

**The construction and operation of the project have a positive impact on the population, and the effects are assessed as permanent, positive, indirect, local in scale, and of moderate intensity.**

### 9.7.2. Impacts on the Structure of the Local Economy

**Construction Phase**

During the construction phase, there will be the creation of job opportunities (e.g., for workers, drivers, technical staff, and machine operators), as well as work opportunities for local small enterprises (at a subcontracting level), involving the use of vehicles and technical equipment, the supply of raw materials (aggregates and other construction materials), and consequently a direct or indirect increase in employment.

In addition, indirect economic benefits will occur in the services, commerce, catering, and hospitality sectors in the wider area.

**The construction of the project positively affects the economic and productive activities of the region, and the impacts are assessed as direct and indirect, local, and of high intensity.**

**Operation Phase**

The impacts from the operation of the projects on the local economy are reflected in the Development Plan of the area upon completion of the works, as presented in Chapter 6.5 (Proposed Development Plan of the Area) and in Chapter 4 (Justification of Project Implementation Feasibility) of the present Environmental Impact Study.

The operation of the works will increase production quantitatively, reduce production costs, and enable the cultivation of more profitable crops, bringing undeniable economic benefits to the area. Although the benefits primarily concern farmers and producers, they will also diffuse throughout the broader local community, including stakeholders and related enterprises.

The data regarding the improvement of agricultural productivity are particularly significant, and with the completion of private investments:

- The net added value increases by 136.50%.
- The farm income increases by 136.68%.
- The farm profit rises from €135,022.37 to €7,681,520.73 (5,589.07% increase).
- The household income increases by 110.27%.

The strengthening of all sectors related to both production and services in the local economy will be a direct consequence and the expected result of the investment from the construction of the works, with long-term positive effects on the region’s economic development.

**Overall, the impacts from the operation of the works are characterized as positive, both direct and indirect, affecting the entire area, and of high intensity.**

### 9.7.3. Impacts on Employment

**Construction Phase**

As mentioned in the previous section, during the construction phase there will be a creation of job opportunities (e.g., for workers, drivers, technical personnel, and machinery operators), as well as contracting opportunities for small local businesses (at the subcontracting level) through the use of vehicles, construction machinery, and supply of raw materials (aggregates and other building materials), resulting in a direct or indirect increase in employment.

In addition, indirect economic benefits will emerge in other sectors such as services, commerce, catering, and hospitality in the wider region, leading to a general boost in employment across multiple activities.

**Since the construction of the project positively affects the economic and productive activities of the area, it will also have positive effects on employment, which are assessed as direct and indirect, local and general, and of high intensity, proportionate to the project's scale.**

**Operation Phase**

Similarly, during the operation phase — according to the data presented in the Regional Development Plan — the operation of the works will increase production, reduce production costs, and enable the establishment of more productive crops, with clear economic benefits for the area. Although the benefits mainly concern farmers and producers, they will spread to the broader community, including local stakeholders and businesses.

- Specifically for employment, the total number of absorbed workdays is expected to almost double (+373,899.65).

**Conclusion: The impacts from the operation of the projects are characterized as positive, both direct and indirect, covering the entire area, and of high intensity.**

### 9.7.4. Contribution of the Project to the Regional and National Economy

**Construction Phase**

The project's contribution to both the regional and national economy will be particularly significant, given the substantial investment value, which is expected to reach €136,000,000. Of this amount, approximately €24,000,000 will concern private investments for the implementation of local irrigation networks, greenhouse construction, and related equipment.

According to the data from the Agro-Economic and Technical Study and the Regional Development Plan, which are presented in detail in Chapter 6.5 of this Environmental Impact Study, the productivity and efficiency indices of the project show the following notable changes:

- The gross added value increases by 132.67%, while the gross added value excluding interest increases by 134.29% after the project's implementation.
- The Internal Rate of Return (IRR) is estimated at 10.60%.
- The Benefit/Cost Ratio is calculated at 1.41.

**The aforementioned values of the key economic parameters demonstrate that the project is of high efficiency and viability from a national economic perspective.**

The allocation of the planned investment amount for the project's construction in a region with one of the lowest GDP levels in the country is considered a particularly positive development.

At the same time, the inflow of the majority of this amount from European funding sources constitutes a highly significant factor at the level of overall project financing.

**The construction of the project has a positive impact on both the regional and national economy, and these effects are assessed as positive, direct and indirect, broad in scale, and of high intensity.**

**Operation Phase**

The economic impacts resulting from the operation of the project on the regional and national economy are reflected in the Regional Development Plan presented in Chapter 6.5 of this Environmental Impact Study (EIS) and in Chapter 4 (Justification of Project Implementation Feasibility). Based on these data, it is evident that upon completion of the project, the improvement in agricultural productivity and output will be particularly significant, especially when combined with complementary private investments. Specifically:

- The net added value increases by 136.50%.
- The farm income increases by 136.68%.
- The farm profit rises from €135,022.37 to €7,681,520.73 (an increase of 5,589.07%).
- The household income increases by 110.27%.
- The total absorbed workdays are expected to almost double (+373,899.65).

Although the aforementioned benefits primarily concern farmers and agricultural producers, they will disseminate throughout the broader regional and national economy, encompassing local stakeholders and associated enterprises. In this way, they will support and strengthen developmental factors that promote spatial and sectoral integration, as well as wider economic and social connectivity.

The aforementioned economic indicators once again confirm that the project demonstrates high efficiency from a national economic standpoint. Therefore, **the impacts from its operation are characterized as positive, direct and indirect, broad in scale, and of high intensity.**

### 9.7.5. Contribution of the Project to Quality of Life, Land Value, and Connectivity Opportunities

**Construction and Operation Phase**

The examined projects will inevitably enhance the value of agricultural land as well as the broader land value of the area, for the reasons already discussed in previous sections. The increase in income constitutes the primary factor for the improvement of quality of life, accompanied by a corresponding enhancement of public services, infrastructure, and daily living conditions for residents, as well as improvements in connectivity and accessibility.
Furthermore, the dam and reservoir are expected to become a new landmark feature in the area, potentially serving as a point of attraction for visitors and a reference site for the region's identity and development.

**The impacts from both the construction and operation phases are therefore assessed as positive, direct and indirect, local and regional in scale, and of high intensity.**

#### 9.7.6. Potential Conflicts with Other Programs – Development Trends

**Construction and Operation Phase**

Based on the data recorded and presented in Chapter 8, no conflicts or contradictions with any existing plans or programs have been identified. The only potentially competitive trend, in purely economic terms, concerns the increasing demand for land for tourism and residential use observed in the southern coastal areas.

On the contrary, the examined projects are fully consistent with all existing development plans and guidelines, as described in Chapter 5.

**The impacts arising from both the construction and operation phases are characterized as positive, direct and indirect, local and regional in scale, and of high intensity.**

### 9.8. Impacts on Technical Infrastructure

#### 9.8.1. Construction Phase

According to the information provided in Chapter 8.8, the examined projects relate to the following technical infrastructure components:

**Road Network**

The road network in the area surrounding the dam site consists primarily of agricultural and forest roads. The project foresees the use of this existing network, along with the construction of short supplementary road segments to provide access to the construction site and, possibly, to the borrow pit area. Additionally, the creation of the reservoir will result in the interruption of the existing agricultural road network at two points (as shown in Plans GO-1.4 and XE-1).

This road network currently allows farmers to access both the riverbanks for cultivation and other properties located outside the reservoir area, which they would otherwise lose access to. It also serves as a connection between the settlements of Vlassaïika and Kallithea.

Regarding the construction of the irrigation network (main pipelines and tanks at this stage), it will follow the existing road alignments, with the pipes installed beneath the roads. Only for very short sections will the alignment diverge from existing routes; in these locations, after land expropriation, a new road will be constructed to connect to and improve the existing road system. During construction, there will be a temporary need to close short road sections for limited periods, after which traffic will be fully restored.

This approach is expected to minimize impacts on road users, while the restored sections will be returned in improved condition with better traffic standards.

In any case, within the reservoir basin area, it is necessary to restore communication and access between settlements and farmlands with roads of improved quality compared to the existing ones. For this purpose, this issue will be addressed during the detailed design phase, and the required engineering solutions will be implemented.

**The impacts from the construction of the examined projects on the road network are assessed as negative, direct, local, of moderate intensity, but reversible and manageable.**

**Transportation and Traffic**

During the implementation phase, there will be an increase in heavy vehicle traffic, and it is also expected that there will be needs for temporary traffic management measures (e.g., temporary diversions and detours) due to the installation of main pipelines beneath existing roads.

**The construction of the project will affect road transportation and traffic, and the impacts are assessed as temporary, negative, direct, local in scale, low in intensity, reversible, and fully manageable.**

**Water Supply – Communities of Militsa (Municipality of Messini) and Lachanada–Finikounda (Municipality of Methoni)**

In the project area, and specifically at the location of the dam and reservoir, as already mentioned in Section 8.8.3.1 (Water Supply Sources), there are springs and installations that supply the water systems of these settlements, which fall under the jurisdiction of DEYA Messini and DEYA Methoni, respectively.

These springs and water supply installations are located within the reservoir basin (see Plan XE-1) and will cease to function once the project is implemented. Consequently, their replacement by an alternative water source must be secured prior to the start of dam construction works.

Regarding the construction of the irrigation network, particularly the main pipelines that will run along existing roads, which also host the municipal water supply pipelines, no impacts are expected, since the water supply pipelines have small diameters and are placed at the sides of the roads rather than underneath them.

**The impacts from the construction of the examined projects on the water supply system (springs and pipelines) are therefore evaluated as negative, direct, local, of high intensity, but reversible and manageable.**

**Waste Management during Construction**

During the construction phase, Excavation, Construction, and Demolition Waste (ECDW) will be generated — for instance, unusable fragments of materials (pipes, reinforcement steel, wooden formwork), as well as waste resulting from the removal of construction site installations, etc.
If such waste is not properly managed in accordance with current legislation, and disposed of uncontrollably, it could pose pollution risks.

Waste from office areas must be collected and managed in the same way as household waste.

The construction of the project will therefore increase the volume and alter the type of generated waste, and the impacts are characterized as temporary, negative, direct, local, low in intensity, reversible, and fully manageable.

### 9.8.2. Operation Phase

**<u>Waste Management</u>**

During the operation phase of the projects, the most environmentally critical factor, due to its potential hazardous nature, is the management of empty pesticide containers and the pollution caused by the uncontrolled disposal of plant protection product packaging (PPPs) — a common and severe problem in most irrigation projects.

The project management authority (TOEB) will be responsible for informing users and ensuring the implementation of Best Management Practices (BMPs) for the use of agricultural chemicals, in accordance with relevant national legislation on the management of packaging waste.

The management of packaging waste generated after the use of their contents and containing residues thereof (EWC code 15 01 10) must comply with the following legal provisions:

- Law 2939/2001 (Government Gazette 179/A/2001), as amended and in force.
- Law 4036/2012 (Government Gazette 8/A), as amended and in force.
- Joint Ministerial Decision 8197/90920/2013 (Government Gazette 1883/B).

- Circular 5919/62354/13-5-2014 (Ref. ADA: ΒΙΦ2Β-ΡΟΗ) issued by the Ministry of Rural Development and Food, concerning best practices for the use of agricultural pesticides.

According to Article 29 of Decision 8197/90920/2013 (Government Gazette 1883/B/1-8-2013), the management of empty pesticide containers (EWC code 15 01 10*) must be carried out in accordance with Law 2939/2001, as in force.

For the effective management of such packaging waste, the following minimum measures are required:

- A) Containers must be washed immediately after use (triple rinsing by hand or mechanical cleaning under pressure), and the rinsing water must be poured into the spray tank.
- B) Separate collection of such waste must be organized — distinct from other packaging waste — using special collection bins placed, as far as possible, close to the points of pesticide use and emptying.
- C) The further collection and transportation of these materials must be directed to authorized facilities for processing and recovery of materials or energy. In the case of recycling, appropriate measures must be taken to ensure that the recycled materials are used only for permitted purposes, thereby safeguarding public health in accordance with existing legislation.

The organization of packaging waste management in accordance with the above requirements will be carried out by an Alternative Waste Management System, as stipulated by the provisions of Law 2939/2001 (Government Gazette 179/A/2001), as currently in force.

The implementation of these measures by both the farmers and the project's management authority (TOEB) will minimize the risk of pesticide residue dispersion into the environment, particularly in water bodies.

The application of these procedures is currently mandatory and is already being implemented by farmers. With the completion of the project and the establishment of collective management through the TOEB, further improvement in performance on this issue is expected.

The anticipated impacts are therefore considered positive, contributing to optimal management of pesticide containers, while the possible increase in waste quantities does not constitute a negative impact.

For the implementation of these provisions, the relevant measures for the installation of the collection and management system are detailed in Section 10.4 of this study.

**Road Network**

As mentioned earlier, the existing agricultural road network will be interrupted at two points; however, in the subsequent detailed design phase, its restoration will be studied to ensure at least equivalent functionality to its current condition. Consequently, no negative impacts are expected during the operation phase. On the contrary, with the construction of the peripheral road around the dam reservoir, the local road network is expected to improve significantly.

## 9.9. Correlation with Human-Induced Environmental Pressures

### 9.9.1. Construction Phase

Operation of Borrow Pits

During the construction phase, to meet the material needs, borrow pits will be operated. These pits will function as supporting works for the dam, and their operation and restoration terms will be approved simultaneously with the main project. They will be used exclusively for the project’s needs.

Given that the required quantities are relatively small, the interaction with existing human-induced pressures in the area will be limited and temporary.

The impacts of this subsection overlap with those discussed in Sections 9.4 and 9.13, where they are analyzed in detail. From the perspective of anthropogenic pressures, they are considered neutral.

### 9.9.2. Operation Phase

Irrigation Wells

According to the data presented in Chapter 8.9, the examined projects are directly related to irrigation activities, and consequently to a significant portion of the 89 existing irrigation wells in the area under study.

It is estimated that the wells irrigating the areas included in the project design will gradually cease operation, leading to a quantitative and qualitative improvement in the groundwater resources, not only within but also beyond the irrigated area.

It is also noted that no increase in cultivated land is expected following the operation of the projects.

**The impacts from the operation phase are therefore assessed as positive, direct and indirect, local and regional in scale, and of high intensity.**

## 9.10. Impacts on Air Quality

### 9.10.1. Construction Phase

During the construction of the projects, due to the nature of the works (excavations, backfilling, gravel spreading, aggregate and concrete production, and material transport by heavy vehicles), localized dust emissions and temporary degradation of air quality are expected.

However, the small scale of the works and the location of the main structure (the dam)—within the stream bed and far from settlements—minimize these effects, restricting them both spatially and temporally, mainly during earthworks.

The topography of the area and its almost complete vegetation cover act as natural barriers to dust and exhaust dispersion. It is estimated that one hectare of forested land can retain 3,200 kg of dust per year, bind 400 kg of carbon dioxide, and that a 500-meter-wide green zone can reduce sulfur dioxide concentrations by up to 80%.

The exhaust gas emissions from construction machinery will be periodic and low in volume, thus not significantly burdening the surrounding environment.

**Therefore, the construction phase will have temporary, direct, local, low-intensity, and partially manageable impacts on air quality.**

### 9.10.2. Operation Phase

During the **operation phase**, **no impacts on air quality** are expected from the functioning of the examined projects.

## 9.11. Impacts on the Acoustic Environment

### 9.11.1. Construction Phase

During the construction of the project, various vehicles and earthmoving machinery will be used throughout the project area, while at the construction sites, there will also be production activities (e.g. concrete production). As a result, a temporary increase in noise levels is expected in the project area during the construction of the dam, the installation of networks, and at the construction sites, throughout the duration of the works.

Additionally, the operation of the borrow pits for rocky materials (L1 and L2) will cause an increase in noise levels due to extraction activities. This situation is unavoidable, but to a significant extent manageable, through the adoption of appropriate measures — both in the exploitation study (precise siting of the installations on the alluvial formation, selection of suitable machinery, etc.) and in the operation plan (methods used, operating hours, etc.). These issues, along with the restoration of the areas after the completion of extraction works, will be addressed in the Special Environmental Restoration Study (SERM), as well as in the Technical Exploitation Study and the corresponding Environmental Impact Assessment (EIA).

At this stage, guidelines and conditions are provided that will be included in these specific studies, which will be prepared based on high-accuracy and reliability data produced in the subsequent stages of the project's technical studies.

The acoustic impacts depend on the scale of activities, the noise specifications of the equipment used, and the location of the project (far from settlements). An increase in sound levels is expected, but no significant rise in noise indicators is anticipated in sensitive environments or receptors during the construction period.

The dam site, which constitutes the main construction area, as indicated in Chapter 8.11, is located far from settlements and residences; therefore, no special measures are deemed necessary to limit the noise generated by the operation of the construction machinery.

For the installation of irrigation pipelines, some construction sites will be established near or within settlements. However, this activity will be temporary, mobile, and of low intensity.

During the construction phase, a temporary disturbance of the acoustic environment is expected in the immediate vicinity of the works, caused by construction machinery and heavy vehicles. Based on estimates from similar projects (e.g. the EIA of the Filiatrino Dam), noise levels are not expected to exceed 65 dB(A) Leq over 12 hours at a distance of approximately 100 meters from the construction site — a distance within which no settlements or residences are present.

Furthermore, the additional noise levels due to the movement of heavy vehicles for the transportation of materials or aggregates are expected to be negligible, and therefore no further calculations are required.

As for the disturbance caused by construction noise on local fauna, it cannot be precisely evaluated since no standardized limits exist. Empirical evidence suggests that some species may temporarily move away, but this effect is short-lived, as fauna generally adapts to new conditions and returns after the completion of the works.
The application of Environmental Terms (E.T.) for the operation of the construction sites will significantly reduce these impacts.

The road traffic noise resulting from the movement of vehicles related to the project is estimated to be very low for the examined environment.

**Therefore, the construction of the project will affect the acoustic environment, and the impacts are characterized as temporary, direct, local in scale, low in intensity, and partially manageable.**

### 9.11.2. Operation Phase

No impacts on the acoustic environment are expected during the operation phase of the project, as no noise-generating processes or machinery will be involved. The mechanical equipment that will operate—electric motors and pumps—will be located at the pumping stations, both at the main downstream point of the stream and at peripheral sites. This equipment is not particularly noisy and is also situated far from sensitive receptors.

## 9.12. Impacts from Electromagnetic Fields

The project is not associated with this parameter.

## 9.13. Impacts on Water Resources

### 9.13.1. Construction Phase

Surface Waters

The main construction activities that may affect surface water resources are the earthworks involved in building the dam along the stream bed, which may cause a temporary increase in suspended solids (sediment load) during construction. These impacts are particularly related to the construction and operation of the cofferdam and the diversion pipeline.

Additionally, there remains the risk of accidental water pollution from potential leakages or spills of fuels, lubricants, and other construction materials necessary for the works. These issues have already been examined in Section 9.4.1 – Supporting Infrastructure of the Works.

No significant alteration in the quantity or runoff pattern of surface waters is expected due to construction activities.

**Therefore, the impacts from these works are assessed as: Direct, general in scale, low in intensity, reversible, and manageable**.

Groundwater

During the construction phase, groundwater resources will not be affected, since there will be no water extraction or addition. The only potential risk concerns accidental pollution, which, if not addressed promptly, could result in pollutant infiltration into groundwater. However, this likelihood is considered very low and is therefore not evaluated further.

Consequently, these activities **do not affect groundwater resources**, and **no impacts are expected**.

### 9.13.2. Operation Phase of the Project

Compatibility with WFD and FRMP Objectives

As mentioned in Chapter 5 (Compatibility) and Section 8.13 (Water), the project is fully consistent with the objectives of the Water Framework Directive (WFD). The proposed works are explicitly listed in Table 4.2 of the Program of Measures for the Pamisos–Nedon–Neda River Basin District, under:

- Project No. 106: Minagiotiko Dam, and
- Project No. 118: Minagiotiko Dam Irrigation Networks.

Furthermore, the type of project aligns with, and will be highly beneficial regarding flood management, as it will retain flood discharges, thereby preventing flood phenomena in the lower sections of the stream bed. Hence, the project is consistent with the principles and objectives of the Flood Risk Management Plan (FRMP).

Water Resources

The impacts from the operation of the project primarily involve an increase in the use of the region's water resources, as prior to the project's implementation there was no systematic utilization of surface waters for irrigation.

The construction and operation of the works are fully aligned with all policies and directives aiming at the optimal use of water resources, both for agricultural and environmental management purposes (see Chapter 5 – *Compatibility with Other Plans*). These policies promote the increased use of surface waters through reservoirs and distribution networks, while reducing reliance on groundwater extraction.

It is also noted that, for an annual extractable volume of 8,633,410 $m^3$/year and an irrigated area of 35,000 stremmas, the average annual water demand is 247 $m^3$/stremma, which is considered environmentally sustainable and efficient.

From a quantitative perspective, downstream flows of the dam will decrease, remaining limited to those originating from the downstream part of the catchment area up to its mouth, including the mandatory ecological flow.

An adequate ecological flow has been ensured throughout the year (see Chapter 6.6.2.7 of this EIA), as provided by the dam's continuous water release system, described in Chapter 6.1.4 and Drawings 3.7–3.10 of the preliminary hydraulic study.

Among the positive aspects of the dam's operation is its significant flood control function, as flood discharges from the upstream basin will be retained, thereby preventing flooding events in the downstream reaches of the stream.

Another important parameter related to surface waters is sediment transport, which occurs mainly during flood events. Within the framework of the final design phase of the dam, this issue will be studied in detail, and appropriate measures will be proposed to control sediment inflow and preserve the reservoir's dead storage volume.

However, there remains the possibility of impacts due to the reduction in the stream's hydraulic discharge downstream of the dam. To better assess the future hydrological conditions of the downstream basin up to its outflow, it is proposed in the next chapter to prepare a specialized study, which will include an analysis of sediment transport for the estimation of total hydraulic and sediment discharge.

**The operation of the project affects surface waters, and the impacts are evaluated as follows:**

- **Negative in quantitative terms, but highly positive regarding the sustainable management of natural resources (i.e., surface water storage). These impacts are permanent, direct and indirect, broad in scale, low in intensity, and manageable.**
- **Positive, of equivalent nature, intensity, and scale, both due to the ensured ecological flow throughout the year and the significant flood control function of the dam, as well as because the overall water management approach is permitted and compatible with relevant directives.**

<u>Groundwater</u>

The impacts on groundwater resources will be positive, as the existing pumping operations will cease following the commencement of the project's operation. Additionally, the reservoir's presence and the potential infiltration of stored water will further enhance groundwater recharge.
Overall, the impacts are assessed as positive, direct and indirect, local and regional in scale, and of moderate intensity.

### 9.14. Impacts from the Risk of Dam Failure

Although dams are generally designed with adequate safety factors and their construction is carried out with high precision and quality control, the possibility of failure, whether due to overtopping or other causes, cannot be entirely ruled out—even though it is considered an exceptionally rare event.

The relevant stability analysis of the dam embankment was conducted as part of the dam's preliminary design study (see Chapter 6). The following operational conditions were examined:

- Normal operation (with and without seismic loading),

- Operation during filling (with and without seismic loading), and
- Flood conditions, under the predicted loading scenarios.

<u>From this analysis, it was determined that safety factors are fully satisfied under all examined conditions.</u>

In the subsequent stages of the technical studies, a Dam Break Analysis will be prepared to determine the associated risks.

Upon completion of this study and the implementation of its recommendations and guidelines, the optimal management of potential hazards will be achieved. This analysis will also be integrated into the regional civil protection plan for the area.
In any case, the small size of the dam and its operational mode (non-perennial water storage) minimize the associated risk.

At this stage of the studies, no evaluation of potential impacts resulting from a dam breach has been recorded. However, based on the existing studies, it is confirmed that technical requirements and safety standards are met, and no significant impacts are expected.

## 9.15. Summary Assessment of Impacts

### 9.15.1. General

From the findings presented in the previous chapters, the following general conclusions can be drawn regarding the impacts of the dam's construction and operation:

- **<u>Impacts during the construction period.</u>**

These impacts are temporary and generally reversible, provided that the contractor adheres to the required mitigation measures and procedures, and that the Environmental Terms and Conditions (E.T.C.) are strictly implemented.

During the construction phase, some burden on the environment will arise due to the movement of vehicles for the transportation of materials, machinery, and workers, as well as from the construction works for external aqueducts, which are generally installed beneath existing roads.

The clearing of vegetation in the areas occupied by the dam and the reservoir will affect a small area within the stream bed, covered with shrubby and scattered tree vegetation. This vegetation is not particularly significant in terms of forest species composition and will be partially restored, considering the already dense natural vegetation around the reservoir's perimeter.

- **<u>Impacts during the operational phase</u>**

By their nature, the works are expected to produce strong, positive, and permanent impacts on agriculture and the economy (both local and national). These beneficial effects constitute the primary objective of the project's implementation.

Additionally, there will be significant diffusion of positive impacts across all sectors of the local and regional economy, contributing to the overall socio-economic development of the broader area.

### 9.15.2 Evaluation of Major Impacts

The following section provides a concise assessment and evaluation of the substantial impacts resulting from the construction and operation of the project. Specifically, it focuses on impacts of moderate and high intensity and scale.

**Negative Impacts**

Construction Phase

As mentioned previously, the negative impacts during the construction phase are direct and mainly concern:

- The establishment of borrow pits and construction sites, which represent landscape discontinuities and may cause visual disturbance.
- The disruption of sections of agricultural and forest road networks, which will be submerged as they are located within the reservoir inundation area.
- The submergence of springs and water supply facilities serving the communities of Lahanada and Militsa, which will also fall within the reservoir basin.
- The reduction of surface runoff in the stream due to the operation of the reservoir.

Operation Phase

During the operation phase, the negative impacts recorded relate only to the reduction of surface runoff in the stream. These are of low intensity, primarily concerning seasonal flood discharges, and are offset by the ensured ecological flow, which remains continuous even during dry summer months.

The dam will, to a very large extent, enable optimal interseasonal regulation of flood discharges, particularly in the upstream section of the overall catchment area. The downstream flows, combined with the stable ecological discharge from the dam (maintained throughout the year), will continue to feed the stream channel up to its outflow.

This water management regime fully aligns with all relevant directives and policies, both concerning water use and sustainable environmental management.

**Positive Impacts**

Construction Phase

As previously noted, positive impacts during the construction phase are strong, direct, and indirect, affecting multiple sectors and levels of the economy. The project represents a clearly developmental intervention, producing beneficial and reinforcing effects that support the implementation of spatial and urban planning frameworks.

Operation Phase

The positive impacts expected during the operation phase are permanent and significant, contributing meaningfully to:

- **The improvement of agricultural conditions and the economic performance of** farming activities, with substantial benefits for the overall regional economy.
- **The flood control function of the stream, through regulated flow retention and protection of downstream areas.**
- **The enhancement of groundwater resources, due to the cessation of irrigation borehole use and recharge effects from the reservoir's infiltration processes.**

### 9.15.3 Overall Impact Assessment

The negative impacts of the examined projects essentially concern only the construction phase, are local in scope, and of limited scale and intensity. Moreover, they will be effectively mitigated through the proposed measures presented in the following chapter, as well as through the Environmental Terms and Conditions, which ensure proper management of potential disturbances.

In contrast, the positive impacts will manifest during both phases — construction and operation — and will be of high intensity, affecting the overall economy of the region. These positive effects are also expected **to be permanent**.

In essence, from the combined evaluation of all impacts, it is concluded that the examined projects:

- Are fully compatible with the institutional and regulatory framework;
- Are inherently developmental and environmentally friendly in nature;
- Generate solely positive and lasting effects on both the natural and socio-economic environment.

A comprehensive evaluation matrix of the project's impacts, distinguishing between the construction and operation phases, is presented below to provide a holistic overview of the environmental implications.

The classification follows the broad categories of impact receptors used throughout this chapter, ensuring consistency and clarity in the assessment process.

Finally, the mitigation and management measures for addressing the identified impacts are detailed in the next chapter of the study.

**Table 9.2 – Assessment of Impacts from Construction Phase**

| Impact Receptor | Positive Impacts | | | Negative Impacts | | | | | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | Direct / Indirect | Extent Local / General L/G | Intensity 3>2>1 | Direct / Indirect | Extent Local / General L/G | Intensity 3>2>1 | Reversibility N/O | Adressing Yes/No/Partial | |
| 9.2. Climate, Bioclimate | | | | | | | | | No expected impacts. |
| 9.3. Morphological and Topological Characteristics | | | | A | T | 2 | O | Y | Due to earthworks, creation of borrow and disposal pits. |
| 9.4. Geological and Soil Characteristics | | | | A | T | 2 | O | P | From the dam, due to earthworks and borrow pits |
| | | | | A | T | 1 | N | Y | From the construction of the irrigation network |
| | | | | A | T | 1 | N | P | From the establishment of the construction sites |
| 9.5. Natural Environment | | | | | | | | | |
| 9.5.1. Habitats, Flora, Fauna | | | | A | T | 2 | O/N | O/N | The occupation and covering of stream areas, resulting in their conversion into a water surface, had a local and moderate impact, which was reversible and adequately mitigated. The occupation of zones intended to be used as borrow pits also constituted a negative impact, which was immediate, local, of moderate intensity, |

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| | | | | | | | | | reversible, and mitigated through the use of vegetation. |
| 9.5.2. Protected Areas | | | | A | T | 2 | O/N | O/N | The same considerations mentioned above apply to the areas that fall within the Natura 2000 network. |
| 9.5.3. Forests and Forested Areas | | | | A | T | 2 | O/N | O/N | The same considerations mentioned above also apply to the areas that fall within the forested zones. |
| 9.5.4.1. Other Important Terrestrial and Inland Water Areas | | | | - | - | - | - | - | None exist |
| 9.5.4.2. Other Important Marine Areas | | | | - | - | - | - | - | None exist |
| 9.6. Human-made Environment | | | | | | | | | |
| 9.6.1. Spatial Planning, Land Use | I | G | 2 | | | | | | For design compatibility and to support sustainable agricultural practices |
| 9.6.2. Structure of the Human-made Environment | I | G | 2 | | | | | | For design compatibility and to support sustainable agricultural practices |
| 9.6.3. Cultural Environment | | | | | | | | | No impacts are expected, provided that the mitigation measures recommended by the competent authority (TP.PO.) are implemented. |

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| 9.7. Socio-economic Impacts | | | | | | | | | |
| 9.7.1. Population, Housing | I | G | 2 | | | | | | Due to the strong retention capacity of the local population. |
| 9.7.2. Structure of Local Economy | D,I | G,L | 3 | | | | | | Due to the increase in employment opportunities, enhancement of supply services, catering, and commercial activities. |
| 9.7.3. Employment | D,I | L,G | 3 | | | | | | A significant increase in employment is expected during the construction phase. |
| 9.7.4. National and Regional Economy | D,I | G | 3 | | | | | | Due to the inflow of funding into the region, the level of investment, and the project's efficiency. |
| 9.7.5. Quality of Life, Land Value | D,I | L,G | 3 | | | | | | Increased agricultural land value, production, and income. |
| 9.7.6. Conflicts with Development Trends | D,I | L,G | 3 | | | | | | On the contrary, full compatibility |
| 9.8. Impacts on Technical Infrastructure | | | | | | | | | |
| Road Network | | | | A | T | 2 | Y | Y | Due to the removal of sections of the agricultural network in the reservoir area, as well as their subsequent restoration. |
| Transport – Traffic | | | | A | T | 1 | Y | Y | As a result of the temporary blockage of certain roads during |

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| | | | | | | | | | the construction of the main irrigation network |
| Community Water Supply | | | | A | T | 3 | Y | Y | Due to the removal of the irrigation sources and facilities of the communities of Lachanadas and Militsa, as well as their subsequent restoration. |
| Waste | | | | A | T | 1 | Y | Y | Limited impacts are anticipated from construction sites and related activities, but they are controllable. |
| 9.9. Human-induced Pressures on the Environment | | | | | | | | | The related pressures concerning the aggregates are assessed in Sections 9.3 and 9.4. |
| 9.10. Air Quality | | | | | | | | | Due to dust emissions from construction sites. |
| 9.11. Noise | | | | | | | | | Construction and vehicle operations may cause moderate, manageable noise increase. |
| 9.12. Electromagnetic Fields | | | | | | | | | No impacts are expected. |
| 9.13. Impacts on Water Resources | | | | | | | | | |
| 9.13.1. Compatibility with RBMP | | | | | | | | | No impacts are expected, as the project is fully compatible. |
| 9.13.2. Surface Waters | | | | A | G | 1 | Y | P | Possible impacts from decreased surface runoff, although the project is |

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| | | | | | | | | | compatible and its construction is foreseen. |
| 9.13.3. Groundwater | | | | | | | | | No impacts are expected. |
| 9.15. Impacts on Public Safety – Civil Protection | | | | | | | | | No impact, provided that safety measures and environmental conditions are observed. |
| 9.15 Overall Impact Assessment | D,I | L,G | 3 | | | | | | **Due to institutional compatibility and the purely developmental and environmentally friendly nature of the projects, permanent positive impacts prevail.** |

**Table 9.3 – Assessment of Impacts during Operation**

| **Impact Receptor** | **Positive Impacts** | | | **Negative Impacts** | | | | | **Remarks** |
|---|---|---|---|---|---|---|---|---|---|
| | **Direct / Indirect** | **Extent Local / General L/G** | **Intensity 3>2>1** | **Direct / Indirect** | **Extent Local / General L/G** | **Intensity 3>2>1** | **Reversibility N/O** | **Reversibility Yes/No/Partial Y/N/P** | |
| 9.2. Climate, Bioclimate | | | | | | | | | No impacts are expected. |

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| 9.3. Morphological and Topological Characteristics | | | | | | | | | No impacts are expected, provided that the proposed restoration measures for the borrow pit areas and the proper implementation of the corresponding studies are applied. |
| 9.4. Geological and Soil Characteristics | | | | | | | | | No impacts are expected, provided that the proposed restoration measures for the borrow pit areas and the proper implementation of the corresponding studies are applied. |
| 9.5. Natural Environment | | | | | | | | | |
| 9.5.1. Habitats – Flora and Fauna | D | L | 2 | D | L | 2 | Y | Y | Positive impacts are expected in the local fauna, where a habitat will be created in the area, enhancing biodiversity and supporting wildlife species.<br>Positive impacts are also anticipated in the cultivated areas, which will benefit from the improved effect of the irrigation network.<br>Negative impacts are expected to occur in wetlands located within the dam area, where the |

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| | | | | | | | | | inflow of irrigation water and the local ecosystem could be affected, potentially exerting pressure on the conservation of the habitats of protected species. All negative impacts are local, moderate, and can be mitigated through appropriate measures. |
| 9.5.2. Protected Areas | D | L | 2 | D | L | 2 | Y | Y | All species that have been recorded and are present in the Natura 2000 area are listed. |
| 9.5.3. Forests and Woodland Areas | | | | - | - | - | - | - | Forested areas are expected to be affected by the operation of the project. |
| 9.5.4.1 Other Important Areas of Land and Inland Waters | - | - | - | - | - | - | - | - | Forested areas are expected to be affected by the operation of the project. |
| 9.5.4.2 Other Important Marine Areas | - | - | - | - | - | - | - | - | Marine areas are not expected to be affected by the operation of the project. |
| 9.6. Anthropogenic Environment | | | | | | | | | |
| 9.6.1 Spatial Planning, Land Uses | I | G | 2 | | | | | | Due to design compatibility and the enhancement of the sustainability of agricultural activities. |

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| 9.6.2 Structure of the Human Environment | I | G | 2 | | | | | | Due to compatibility with the design and the enhancement of the sustainability of agricultural activities. |
| 9.6.3 Cultural Environment | | | | | | | | | No impacts are expected, provided that the measures recommended by the EIA are implemented. |
| 9.7. Socio-economic Impacts | | | | | | | | | |
| 9.7.1. Population – Housing | D,I | L,G | 2 | | | | | | Due to retention of the local population and attraction of new residents. |
| 9.7.2. Structure of the Local Economy | D,I | L,G | 3 | | | | | | Due to the increase in jobs, production, services, and trade. The large scale of the investment, as well as the permanence of the improvements in agricultural economic results, will positively affect all sectors of the economy. |
| 9.7.3. Employment | D,I | L,G | 3 | | | | | | A doubling of daily wages in agriculture is expected, as well as a spillover of this increase to other sectors. |
| 9.7.4. National and Regional Economy | D,I | L,G | 3 | | | | | | Due to the inflow of funding into the region, the large scale |

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| | | | | | | | | | of the investment, and the project's efficiency. |
| 9.7.5. Quality of Life, Land Value | D,I | L,G | 3 | | | | | | Increase in land value and income, which constitute the main factor for improving quality of life, along with a corresponding improvement in services and amenities. |
| 9.7.6. Compatibility with Development Trends | D,I | L,G | 3 | | | | | | There are no conflicts; on the contrary, there is full compatibility and substantial support for the implementation of the planned actions. |
| 9.8. Impacts on Technical Infrastructure | | | | | | | | | |
| Road Network | | | | | | | | | The project's operation is not expected to cause any impacts, since the section that is occupied will be fully restored. |
| Transport – Traffic | | | | | | | | | No impacts are expected from the operation of the project. |
| Community Water Supply | | | | | | | | | No impacts are expected from the operation of the project, given that the restoration of the water supply sources will precede the works. |
| Waste | I | L | 1 | | | | | | No negative impacts are expected from the operation of |

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| | | | | | | | | | the project. On the contrary, positive effects are anticipated through the enhancement of the collection system for packaging waste. |
| 9.9 Anthropogenic Pressures on the Environment | D,I | L,G | 3 | | | | | | Due to the cessation of the existing irrigation wells in the irrigated area. |
| 9.10 Air Quality | | | | | | | | | The operation of the projects is not related to air quality. |
| 9.11 Noise | | | | | | | | | The operation of the projects will not affect traffic levels. |
| 9.12 Electromagnetic Fields | | | | | | | | | The operation of the projects is not related to this parameter. |
| 9.13 Impacts on Water Bodies | | | | | | | | | |
| 9.13.1 Compatibility with RBMP | | | | | | | | | There is compatibility with the River Basin Management Plans both in terms of surface water utilization and in terms of the area of irrigated land |
| 9.13.2 Surface Waters | D,I | G | 1 | D,I | G | 1 | | Y | <u>Negative impact</u> due to reduced surface runoff. A study is recommended to determine the quantity and timing of the flow.<br><u>Positive impact</u> due to the ensured ecological flow throughout all months of the |

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| | | | | | | | | | year and the flood protection provided by the dam |
| 9.13.3 Groundwaters | D,I | L,G | 2 | | | | | | Broader significant positive impacts are expected due to the cessation of operation of the current wells and the recharge of the groundwater aquifer by the reservoir |
| 9.14. Impacts on Public Safety – Civil Protection | | | | | | | | | Based on the existing safety design data of the dam, no impacts are expected. This will be re-evaluated at a later stage when the dam's structural study is completed |
| 9.15 Overall Impact Assessment | D,I | L,G | 3 | | | | | | Due to institutional compatibility, developmental nature of the projects, and their environmentally friendly design, permanent positive impacts prevail |

# 10. PROPOSED MEASURES FOR ADDRESSING THE ENVIRONMENTAL IMPACTS

This chapter proposes mitigation measures for the significant adverse environmental impacts identified during the construction and operation phases of the studied irrigation projects (the dam and the irrigation network), based on the evaluation carried out in the previous chapter.

The mitigation measures concern both the construction and operational phases of the projects, categorized by thematic unit and presented below.

The construction phase involves the implementation of:

- The dam and the reservoir,
- The network of underground irrigation pipelines, including small sections of new rural road infrastructure,
- Point-based works, such as tanks and pumping stations,
- Associated and supporting facilities for the construction of the works, namely work sites, borrow pits, and disposal areas (W.S.B.D. – Work Sites, Borrow, and Disposal areas).

The operation of these W.S.B.D. facilities is also included in the construction phase, as they cease to function once the construction phase is completed.

Moreover, the total set of measures proposed has an overall positive effect on the project as a whole, not only on the thematic unit in which it is presented. It is important to emphasize that the technical design choices for the projects were made from the outset with environmental criteria in mind—for example, the delineation of irrigation zones considered land use and existing spatial planning frameworks (SCHOAP), and the selection of an RCC-type dam (Roller Compacted Concrete) instead of an earthen one, requiring fewer materials and occupying a smaller area. This process was carried out through continuous cooperation between the technical and environmental teams.

## 10.1 Mitigation of Impacts on Morphological and Landscape Characteristics

### 10.1.1 Construction Phase

The proposed measures to address the impacts on the morphology and landscape of the area are as follows:

The occupation/intervention zones will be limited strictly to the necessary width and surface area, according to the project design plans and the requirements for proper construction, in order to minimize impacts on adjacent agricultural land and forest vegetation.

At the dam construction site, once the works are completed, the final outcome will not require additional restoration. However, for the sites of the work areas, borrow pits, and disposal areas, the implementation of dedicated restoration studies, which will be prepared accordingly, is expected to fully mitigate the landscape impacts. More detailed and specialized measures are presented in the following section.
Within the framework of the restoration study for the borrow pits, the use of planting should be considered not only as a means of restoring the natural vegetation but also as a visual barrier—either at these sites or at another selected off-site location—to conceal the affected areas from nearby settlements and major road axes.

## 10.2 Measures for Addressing the Impacts on Geological, Tectonic, and Soil Characteristics

To prevent negative impacts from the construction sites and the borrow–disposal areas, specific measures can be implemented. These will be included and further specified in the Technical Environmental Study (TES) at a later stage of the project, as presented below.

**Initially, at the level of design and spatial planning:**

1. The project's construction facilities (main worksites) should be located within the intervention zone, in areas of land that will be expropriated for the project. Upon project completion, the worksite and the borrow–disposal areas must be fully restored in accordance with the provisions of the Technical Environmental Study (TES) that will be prepared by the Contractor for their licensing.
2. The borrow pit areas should be located on the hilly masses identified in the geological study. Their exact location will be determined in later study stages or within the TES, using criteria such as accessibility, exploitability, integration into the landscape (avoiding ridgelines), and restoration potential.
3. As stated in Section 9.11, within the framework of the specific studies for licensing the borrow pits—namely, the TES, the Technical Exploitation Study, the corresponding Environmental Impact Study (EIS), and the Restoration Study—the exact location within the suitable areas (hill ranges with appropriate geological materials) will be determined, as well as the extraction method and the corresponding equipment, based on the specific rock conditions and the material requirements of the project.
4. In the context of the restoration study for the borrow pits, the use of planting should be considered not only for restoring natural vegetation but also as a visual barrier to conceal the sites from areas such as settlements and main road corridors—either at these same locations or at another selected off-site point.
5. Within the specific exploitation studies, it should be sought to organize the extraction activities in a manner that allows for simultaneous restoration of the excavation areas. This ensures that extraction incorporates restoration requirements and facilitates the management of surplus excavation materials.
6. In the exploitation–restoration study, the morphological restoration should be planned from the outset, considering slope height and final topographic gradients, and selecting final slopes suitable for planting that resemble the pre-existing terrain.

7. The final surface, both morphologically and topographically, should be suitable for replanting, with sufficient soil thickness to support vegetation such as shrubs and/or trees proposed in the respective restoration study.
8. The borrow pits used exclusively for the project's needs should also be utilized inversely for the disposal of surplus excavation materials, as outlined in the relevant restoration study.
9. Regarding the construction of the irrigation network's regulation tanks, it should be examined during the design phase whether these can be integrated into the terrain as much as possible (by construction in excavation or semi-excavation) or subsequently surrounded by embankments and vegetation, so as to reduce their volume and visual intrusion.

**At the level of prevention and mitigation of impacts:**

1. The extent of the supporting facilities (construction sites, borrow pits, and disposal areas) shall be the minimum required according to the project's needs and as defined in the Technical Environmental Study (TES) to be prepared by the Contractor for their licensing.
2. The shaping of work surfaces shall be limited to the necessary area, and only technically essential interventions shall be permitted, strictly confined within the above-defined zones.
3. Major disturbances must be avoided, and slope formation must be appropriately designed and implemented both to prevent landslides and erosion phenomena and to facilitate the restoration of vegetation.
4. Care must be taken to ensure minimal disturbance of the natural environment in the project area so that the adverse effects on the local and wider natural environment are kept to an absolute minimum.
5. Measures must be taken to ensure the complete removal of excavation products, while any unsuitable excavation materials shall be deposited in approved disposal areas.
6. Within the framework of the present Environmental Impact Assessment (EIA), it is proposed that both suitable sites identified by the geological survey be licensed: the first at the "Arapolakki" area (L1) and the second (L2) south of the dam, west of the settlement of Vlassaika. Site L2 is initially proposed for the dam, while L1 is closer to the irrigation network area. The locations of the borrow and disposal areas are shown in Plan GM-11 of this EIA.
7. In addition to the aforementioned rocky borrow pits L1 and L2, within the reservoir basin suitable points D1 to D10 (Plans GM-12.1 and GM-12.2) have been identified for the extraction of borrow materials. These materials will be used mainly to reinforce the left abutment of the dam, and their approval is also requested.
8. In cases where surplus soil suitable for cultivation is requested to be disposed of in agricultural plots or public spaces for landscaping or rehabilitation purposes, prior consent must be obtained from the property owner or managing authority of the receiving site.

9. A sufficient quantity of fertile soil layer (typically 0–30 cm thick) generated from excavations must be stored for use in the restoration of disposal areas, borrow pits, and worksites. After restoration, the fertile soil depth in these areas shall be at least 30 cm. Restoration works will be carried out following the preparation of the TES.
10. During the preparation of the restoration study for the disposal areas, the possibility of restoring these sites for specific land uses, in cooperation with the local authorities, should be examined, as provided by Decision D7/A/12050/2223/2011, Article 90, "Special Protection and Restoration Measures." This possibility is particularly important since there are no significant public lands in the area, and the allocation of these restored areas for communal or public-benefit uses would be of great value to the local community.
11. The disposal of surplus excavation materials shall follow the priorities below:
    - Restoration of the project's borrow pits L1 and L2 or other inactive quarries as the first priority,
    - Use in rural road construction to be implemented within the project,
    - Use as surface material for existing rural roads requiring annual maintenance and improvement,
    - Use in the construction of the new perimeter road around the reservoir.

For the restoration of the rocky borrow pits, it is particularly important to implement the points mentioned above at the design level, as the temporal, morphological, and overall success of the restoration depends on the proper application of this planning.

**Establishment and Operation of Borrow Pits**

For the establishment and operation of the borrow pits required for the project, Decision D7/A/12050/2223/2011 (Government Gazette 1227/B/11), *Regulation of Mining and Quarrying Operations (RMQO)*, applies.

Specifically, for the examined case, the following articles and their prescribed measures must be taken into account in the studies required for the licensing of the borrow pits:

- Article 85: Siting of mining and quarrying operations — compliance with siting requirements regarding proximity to settlements, etc.
- Article 88: Protection of the surrounding environment from vibrations and noise — compliance with applicable limit values.
- Article 89: Implementation of Best Available Techniques (BAT).
- Article 90: Special protection and restoration measures — under which it is proposed that, in cooperation with local authorities, the potential use of restored disposal areas to meet local needs for public spaces and facilities be examined, since the area generally lacks significant public land holdings.

If the use of explosives is required, this must be done in accordance with the provisions of Article 85 of the *Regulation of Mining and Quarrying Operations (RMQO)* and must be fully documented in the Technical Exploitation Study and the corresponding Environmental Impact Assessment (EIA). In all cases, the use of explosives must be limited to the absolutely necessary, with controlled blasting operations that account for vibration control and rock projection.

Furthermore, if it is found that the applicable limits are exceeded, the final selection between mechanical extraction and blasting should be reviewed, taking into account the intensity and duration of noise and vibration disturbances.

### 10.3 Measures for Mitigating Impacts on the Natural Environment – Flora and Fauna

**Construction Phase**

Measures can be taken to reduce the environmental impacts mentioned in Chapter 9.5, arising from the construction of the project and its auxiliary facilities. The necessary restoration measures for the natural environment affected by the project's construction are as follows:

- **Immediate restoration of the construction site** upon completion of the works, including the removal of all construction facilities and replanting of the area with plant species characteristic of the local flora, ensuring their protection to achieve successful revegetation.
- **Immediate restoration of the borrow pits** for inert materials after completion of the works, with replanting using native species and appropriate protection measures.
- **Implementation of noise control measures** during construction to prevent disturbance to local fauna and avifauna.
- **Implementation of dust control measures**, such as watering the roads used by trucks transporting inert materials, covering truck platforms with tarpaulins, and watering the inert materials used in dam construction.
- **Restriction of interventions** for the dam and reservoir construction to those strictly necessary to protect the area's vegetation.
    - The minimum number of roads should be used for the movement of construction vehicles to avoid unnecessary clearings or openings that would disturb natural vegetation.
    - Any removal of forest or general vegetation during construction must be limited to the absolutely necessary extent, and landscape alterations must be confined to essential interventions only.
    - Disposal of excavation, construction materials (e.g., cement), and other substances (e.g., mineral oils) into watercourses or any unauthorized locations is prohibited; all such materials must be managed within organized and approved disposal sites, which must be restored upon completion of the works.
- **Fire protection measures** must be implemented during the operation of construction sites to prevent fire outbreaks caused by machinery or crews and to minimize the risk of spread to adjacent areas.
- **All forms of burning materials** (such as oils, rubber, etc.) must be strictly prohibited in the project area.

**Operation Phase**

The operation of the dam and reservoir in the area can, in general terms, be considered an environmentally beneficial project. Nevertheless, certain measures must be taken to mitigate any adverse impacts identified during its operation. Such measures include the following:

- **Maintenance of ecological flow** in the downstream section of the river.
- **In the event of significant bird population development** in the project area, any additional protection or habitat improvement measures shall be developed following the preparation of a specialized study.
- **To protect bird species attracted to the reservoir area**, the establishment of a wildlife refuge within a 1000-meter buffer zone around the project is proposed.
- **Application of Good Agricultural Practice (GAP) standards** during agricultural activities to prevent negative impacts on the surrounding ecosystems due to fertilizer and pesticide use.
- **Prevention of agricultural expansion** into existing forested areas through deforestation, in order to protect biodiversity in the region.

## 10.4 Measures for Addressing Impacts on Technical Infrastructure

**Existing Road Network**

As mentioned in Section 9.8.1, the implementation of the dam and reservoir basin works will interrupt access to farmland on both sides of the river, as well as communication between settlements and the rural–forest road network (see Plan XE-1).

The issue of restoring the road network is directly related to the construction of access roads to the dam and will form part of the final design study of the dam to be carried out in the subsequent project phase.
It is proposed that a restoration study for these access routes be prepared, based on an inventory of the users' actual needs. This study should be carried out in cooperation with the local authorities (OSAs) and representatives of the residents, ensuring at least the current level of service and improved safety.

Furthermore, wherever damage to the pavement of the existing road network in the settlements occurs due to the movement of heavy vehicles, it shall be restored at the contractor's expense upon completion of the dam construction works.

It is estimated that approximately 15 kilometers of existing roads will require repair, with an average repair cost of €300,000 per kilometer.

**Mitigation of Impacts on Transportation and Traffic**

The construction contractor must ensure continuous access for farmers to their agricultural plots throughout the duration of the works. The interruption of access to any field during the cultivation period shall not exceed 48 hours, and outside the cultivation period, 7 days. These time limits may be extended only with the consent of the landowners or tenants.

Excavations for the installation of irrigation pipelines shall be carried out by sections (e.g., areas of less than 500 stremmas). The refilling of trenches shall be done carefully, with proper compaction of the materials, in accordance with the project study and technical specifications. During the implementation of the works, the contractor shall provide all necessary signage and warning boards regarding traffic changes and safety conditions.

The work schedule must be announced well in advance (at least 30 days before construction begins) to the public—and especially to local farmers—through notices in the Municipality, Municipal Unit, Local Land Reclamation Organization (TOEB), and Traffic Police.

All required traffic regulations must be carried out according to the approved traffic management plan and corresponding road signage—not arbitrarily by machinery operators or subcontractors during the construction period.

Overloading of transport vehicles must be avoided, and vehicles transporting materials with a particle size smaller than 10 cm must be covered during transportation.

Sections of paved roads used by vehicles and self-propelled machinery involved in the project must be cleaned regularly of residues of inert materials (e.g., mud from tires, material spills from truck beds, etc.).

During project execution, care must be taken to prevent damage to existing infrastructure in the wider area. If modification of existing facilities or any type of intervention in them is required (e.g., at points where the project intersects with the existing road network), such works must be carried out according to the instructions of the competent infrastructure authorities, ensuring their proper operation.

The restoration of affected infrastructure must take place immediately once it becomes technically feasible for each completed construction section of the project.

Finally, the contractor shall be responsible for restoring the surface of the rural road network in the project area wherever it becomes difficult to traverse due to deformation (e.g., rutting from heavy vehicle traffic such as concrete mixers or excavation trucks).

**<u>Mitigation of Impacts on Water Supply</u>**

Based on the mapping of the existing networks in the project area, an issue was identified concerning the water supply installations of the settlements of Lachanadas and Militsa, which are located within the dam reservoir basin and will therefore be submerged (see Plan XE-1).

Since this is a matter of high importance, it must be addressed immediately and effectively. Specifically, it is proposed that the following studies be undertaken:

- A hydrogeological investigation and study, including geological mapping and geophysical surveys in the following areas:
    1. Upstream of the reservoir's water level for the settlements of Vlassaika–Militsa.
    2. Downstream of the dam site toward Finikounda for the settlements of Lachanadas–Finikounda.
- A corresponding hydraulic study for the restoration of the water supply of the above-mentioned settlements.

<u>These studies aim to ensure quantitative and qualitative adequacy of water supply from alternative sources and should be included in the overall project budget, along with the costs of the corresponding construction works.</u>

These studies must be completed before the preparation of the project's tender documents, and after determining the most suitable solution, the new water supply system must be constructed and operational before dam construction begins.

Regarding the remaining water supply networks of nearby settlements, no significant impacts are expected. However, to minimize the risk of potential damage, before starting the construction of the irrigation networks, the contractor must cooperate with the competent water supply authorities of the Municipalities of Pylos–Nestor and Messini, requesting verification of the recorded network routes and their on-site confirmation.

**<u>Mitigation of Impacts from Solid Waste</u>**
**<u>Construction Phase</u>**

As mentioned in Section 9.8.1, the implementation of the dam works and associated supporting facilities is not expected to cause significant impacts. However, for optimal waste management, the following measures are proposed.

Construction sites must have a waste collection system for municipal-type waste and a management system for Construction and Demolition Waste (CDW), i.e. Excavation, Construction, and Demolition Waste (E.C.D.W.), including non-usable small material pieces (e.g., pipe sections, reinforcement, formwork timber), and waste generated from the removal of construction installations.

Solid waste from office areas, resembling municipal waste, must be collected and disposed of through the existing municipal waste collection system.

In all cases, the management of non-hazardous waste shall comply with the provisions of Joint Ministerial Decision 50910/2727/2003 (Government Gazette 1909/B/2003) and Law 4042/2012 (Government Gazette 24/A/2012), as currently in force.

Regarding E.C.D.W., the regulations of Joint Ministerial Decision 36259/2010 on their alternative management apply, and the contractor is responsible for the implementation of the corresponding management system.

**Operation Phase**

As mentioned in Chapter 9.8.2, pollution from the uncontrolled disposal of empty pesticide containers is a common and serious issue in most irrigation projects.

To address this problem, it is imperative to enforce the relevant legislation, with the project's operating authority assuming collective responsibility for both:

- Educating farmers on Best Management Practices (BMPs) for the use of agricultural pesticides, and
- Establishing a Management System for Empty Plastic Pesticide Containers.

The operating authority shall install collection bins for empty containers, painted in a distinctive color (recommended: red), distributed throughout the project area—particularly at pesticide mixing and filling points. The placement of these bins must maintain a minimum safety distance of 20 meters from water surfaces.

The collection bins should be located near cultivation zones, in visible and easily accessible areas (close to roads), to facilitate the collection process by appropriate vehicles.

Farmers must be provided with special plastic collection bags to transport empty containers to the designated bins.

The Management of Empty Plastic Pesticide Containers shall follow these guidelines:

1. The plastic bottle should be opened carefully to avoid damaging the cap. The pesticide content should be completely emptied into the sprayer tank.
2. The empty plastic container must be rinsed three (3) times.
3. The rinsed and dry empty containers must be placed in the special plastic collection bag.
4. Once the bag is filled with rinsed containers, it must be placed in the designated red collection bin.
5. In this way, the plastic containers are considered non-hazardous waste (after verification), since triple rinsing ensures that the concentration of pesticide residues is below 0.1%. *(Source: Guidelines on Management Options for Empty Pesticide Containers, WHO & Food and Agriculture Organization of the United Nations, May 2008; Law No. 2939/2001 "Packaging and Alternative Management of Packaging and Other Products – Establishment of the National Organization for the Alternative Management of Packaging and Other Products (E.O.E.D.S.A.P.) and other provisions.")*
6. If the residual concentration exceeds 0.1%, these containers must be treated as hazardous toxic waste, which will increase the overall management cost.

The operating authority shall be responsible for implementing the provisions of Decision 8197/90920/2013 and the National Action Plan for the Sustainable Use of Pesticides, as well as for organizing and ensuring the effective operation and management of the system. It must also ensure the final delivery of the containers to an authorized alternative management system, in accordance with the provisions of Law 2939/2001 (Government Gazette 179/A/01), as currently in force.

### 10.5 Measures for Mitigating Impacts on Air Quality

During the construction and operation of the project, the limit and guideline values for air quality specified in the following regulations will be observed:

i. Joint Ministerial Decision (JMD) H.P. 22306/1075/E103/2007 (Government Gazette 920/B/2007) – "Determination of target values and assessment thresholds for concentrations of arsenic, cadmium, mercury, nickel, and polycyclic aromatic hydrocarbons in ambient air," in compliance with Directive 2004/107/EC of the European Parliament and Council of 15 December 2004.
ii. JMD H.P. 14122/549/E.103/2011 (Government Gazette 488/B/30-3-2011) – "Measures for the improvement of air quality," in compliance with Directive 2008/50/EC of the European Parliament and Council of 21 May 2008 "on ambient air quality and cleaner air for Europe."

For point-source emissions of suspended particulate matter (dust) from construction sites, the limit of 100 $mg/m^3$ applies, as defined in Article 2, paragraph (d) of Presidential Decree 1180/1981 (Government Gazette 293/A/1981) "On the regulation of issues related to the establishment and operation of industries, workshops, etc."

All machinery used at the construction sites must have EEC type approval, in accordance with Ministerial Decision 69001/1921 (Government Gazette 751/B/18.10.88).

**<u>Construction Phase</u>**

Mitigation of air pollution impacts from dust emissions will be achieved through the implementation of the following specific measures:

- Application of dust control measures in construction areas, such as regular watering and spraying with water, to reduce the amount and concentration of generated dust.
- Frequent wetting of work areas and aggregate piles to minimize dust emissions during earthworks, with special emphasis during the summer months and windy days.
- Speed limits for construction vehicles on unpaved surfaces:
  - < 30 km/h within the project area,
  - < 20 km/h within the construction sites and borrow pits.
- Cleaning of shoulders and access routes used by construction vehicles to prevent dust accumulation.
- Immediate removal of excavated materials from the project area. Temporary storage of excavated materials shall be allowed only when these are to be reused for project needs.

- Coordination of excavation, construction, and transport operations to minimize the duration of material storage in piles.
- Installation of dust filters on cement storage silos at construction sites, which must remain enclosed at all times.
- Covering of heavy transport vehicles (trucks) carrying excavation products with suitable tarpaulins, in accordance with Legislative Decree 4433/64 on Public Mining Research, as amended by Law 273/76 (Government Gazette 50/A) and Ministerial Decision II-5th/F/17402/84 (Government Gazette 931/B) "Regulation of Mining and Quarrying Operations."
- The borrow pit exploitation study must include measures for dust emission reduction, such as ensuring that the crushing and screening plant is equipped with a water spraying system for complete material wetting, and that any conveyor belts are enclosed to achieve full suppression of dust emissions.

Additionally, the following measures are proposed concerning gaseous pollutant emissions:

- All machinery and equipment used in construction must be in good working condition and comply with the manufacturer's specifications.
- All construction machinery must meet the emission standards defined by Greek and EU legislation concerning exhaust gases and pollutants.
- The burning of any materials (e.g., rubber, oil, planks, construction timber, waste, etc.) is strictly prohibited within the project area.

### 10.6 Mitigation of Impacts on the Acoustic Environment

**Construction Phase**

The construction site of the dam and borrow pits—the project's most significant components—is located at a distance from settlements and residential areas, and therefore no significant noise impacts on sensitive receptors are expected. Consequently, there is no need for special noise control measures related to the operation of construction machinery.

Additionally, for the construction of the irrigation pipelines, excavation and backfilling worksites will be developed near or within settlements. This activity will be temporary, mobile, and of limited intensity.

Nevertheless, during the execution of works, compliance with the current legislation and the following general measures is required:

- Application of the provisions of JMD 37393/2028/03 (Government Gazette 1418/B/1-10-2003), "Measures and conditions for noise emissions in the environment by equipment intended for use outdoors."
- Application of Article 3 of Presidential Decree 1180/81 (Government Gazette 293/A/6-10-1981), "On the regulation of issues related to the establishment and operation of industries, workshops, and all types of mechanical installations and storage areas, and their impact on the environment," regarding maximum allowable noise levels from construction sites and project installations.
- Avoidance of construction activities within or near settlements during designated quiet hours.

- Implementation of noise-reduction practices in construction sites, such as minimizing the simultaneous operation of multiple machines and avoiding unnecessary idling.
- Movement of heavy vehicles through residential areas only when no alternative safe routes exist, maintaining low speeds (<30 km/h) and ensuring proper signage for the movement of construction vehicles.
- Prohibition of the use or presence of machinery not equipped with EEC type-approval certification for noise, in accordance with JMD 69001/1921/88 (Government Gazette 751/B).
- During the operation of borrow pits, the restrictions of Decision D7/A/12050/2223/2011 (Government Gazette 1227/B/11), *Regulation of Mining and Quarrying Operations (RMQO)*, apply—particularly Article 88, "Protection of the surrounding environment from vibration and noise," ensuring compliance with the respective limits.
- Blasting operations must not be conducted during quiet hours.
- The overpressure of the acoustic shockwave in residential areas must not exceed 134 dB(L).
- In every project, the operation of earthmoving and mechanical equipment (excavators, loaders, bulldozers, etc.) must be regulated and all appropriate measures taken to limit environmental noise levels within the boundaries of residential areas, in accordance with Presidential Decree 1180/81 and any other applicable regulation.

## 10.7 Measures for Mitigating Impacts on Water Resources

**Construction Phase**

During the construction works and the operation of the construction sites, no significant direct or indirect impacts are expected. However, it remains essential to apply best environmental practices and control measures to avoid accidental pollution or any form of water disturbance. Construction sites must be equipped with pre-treatment and treatment units for liquid waste, as their discharge into public collection and transfer networks is not permitted. Specifically, the following facilities must be available at a minimum:

- System for collecting used mineral oils,
- System for collecting waste requiring special management (such as batteries, tires, oil filters, catalysts, etc.),
- Facilities for the storage, pre-treatment, and treatment of liquid waste generated during operations (e.g., watertight pits, sedimentation tanks, oil separators, etc.). A typical sedimentation unit for washing concrete mixer trucks is schematically shown in Figure 10.1 below,
- Chemical toilets for use at all project worksites.

In addition, the following general measures and conditions must be implemented:

- Disposal or discharge of any materials, waste, or liquid effluents associated with construction—such as mineral oils, fuels, inert materials, surplus products, waste from concrete batching plants, wash water from concrete mixer trucks and pumps, and rejected concrete batches (due to delivery delays or poor setting quality)—into water bodies is strictly prohibited.

- Disposal of used mineral oils onto the ground is prohibited.
- Oils and lubricants must be stored in sealed containers, located in covered areas with impermeable flooring, while used oils and leaks must be collected and disposed of in accordance with Presidential Decree 82/2004 (Government Gazette 64/B/2004) and Joint Ministerial Decisions 13588/725/2006 (Government Gazette 383/B/2006), 24944/1159/2006 (Government Gazette 791/B/2006), and 8668/2007 (Government Gazette 287/B/2007).
- To prevent soil and water pollution from potential fuel or lubricant leaks, suitable absorbent materials (e.g., sawdust, sand, etc.) must be used to contain the spill. These materials should be readily available at all construction sites. After use, they must be collected in watertight containers and managed in accordance with Presidential Decree 82/2004.
- Maintenance of vehicles or self-propelled machinery, including oil changes, is prohibited outside the main project construction sites. To prevent contamination of surface or groundwater by lubricant leaks or liquid waste from maintenance works, temporary watertight tanks must be installed at appropriate locations to collect any leaks. Both new and used lubricants must be stored in sealed containers located in covered, impermeable areas.

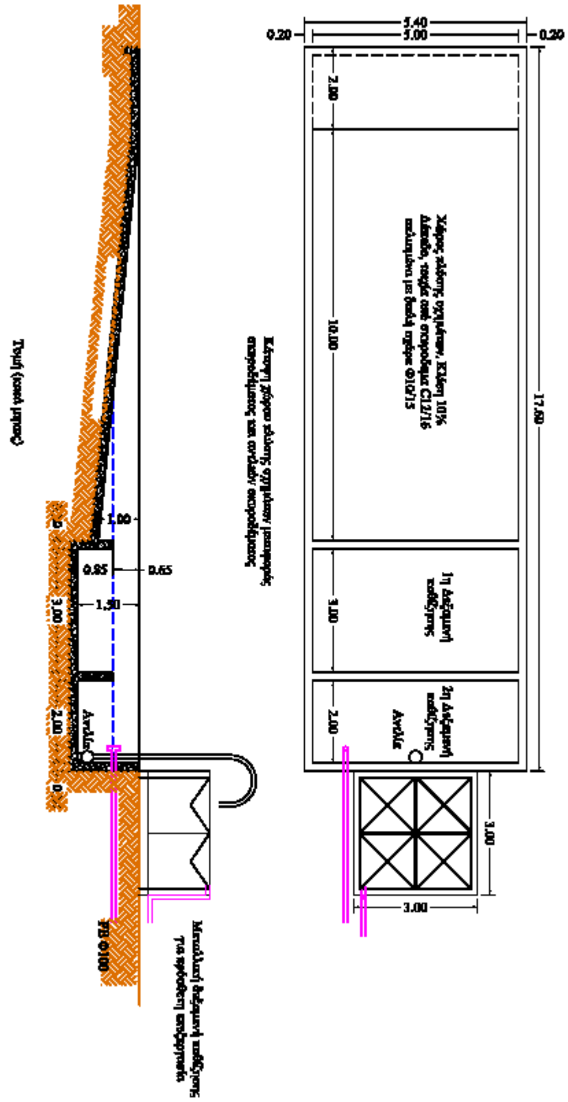

**Figure 10.1 Typical Sedimentation Unit for the Wash Water of Concrete Transport Vehicles**

## Operation Phase of the Projects

During the operation phase of the projects, no significant direct impacts are expected. The potential impacts will be indirect and will primarily concern the management authority, which will be responsible for operating the projects.

As mentioned in Chapter 9.13.2, there remains a possibility of impacts due to the reduction of hydraulic flow in the downstream section of the river, from the dam to its estuary. To better understand the potential impacts and assess the future condition of the downstream basin, it is proposed to carry out a special hydraulic study for the downstream basin of the dam.

This study should include sediment transport analysis to estimate both total water discharge and sediment yield. It must be prepared once the dam's final dimensions are determined, in the subsequent stages of the technical studies.

**Establishment of a Management Authority**

For the operation of the projects—the dam and the irrigation network—a management body will be established, likely the Local Land Reclamation Organization (TOEB), operating on a joint inter-municipal basis between the Municipalities of Pylos-Nestor and Messini.
This body will be responsible for implementing the Operation and Maintenance Monitoring Plan for the dam and irrigation networks.
The monitoring plan shall include, among other elements, the following:

- Operational schedule ensuring sufficient irrigation supply for the designated irrigation area,
- Preventive maintenance and repair program for mechanical, electromechanical, and other facilities and equipment,
- Maintenance of ecological flow downstream of the dam,
- Monitoring of water inflow quantity and quality into the reservoir, as well as monitoring of usage volumes and leakage,
- Collaboration with the competent services of the Ministry of Rural Development to inform and train farmers on agricultural practices and environmentally compatible methods for the rational use of fertilizers, pesticides, and irrigation water,
- The management body (TOEB) will also be responsible for informing users about Best Management Practices (BMPs) regarding the use of agricultural pesticides, in accordance with the relevant legislation on waste container management, as detailed in Section 10.4,
- Preparation of an Emergency Response Plan for incidents such as the leakage of harmful substances into the hydrographic network, including reporting procedures to the competent authorities (TOEB and the Directorate of Environment and Health of the Regional Unit of Messinia).

**Discontinuation of Existing Boreholes**

After the completion and commissioning of the irrigation project, an official decision (by the Secretary General of the Region) must be issued for the mandatory cessation of the use of existing boreholes within the irrigation zone, as well as the prohibition of drilling new irrigation wells for agricultural plots that will be served by the newly constructed irrigation network.

**Surface Runoff Regulation – Ecological Flow**

As noted in the previous Chapter 9.13, the reduction in surface runoff, particularly during flood events, is offset by the guaranteed and evenly distributed ecological flow throughout the year. Ensuring this flow constitutes a legal obligation of the Project Management Authority and represents the most effective measure for mitigating potential environmental impacts.

**Pesticide Sprayer Filling Stations**

The filling of sprayer tanks is strictly prohibited from watercourses, ditches, or drinking water networks, due to the risk of accidental contamination from backflow of pesticide solution into the water source.
A notable case occurred in the Florina region in 2009, where contamination of a settlement's drinking water network was recorded as a result of pesticide solution backflow during sprayer tank filling directly from the water supply system.

Therefore, the filling setup must follow the configuration shown in Figure 10.2, ensuring that the filling pipe remains at least 10 cm above the top of the tank to prevent back-siphoning.
To ensure safe and environmentally sound practices, it is proposed to construct ten (10) designated sprayer filling stations, with at least one per settlement, as illustrated in Figure 10.3.

The final selection and distribution of these stations will be determined during the next phase of the design studies.

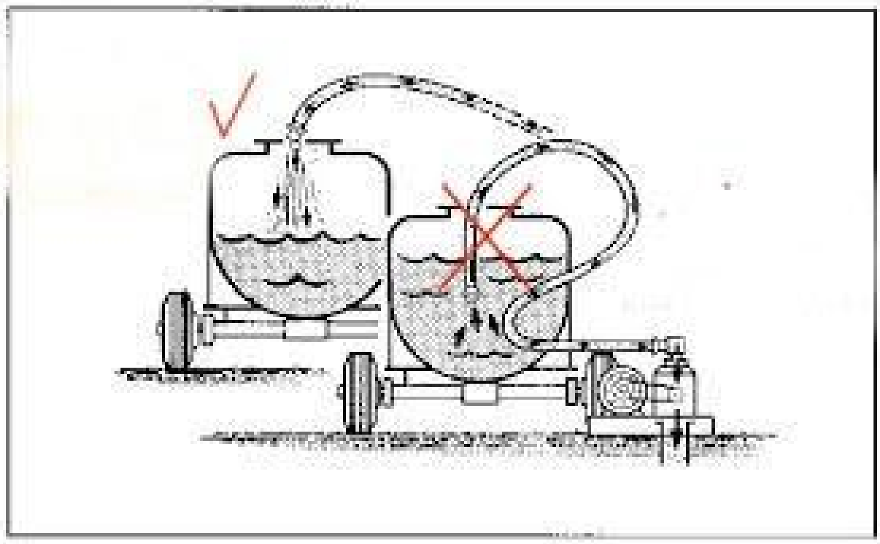

**Figure 10.2 Typical Layout of a Pesticide Sprayer Tank Filling System**

An indicative layout for the construction of the filling stations is presented below (Figure 10.3). The construction cost is estimated at approximately €3,000 per station, excluding VAT.

Each of these stations will also include special collection bins for pesticide containers, as described in Section 10.4.

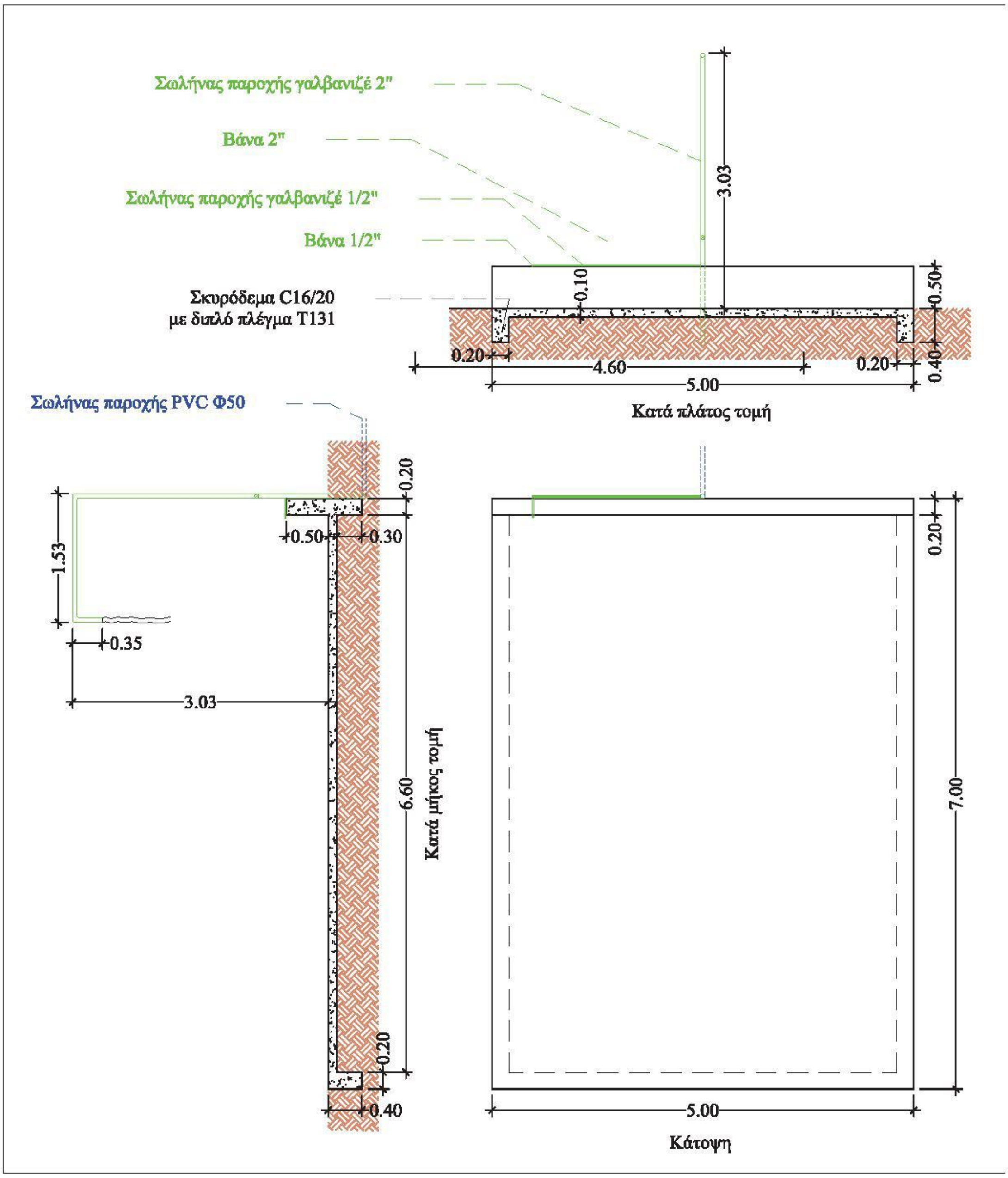


**Figure 10.3 Typical Layout of a Sprayer Filling Station**

### 10.8 Mitigation Measures for Impacts on Human Health

**Construction Phase**

The Contractor of the project shall implement a Health and Safety Management System, incorporating procedures consistent with Greek legislation and best practices applicable to construction sites.

**Operation Phase**

The Project Operating Body (TOEB) shall organize informative sessions for professional farmers—users of the project—upon its commencement of operation, focusing on:

- The technical characteristics and operational principles of the project.
- The necessary personal protective measures during agricultural activities.
- The management and prevention of accidents related to agricultural operations.

### 10.9 Mitigation Measures for Impacts on the Archaeological and Cultural Environment

Due to the nature of the works—particularly the dam and reservoir, which involve extensive excavations—the project implementation body is required to formally notify, prior to the commencement of construction activities, the Ephorate of Antiquities of Messinia and the Ephorate of Paleoanthropology and Speleology.

Although the designated construction areas have not been registered as archaeological sites or areas of archaeological interest, it is recommended that a specific budget allocation be made for the employment of an archaeologist, with the consent of the Ephorate of Antiquities of Messinia, to monitor excavation activities throughout the cleaning and foundation works of the dam site.

According to the project's implementation schedule, it is estimated that the excavation works for the dam and main network pipelines will last approximately 18 months. It is projected that around 18 person-months of archaeological employment will be required out of a total project construction duration of 48 months (4 years). This cumulative duration provides flexibility for simultaneous employment of 2–3 archaeologists, if multiple excavation fronts are active. This provision is conditional upon confirmation of necessity by the competent Ephorate of Antiquities.

In the event that antiquities, caves, or paleontological remains are discovered during construction, all works must be suspended, and an archaeological excavation shall be conducted. The continuation or modification of the project will depend on the findings and subsequent recommendations of the competent authorities of the Ministry of Culture.

The costs for the recruitment and remuneration of supervising archaeological personnel, as designated by the competent Ephorates, as well as for any required excavations,

conservation, study, publication of findings, and restoration of monuments, shall be included in the project budget, in accordance with Articles 8, 9, 10, and 37 of Law 3028/2002.
If the said costs exceed 10% of the total project budget, written consent from the implementing authority must be obtained following a formal inquiry by the competent service of the Ministry of Culture, determining whether the authority wishes to continue or permanently abandon the section of the project where antiquities were found.

In cases where the project is co-funded by the European Union, if the archaeological-related expenses exceed 5% of the total project budget, they must be approved by the Minister of Culture, as stipulated in Article 25 of Law 3614/2007 (Government Gazette 267/A/2007), as amended by paragraph 15, Article 10 of Law 3840/2010 (Government Gazette 53/A/2010).

## 10.10 Cost Estimation of Environmental Measures and Interventions

For certain proposed mitigation measures mentioned in the previous chapters, the following table provides an indicative cost estimation.

**Table 10.1: Cost Estimation of Proposed Environmental Interventions**

| No. | Description of Measure | Quantity / Unit Cost | Estimated Cost (€) |
|---|---|---|---|
| 1 | Construction of pesticide sprayer filling stations | 10 units × €3,000/unit | 30,000€ |
| 2 | Construction of concrete transport vehicle washing station | 1 unit × €12,000/unit | 12,000€ |
| 3 | Collection bins for empty pesticide containers | 2 bins per station = 20 bins<br>20 bins × €1,500/bin = | 30,000€ |
| 4 | Water supply restoration studies (Hydrogeological and Hydraulic) | — | 400,000€ |
| 5 | Hydraulic study for surface flow downstream of the dam (including total hydraulic and sediment transport assessment) | — | 40,000€ |
| 6 | Repair of damages to the existing road network (approx. 15 km × €300,000/km) | 15 × €300,000 | 4,500,000€ |
| 7 | Employment of archaeologists during construction (18 person-months over 4 years × €2,500/month) | 18 × €2,500 | 45,000€ |
| **Total indicative cost of environmental measures excluding VAT** | | **5.057.000€** | |

## Study Approval and Signatures

| | | | |
|---|---|---|---|
| ADK Consultants Engineers S.A. | | Approved for the Supervising Authority | |
| Prepared by | For the Contractor | Supervision Team | |
| D. Ziogas | M. Aronis | A. Avgenaki | S. Gerodimitriou |
| Coordinator<br>of the Study Team | Coordinator of<br>Legal Representative | Supervising Engineer | The Supervisors<br>of the Consortium |

# 11. ENVIRONMENTAL MANAGEMENT AND MONITORING

The proposed Environmental Management Plan aims to ensure the effective protection of the environment and the implementation of the proposed mitigation measures. It also includes the proposed monitoring program. The monitoring program, which the project owner or activity operator is committed to implementing, includes — in accordance with the requirements of Law 4014 (Annex II, Minimum content of the Environmental Impact Assessment file):

a) the environmental parameters, elements, and indicators to be monitored,
b) the methods, location, timing, and frequency of the recordings,
c) the measures ensuring the quality and reliability of the recordings,
d) the timetable for updating the National Environmental Information System (HEMIS).

## 11.1 Environmental Management During the Construction Phase

The project contractor is obliged to apply best practices, comply with the technical studies and permits for the works, and adhere to the relevant Environmental Terms. The contractor must prepare and implement an information plan for the residents of the project area and local authorities (municipality, involved technical services, Police – Traffic Department, public utilities), concerning the construction works and the Environmental Terms that must be followed.
Furthermore, the contractor must implement information points for issues related to the project, particularly regarding road safety (traffic interruptions or diversions, lane narrowing, etc.) and temporary traffic regulations due to construction works. Special care must be taken to ensure complete and proper worksite signage and to implement the Health and Safety Plan.
The contractor must inform every subcontractor used about the project's Environmental Terms and maintain relevant documentation as proof.
The operating body must record all irrigation boreholes located within the project area whose use will be prohibited once the project becomes operational and must inform their owners accordingly.
Before the project begins operation — even partially — it must have obtained the required water use permit from the competent Water Directorate of the Decentralized Administration of Peloponnese.

## 11.2 Environmental Management During the Operation Phase

### 11.2.1 Environmental Parameters, Elements, and Indicators to be Monitored

**Technical Works**

Major infrastructure works are inspected by an engineer to ensure safe operation and the protection of the built environment from potential changes, damage, or deterioration. Specifically, the following are inspected:

- The Dam: According to recent legislation (Ministerial Decision DAEE/oik.2287/2016, Government Gazette 4420/B/30-12-2016), the dam must be monitored during the construction, first filling, and operational phases, with the corresponding register maintained by the Dam Operating Authority and the submission of the required files to the Dam Administrative Authority.

In cooperation with the Dam Operating Authority, as mentioned above, the irrigation network operator is responsible for ensuring inspections by an engineer, agronomist, or technologist of all individual works and installations that are critical for the proper functioning of the project, namely:

- Pumping stations
- Reservoirs
- Pressure relief chambers of the main pipelines
- The Minagiotiko stream
- Water intakes
- Primary and secondary rural roads

During these inspections, all parameters defined in the maintenance plan are recorded, including any detected leaks or other issues, as well as the significant restoration works required to address them.

**Surface Water**

<u>a. Quantitative</u>

1. The monthly withdrawals and consumption of irrigation water are recorded for each project zone and in total.
2. The required ecological flow is ensured at the dam outlet and along the downstream section of the riverbed up to its estuary.

<u>b. Qualitative</u>

Water samples (grab samples) are collected from two locations: one from the reservoir and the other from the stream at its mouth, at the bridge along the Methoni–Finikounda National Road. The samples are analyzed to determine the following parameters: Conductivity (EC), pH, Dissolved Oxygen (DO), Biological Oxygen Demand ($BOD_5$), Chemical Oxygen Demand (COD), Total Phosphorus (TP), Phosphate ($PO_4$), Total Nitrogen (TN), Dissolved Inorganic Nitrogen (DIN) ($NH_4^+$, $NO_2^-$, $NO_3^-$), Aluminum (Al), Arsenic (As), Boron (B), Calcium (Ca), Cadmium (Cd), Cobalt (Co), Chromium (Cr), Copper (Cu), Iron (Fe), Mercury (Hg), Potassium (K), Magnesium (Mg), Manganese (Mn), Molybdenum (Mo), Sodium (Na), Nickel (Ni), Phosphorus (P), Lead (Pb), Sulfur (S), Silicon (Si), Strontium (Sr), and Zinc (Zn).
The results of these analyses are kept on record and communicated to the Water Directorate of the Peloponnese Region.

**Groundwater**

If the results of the surface water or soil analyses indicate the presence of critical levels of the aforementioned parameters, groundwater must also be examined for the reasons outlined in section 11.2.2.

**Soils**

<u>Nutrient Inputs – Fertilization</u>

To monitor soil nutrient levels, a soil study is conducted for all agricultural plots. The analyses determine: soil texture, pH, EC, total $CaCO_3$, organic matter, $NO_3$, P, K, Mg (available), Fe, Mn, Cu, and B. A database is created in which the nutrient status of each plot is recorded according to the type of crop cultivated.

Pesticides

A database is also created to record the quantity and type of each pesticide used on every agricultural plot.

**Energy**

The project's total monthly electricity consumption is recorded.

**Accidental Pollution**

An Administrative and Operational Action Plan is prepared to address severe pollution incidents resulting from accidents related to the project's operation. The Project Management Authority must inform all users of the irrigation network about this plan.

Indicative examples include pollution of surface water bodies, drinking water networks, or soil caused by a tanker or load containing pesticides, fertilizers, etc.

### 11.2.2 Methods, Location, Timing, and Frequency of Recordings

**Technical Works**

Inspections are carried out during the first two months of each year after the project's Final Acceptance or as specified in the respective maintenance plan. The results are recorded in a dedicated database.

**Surface Water**

a. Quantitative

The recordings of irrigation water withdrawals and consumption per project zone and in total are made monthly, using the installed measuring devices (flow meters) of the project.

b. Qualitative

Water sampling and analyses are performed in spring (at the beginning of the season) and autumn (at the end of the season) every three years, by a certified laboratory/company holding the required ISO certification and accreditation by the Hellenic Accreditation System (ESYD).

The analytical methods applied are determined by the laboratory's accreditation system. The results are entered into a database.

**Groundwater**

If the results of soil or surface water analyses indicate the presence of pollutants, corresponding groundwater sampling will be conducted in cooperation with the Water Directorate of the Peloponnese Region.

**Soils**

a. Fertilization – Nutrients

Soil sampling and analyses are conducted in autumn (at the end of the season) every three years by a certified laboratory/company holding the required ISO certification and ESYD accreditation.

The sampling density is one sample per 10 stremmas (1 ha), taken from a depth of 0–30 cm. The analytical methods applied are determined by the laboratory's accreditation system. The results are recorded in a database.

b. Pesticides

A database is created in which the quantity and type of each pesticide used on every agricultural plot are recorded annually.

**Energy**

A database is created to record the project's total monthly electricity consumption, based on the supplier's electricity bills.

**Accidental Pollution**

An Administrative and Operational Action Plan for responding to severe pollution incidents resulting from accidents is prepared within three months after the completion of the project's construction (temporary acceptance) and the establishment of the project's Operating Authority. The plan is revised every five years.

### 11.2.3 Measures Ensuring the Quality and Reliability of Recordings

These are described in section 11.2.2.

### 11.2.4 Timetable for Updating the National Environmental Information System (HEMIS)

The applicable national requirements in force at the time are implemented.

# 12. ENVIRONMENTAL TERMS PLAN

This chapter presents, in summary form, the measures, conditions, and restrictions proposed for implementation during the construction and operation phases of the proposed projects — the Minagiotiko Dam and its associated works — to ensure maximum possible environmental protection and compliance with the current environmental legislation.

## 12.1 Project Description

### 12.1.1 Summary Description of the Project

#### 12.1.1.1 General Information – Project Location

The project under study concerns the construction of the Minagiotiko Dam, including the reservoir, the irrigation network for watering the designated agricultural areas, and the associated supporting works such as borrow pits, spoil disposal sites, and road infrastructure. The main purpose of the project is to retain surface runoff within the reservoir, which will then be used for irrigation — through the corresponding network — of agricultural lands located within the Municipalities of Pylos–Nestor and Messini.

The **associated works** include:

1. Roadworks for the restoration of existing rural road sections that will be flooded by the reservoir,
2. Access roads leading to the dam site, the main pumping station, and around the reservoir,
3. Small access sections to be further specified in the final design of the networks along the water conveyance pipelines.

Additionally, **borrow and disposal areas** with their respective access routes will be established, from which the required material quantities will be extracted or deposited during the construction phase.

Based on the data of the preliminary design, the key technical characteristics of the dam and reservoir are summarized as follows:

**Catchment Area**

- Catchment area: 28.9 km²
- Mean elevation of the catchment: +249 m

**Reservoir**

- Normal retention level (crest of spillway): +122.0 m
- Minimum operating level (intake threshold): +95.0 m
- Effective water depth: 23.5 m
- Total storage volume: 10,959,007 m³
- Useful storage volume: 10,490,105 m³
- Reservoir surface area at spillway crest level: 886,733 m²

**Dam**

- Dam type: Gravity Dam made of Hardfill (Lean RCC)

- Total embankment volume: 196,000 $m^3$
- Maximum height from foundation: 49 m
- Crest length: 177 m.

**Irrigation Network**

The total net area covered by the irrigation network design is 35,000 stremmas (3,500 hectares). The project also includes the construction of supply pipelines, storage reservoirs, and pumping stations.
According to the Hydrological Study, the dimensioning of the irrigation water conveyance pipeline to the consumption areas corresponds to an annual water withdrawal from the reservoir of 8,633,220 $m^3$.
The layout of the main conveyance pipelines and the reservoir locations are shown in the plan drawings (Sheets GO-1 to GO-8), while their main characteristics are presented in the following table.

**Water Conveyance Pipelines – Regulation Reservoirs**

| Pipeline | Start Node | Stop Node | Length (m) | Irrigated Area |
|---|---|---|---|---|
| Main conveyance pipeline | Dam | Pumping Station A1 | 410 | Zones 1, 2, 3, 4, 5 |
| Main conveyance pipeline | Pumping Station A1 | J-1 | 880 | Zones 1, 2, 3, 4 |
| Main pipeline to Reservoir Δ1 | J-1 | J-2 | 4,440 | Zones 1, 2 |
| Main pipeline to Reservoir Δ1 | J-2 | Reservoir Δ1 | 26 | Zone 1 |
| Pressure pipeline to Reservoir Δ2 | J-2 | Reservoir Δ2 | 1,740 | Zone 2 |
| Main pipeline to Reservoir Δ3 | J-1 | Reservoir Δ3 | 2,966 | Zones 3, 4 |
| Main pipeline to Reservoir Δ4 | Pumping Station A1 | Reservoir Δ4 | 6,480 | Zone 5 |

Regarding the **borrow areas**, the use of two sites for the extraction of rocky and inert materials (L1 and L2) is foreseen, as well as borrow areas for earthy materials located within or near the inundation basin. As for the **disposal areas**, a combined approach is proposed, utilizing the borrow areas in conjunction with their subsequent restoration. The above are described in detail and illustrated in the Environmental Impact Assessment (EIA) dossier (text and drawings) that accompanies this Decision.

### 12.1.2 Project Classification – Activity Type

According to the classification of projects into categories set by Ministerial Decision 1958/13.01.2012 (Government Gazette 21/B/12), as amended by Decision DIPA 37674/27-7-2016, the examined projects fall under Group 2: Hydraulic Works.

More specifically, the classification by project type is as follows:

- The dam is classified under project type no. 1, subcategory A2, since its height is 49 meters.

- The irrigation network is classified under project type no. 9, subcategory A2, as the irrigated area covers 35,000 stremmas (3,500 hectares), exceeding the 5,000-stremma threshold required for inclusion in subcategory A2.
- The reservoir is classified under project type no. 2, “Water storage works with a total reservoir volume at overflow level V > 10,000,000 $m^3$,” and therefore belongs to subcategory A1, since the total reservoir volume amounts to 10,959,007 $m^3$.

Due to the classification of the reservoir in subcategory A1, the other works (the dam and the irrigation network) are consequently included in the same subcategory, and the entire project will be studied as belonging to subcategory A1.

### 12.1.3 Inclusion of the Project within the Scope of Joint Ministerial Decision (JMD) 36060/1155/E.103/2013 (Government Gazette 1450/B’) “Measures for the Prevention and Control of Environmental Pollution from Industrial Activities”

**The proposed project does not fall within the scope of JMD 36060/1155/E.103/13/2013 (Government Gazette 1450/B/14.6.2013), in compliance with the provisions of Directive 2010/75/EU.**

### 12.1.4 Inclusion of the Project within the Scope of JMD 54409/2632/2004 (Government Gazette 1931/B’)

The project does not fall within the scope of JMD 54409/2632/2004 (Government Gazette 1931/B’),
“System for the Trading of Greenhouse Gas Emission Allowances in compliance with the provisions of Directive 2003/87/EC on establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC of 13 October 2003 and other provisions,” as amended and currently in force under JMD 57495/2959/2010 (Government Gazette 2030/B’).

### 12.1.5 Inclusion of the Project within the Scope of JMD 12044/613/2007 (Government Gazette 376/B’)

The project does not fall within the scope of JMD 12044/613/2007 (Government Gazette 376/B’),“Establishment of measures and conditions for addressing risks from major accidents at installations or units due to the presence of hazardous substances, in compliance with Directive 2003/105/EC.”

### 12.1.6 Cartographic Representation of the Project – Activity

The project is illustrated in the drawings included in the Environmental Impact Assessment (EIA) as presented in the following table.

**A. ENVIRONMENTAL CONTENT DRAWINGS**

| No. | Code | Description |
|---|---|---|
| 1 | ΜΠΕ-1 | Orientation Map |
| 2 | ΑΠ-1 | Human Environment Features (Sheet 1 of 2) |
| 3 | ΑΠ-2 | Human Environment Features (Sheet 2 of 2) |
| 4 | ΑΠ-3 | Spatial Planning and Urban Organization Elements (SCHOAP) |

| | | |
|---|---|---|
| 5 | ΕΠΜ-Χ2 | NATURA 2000 Network, TKE, and SPA Areas |
| 6 | ΕΠΜ-Χ13-1 | Vegetation – Habitat Map |
| 7 | ΕΠΜ-Χ17-1 | Protection Zones Delimitation Map |
| 8 | III-1 | Land Use (Hydrological Study) |
| 9 | ΧΕ-1 | Environmental Impact Map |

**B. GEOLOGICAL STUDY DRAWINGS**

| No. | Code | Description |
|---|---|---|
| 10 | ΓΜ-1 | Hydro-lithological Map of the Catchment Area |
| 11 | ΓΜ-2 | Geological Map of the Inundation Basin (Sheet 1 of 3) |
| 12 | ΓΜ-2 | Geological Map of the Inundation Basin (Sheet 2 of 3) |
| 13 | ΓΜ-2 | Geological Map of the Inundation Basin (Sheet 3 of 3) |
| 14 | ΓΜ-11 | Borrow Pits – Location Map |
| 15 | ΓΜ-12.1 | Borrow Material Map of the Inundation Basin with Borehole Data (Sheet 1 of 2) |
| 16 | ΓΜ-12.1 | Borrow Material Map of the Inundation Basin with Borehole Data (Sheet 2 of 2) |

**C. DAM PRELIMINARY DESIGN DRAWINGS**

| No. | Code | Description |
|---|---|---|
| 17 | 1-1 | Project Location and Catchment Area |
| 18 | 1-2 | Inundation Basin and Research Borehole Locations |

Earthfill Dam with Clay Core:

| No. | Code | Description |
|---|---|---|
| 19 | 2-1 | Earthfill Dam with Clay Core – General Layout |
| 20 | 2-2 | Earthfill Dam with Clay Core – Typical Cross Section |
| 21 | 2.4.1 | Earthfill Dam with Clay Core – Cross Sections |

Gravity Dam with Hardfill:

| No. | Code | Description |
|---|---|---|
| 22 | 3.1.1 | Gravity Dam with Hardfill – General Layout |
| 23 | 3.2.1 | Gravity Dam with Hardfill – Typical Cross Section at Spillway |
| 24 | 3.3 | Gravity Dam with Hardfill – Longitudinal Section along Axis and Plinth |
| 25 | 3.5 | Gravity Dam with Hardfill – Spillway and Still Basin (Plan View) |
| 26 | 3.6 | Gravity Dam with Hardfill – Spillway and Still Basin (Cross Sections) |
| 27 | 3.7 | Gravity Dam with Hardfill – Diversion–Drainage–Intake, Operation Phase (Plan–Longitudinal Section) |
| 28 | 3.8 | Gravity Dam with Hardfill – Diversion–Drainage–Intake, Operation Phase (Cross Sections) |
| 29 | 3.9 | Gravity Dam with Hardfill – Diversion–Drainage–Intake, Operation Phase (Inlet Works, Longitudinal Section–Cross Sections) |
| 30 | 3.10 | Gravity Dam with Hardfill – Diversion–Drainage–Intake, Operation Phase (Valve Building) |
| 31 | 3.16 | Gravity Dam with Hardfill – Roadworks (Longitudinal Profiles – Typical Cross Section) |

D. IRRIGATION NETWORK – MAIN PIPELINE DRAWINGS

| No. | Code | Description |
|---|---|---|
| 32 | ΓΟ-1.1 to ΓΟ-1.8 | General Layout of Works |
| 33 | ΤΣ | Typical Excavations – Cross Sections of Water Conveyance Pipelines |

### 12.1.7 Geographical Coordinates of the Project

The coordinates, in the EGSA ’87 reference system, for the starting and ending points of the dam axis are as follows:

- Start Point: X = 304492.405   Y = 4080952.431
- End Point: X = 304540.318   Y = 4080793.770

**The corresponding coordinates for the starting and ending points of the main water conveyance pipelines and the regulation reservoirs are provided below.**

Start and End Coordinates of the Pipelines (EGSA ’87 Reference System)

| **PIPELINE START POINT** | | | **PIPELINE END POINT** | | |
|---|---|---|---|---|---|
| **Point** | **EGSA Coordinates** | | | **EGSA Coordinates** | |
| | **X** | **Y** | **Point** | **X** | **Y** |
| Reservoir Δ3 | 301847.64 | 4079029.89 | J-1 | 303672.08 | 4081030.40 |
| J-1 | 303672.08 | 4081030.40 | J-2 | 303536.74 | 4084562.62 |
| J-2 | 303536.74 | 4084562.62 | Reservoir Δ1 | 303513.38 | 4084574.94 |
| J-2 | 303536.74 | 4084562.62 | Reservoir Δ2 | 304362.31 | 4085613.51 |
| J-1 | 303672.08 | 4081030.40 | Pumping Station A1 | 304117.61 | 4080726.59 |
| Pumping Station A1 | 304117.61 | 4080726.59 | Reservoir Δ4 | 307799.05 | 4078996.60 |

## 12.2 Institutional Basic Characteristics of the Project Area and its Environmentally Sensitive Elements

### 12.2.1 Compatibility of the Proposed Works with the Provisions of the National Strategic Plan for Rural Development (NSPRD) 2007–2013

The proposed works are fully compatible and aligned with the provisions and directions of the National Strategic Plan for Rural Development (NSPRD) 2007–2013, both in terms of strategic objectives and specific actions. By Decision No. 4509/26-05-2009 of the Special Managing Authority of the Rural Development Programme (RDP), the project entitled *“Preliminary and Final Design of the Minagiotiko Dam and Final Design of the Irrigation Network of the Municipality of Pylos–Methoni, Prefecture of Messinia”* was included in Measure 125A1 of the programme *“Rural Development of Greece 2007–2013”*. Following Decision No. 4375/07-06-2016, the project was continued as a *committed action* under Measure 4, Sub-measure 4.3.1 “Land Improvement Infrastructure” of the Rural Development Programme 2014–2020 (RDP

2014–2020), with project code KA 2016ΣE8210041. Moreover, the proposed works are identified as complementary measures within the River Basin Management Plans (RBMPs) and constitute a priority under Sub-measure 4.3.1 of the NSPRD 2014–2020. Priority 5.A, under which these works are classified, is one of the main focus areas of the sub-measure, as it states that: “Improving water use efficiency in agriculture (5A) requires a holistic approach to the operation and management of the system — water intake, conveyance, distribution, and application to the crop.”

### 12.2.2 Spatial Planning and Land Use — Provisions and Guidelines of the Regional Framework for Spatial Planning and Sustainable Development of Peloponnese (Government Gazette 1485/B/10-10-2003)

The proposed works — the dam and irrigation networks — are fully consistent and compatible with the Regional Spatial Planning Framework of 2003, as well as with the 2014 revision and specialization proposal of the Regional Framework for Spatial Planning and Sustainable Development (RFSPSD) of the Peloponnese Region.

**Specifically, the projects are consistent with** the sectoral policies and proposals, as they represent multifunctional interventions with positive impacts on agricultural activity, environmental protection, optimal management of water resources, and combating desertification within the spatial unit.

The broader area has been designated for interventions in these sectors, in terms of proposed infrastructure, with explicit reference to the need for the study and implementation of such projects in the Minagiotiko stream, which is precisely the area under examination.

### 12.2.3 Institutional Land Use Framework in the Study Area

**Spatial and Urban Planning Schemes of Open Cities (SCHOAPs)**

The proposed location of the dam under study and the irrigation network lies within the boundaries of the Municipalities of Pylos–Nestor and Messini (see Drawings ΑΠ-1 and ΑΠ-2).

The current study area mainly includes cultivated lands belonging to the former municipal districts of the following municipal units:

1. Municipal Unit of Methoni, including the former municipal districts of Evangelismos, Finikounta, Lachanada, and Finiki;
2. Municipal Unit of Pylos, including the former municipal districts of Pidassos, Chomatada, Kallithea, and Ampelakia;
3. Municipal Unit of Aipeia, including the former municipal district of Militsa;
4. Municipal Unit of Koroni.

Among these, Spatial and Urban Planning Schemes of Open Cities (SCHOAPs) have been prepared for the Municipal Units of Methoni, Koroni, and Aipeia, with the SCHOAPs of Koroni and Aipeia having already been approved.

The proposed projects are fully compatible with the land use and environmental protection provisions of the three aforementioned SCHOAPs.

**Water Management Plan**

The project area belongs to the Water District of Western Peloponnese (WD 01). According to the Water Resources Management Plan prepared and approved by the Special Secretariat for Water of the Ministry of Environment, Energy and Climate Change (ΥΠΕΚΑ), the "River Basin Management Plan of the Western Peloponnese Water District (WD 01)" was approved and published in Government Gazette 1004/B/24-04-2013. The proposed works are planned for implementation in the Minagiotiko Stream, which is located within the River Basin District (RBD) of Pamisos–Nedon–Neda (GR32). This basin has the smallest catchment area, covering 43.42 km², and the second shortest riverbed length, measuring 13.19 km. The main rivers within the Pamisos–Nedon–Neda (GR32) River Basin District are identified and managed under this same framework.

**Main Rivers in the Pamisos–Nedon–Neda (GR32) River Basin District**

| River Name | Main Riverbed Length (km) | River Catchment Area (km²) |
|---|---|---|
| Pamisos River | 43.47 | 567.60 |
| Neda River | 31.44 | 278.55 |
| Aris River | 15.40 | 203.05 |
| Kalo Nero River | 24.67 | 183.31 |
| Velika River | 32.04 | 149.37 |
| Nedon River | 22.43 | 146.11 |
| Myloi River | 19.44 | 134.83 |
| Selas River | 23.95 | 95.87 |
| Kleisouraiiko River | 15.39 | 64.92 |
| Filiatrino River | 24.43 | 62.90 |
| Pannouzagas River | 13.76 | 48.31 |
| Languvardos River | 8.29 | 48.09 |
| **Minagiotiko Stream** | **13.19** | **43.42** |

In Table 4.2 of Annex 8 of the Water Resources Management Plan (WRMP), the scheduled projects include those examined in the present study, as follows:

- Entry No. 106: *Minagiotiko Dam*, located on the Minagiotiko Stream. It is planned to irrigate 44,500 stremmas (with a consumption rate of 265 m³/stremma/year). This derives from the Reconnaissance Study of Reservoirs in the Provinces of Pylia and Trifylia, Prefecture of Messinia (1998).
- Entry No. 118: *Irrigation Networks of the Minagiotiko Dam*, covering an estimated 20,000 stremmas in the Municipal Unit of Pylos and 24,400 stremmas in the Municipal Unit of Methoni, according to the Study Tools of the Ministry of Development.

Within the Western Peloponnese Water District (WD 01), 26 groundwater bodies have been delineated across two basins. The project area belongs to Groundwater Body No. 5 (GR0100120) — the Methoni system, which is classified as a fractured–granular aquifer with a total area of 224.0 km².

**Land Use**

The dominant land use in the project's immediate impact area consists of cultivated agricultural land, with the majority of the population employed in the primary (agricultural) sector.

There are no organized activity zones or informal clusters of professional concentration (such as industrial or craft zones) within the study area, in accordance with Law 3982/2011 (Government Gazette 143A/2011).

Furthermore, the area designated for the project is not classified as high-productivity agricultural land.

**Archaeological Monuments**

Within the project area, there are no registered protected archaeological monuments or sites, except for individual buildings located within settlements, which are generally of local architectural or historical interest only.

### 12.2.4 Environmental Sensitivity Characteristics of the Project Area

The streambed at the dam construction site forms the northern geographical boundary of the Natura 2000 protected area GR2550003, designated as a Site of Community Importance (SCI). The proposed dam and reservoir are located partially within this protected area, as is a significant portion of the irrigated land.
However, according to the data of the Special Environmental Study (SES) that was carried out, both the dam area and the agricultural land to be irrigated are not designated as Nature Protection Areas — which are located mainly along the southern coasts and islands — but rather as part of the Terrestrial Continental Eco-Development Zone of Akritas.
Within this zone, due to its predominantly agricultural character, there are no nature protection subzones, and therefore the proposed works are fully compatible with the protection and management proposals of the SES.

## 12.3 Emission Limit Values for Pollutants in Air, Water, Soil, Noise and Vibration Levels, and Environmental Quality Standards

### 12.3.1 Air Quality Limit and Guideline Values

The limit and target values for atmospheric quality are defined by the following regulations:

#### 12.3.1.1. Joint Ministerial Decision (JMD) No. Η.Π. 22306/1075/Ε103/2007 (Government Gazette 920/Β/2007)

“Setting target and limit values for concentrations of arsenic, cadmium, mercury, nickel, and polycyclic aromatic hydrocarbons in ambient air, in compliance with the provisions of **Directive 2004/107/EC** ‘on arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air’ of the Council of the European Communities of 15 December 2004.”

#### 12.3.1.2. Joint Ministerial Decision (JMD) No. Η.Π. 14122/549/Ε.103/2011 (Government Gazette 488/Β/30.3.2011)

“Measures for the improvement of air quality, in compliance with the provisions of **Directive 2008/50/EC** ‘on ambient air quality and cleaner air for Europe’ of the European Parliament and of the Council of the European Union of 21 May 2008.”

### 12.3.2 Suspended Particulate Matter (Dust) from Construction Sites

For point-source emissions of suspended solids (dust) from construction sites, the provisions of **Presidential Decree 1180/1981 (Government Gazette 293/A/1981)** apply — "On the regulation of issues related to the establishment and operation of industries, crafts, etc."

### 12.3.3 Noise Emissions from Equipment Used Outdoors

For noise emissions from equipment used outdoors during the construction and operation phases, the provisions of Joint Ministerial Decision (JMD) 37393/2028/2003 (Government Gazette 1418/B/2003) apply "Measures and conditions for noise emissions into the environment from equipment used outdoors," as amended by Ministerial Decision 9272/471/2007 (Government Gazette 286/B/2007),"Amendment of Article 8 of JMD 37393/2028/2003 (1418/B), in compliance with Directive 2005/88/EC, amending Directive 2000/14/EC on the approximation of the laws of the Member States relating to noise emissions into the environment by equipment used outdoors, of 14 December 2005."

### 12.3.4 Maximum Permissible Noise Levels for Construction Sites and Project Installations

The **maximum permissible noise levels** for construction sites and installations are defined by the provisions of **Presidential Decree 1180/1981 (Government Gazette 293/A/1981)**.

## 12.4 Conditions, Measures, and Restrictions for Minimizing and Addressing Potential Environmental Impacts

### 12.4.1 General Provisions

**12.4.1.1** The project implementation and operation entity, as well as any natural or legal person assigned part of its execution or operation, shall bear responsibility for compliance with all environmental conditions, measures, and restrictions (hereinafter referred to as "environmental terms") imposed by this Decision, insofar as they concern them, as well as for compliance with all relevant environmental legislation applicable to the project — regardless of whether a specific reference to such legislation is included in these terms.
The project operator is obliged to take all necessary actions to ensure that these environmental terms are fully observed by the individuals or entities involved in the project's implementation and operation.

**12.4.1.2** The project implementation and operation entity must appoint a responsible officer for monitoring the compliance with the environmental terms, measures, and restrictions set forth in this Decision.The details of this officer must be communicated to the Environmental Licensing Directorate (DIPA) and the Special Environmental Inspectors Service (EYPE) of the Ministry of Environment and Energy (ΥΠΕΚΑ).

**12.4.1.3** During both the construction (tendering, supervision, and acceptance procedures) and operation phases, all necessary actions and measures must be taken to ensure:

- compliance with all environmental terms, and
- the ability to respond to and remediate any adverse environmental conditions arising from actions or omissions of the contractor that violate the environmental terms.

**12.4.1.4** Within the project's total construction and operation budget, the costs required for the implementation of the environmental measures (e.g., planting, landscaping, environmental restoration works) must be secured as a priority and executed before or alongside other construction works.The cost of implementing the environmental terms must be explicitly included in the project's budget prior to the commencement of its implementation.

**12.4.1.5** If, within the scope of the project, it becomes necessary to carry out additional works or activities not covered by this Decision — including improvement, modernization, expansion, or modification — their environmental permitting shall be carried out by the authority responsible for the environmental licensing of the overall project.

**12.4.1.6** For any work or activity implemented or operated under the project, all required permits and approvals under applicable legislation must be secured in advance and remain valid throughout the duration of the activity's implementation or operation.
This Decision does not exempt the involved parties from obtaining other permits or approvals required by other competent public authorities, where such are mandated by existing provisions.

**12.4.1.7** For project sections located within forest or woodland areas, this Decision also constitutes approval for forest land intervention under Chapter Six of Law 998/1979, in accordance with Article 12 of Law 4014/2011 and Article 3 (paragraphs 2 and 3) of Ministerial Decision 15277/2012. In such cases, before project implementation begins, all provisions of Ministerial Decision 15277/2012 (Government Gazette 1077/B/9-4-2012), as currently in force, must be observed. For the installation of the project operator on-site, a protocol of establishment must be issued by the competent Forest Directorate.
Additionally, within the framework of the issued approval, the following conditions must be applied:

> **12.4.1.7.1** The shaping of working surfaces must be limited strictly to the necessary areas, and interventions must be confined only to what is technically essential, remaining strictly within the defined zones.
>
> **12.4.1.7.2** Measures shall be taken to ensure the minimum possible disturbance of the natural environment in the project area, so that any adverse effects on the immediate and wider environment are kept to an absolute minimum.
>
> **12.4.1.7.3** All project facilities shall be constructed with materials and methods that do not harm or degrade the natural surroundings. Their design and appearance must be adapted to the landscape, as well as to the social and environmental characteristics of the area.
>
> **12.4.1.7.4** The beneficiary must ensure the complete removal of excavation materials, is responsible for any potential damage caused to third parties, and must take all necessary fire prevention measures to protect the surrounding forest vegetation. Unsuitable excavation materials must be disposed of in approved locations only.
>
> **12.4.1.7.5** The destruction of forest vegetation must be kept to the absolute minimum. The removal of existing vegetation within the project development area shall take place under the supervision and guidance of the local Forest Authority.
> All forest products resulting from such activities must be managed and distributed in

accordance with Forestry Legislation, and where required, a logging table must be prepared.

**12.4.1.7.6** Major disturbances to the natural terrain must be avoided. The formation of slopes must be properly designed and stabilized to:

- prevent landslides and erosion phenomena, and
- facilitate the restoration of vegetation.

**12.4.1.7.7** The intervention areas must be clearly and precisely delineated on the ground through the installation protocol to be prepared.
Any modification of these areas may only occur upon recommendation of the competent Forest Authority, if serious issues of environmental protection arise.

**12.4.1.7.8** All necessary safety measures must be taken for the protection of workers and potential visitors within the forest area. Elegant and visible warning signs indicating possible hazards must be installed accordingly.

**12.4.1.7.9** Provision must be made for the restoration of vegetation in disturbed areas through planting or seeding of species appropriate to the local flora, following a special forest-technical restoration study to be prepared. The maintenance and care of the plants shall continue for at least three years after planting, under the responsibility of the beneficiary.
The removal of the surface soil layer must be done carefully and preserved properly for future use in site restoration.

**12.4.1.7.10** No intervention of any kind shall be carried out outside the designated intervention zones.

**12.4.1.7.11** No modification or expansion of the land use shall take place beyond the approved purpose.

**12.4.1.7.12** The approval granted is strictly personal to the authorized individual or entity. In the event of a change in the beneficiary, this must be formalized through an amendment of the present forest intervention approval, limited only to the change of holder and without alteration of the other terms.

**12.4.1.7.13** If the purpose of the approval is not fulfilled, ceases to exist, or is altered, or if the above conditions are not observed, the land shall automatically revert to the management of the Forest Service, and this approval shall cease to be valid without further formalities.

**12.4.1.7.14** In the event of termination of the project's operation, the beneficiary must remove all installations placed within the area and restore the intervention site in accordance with a restoration plan to be prepared.
The land shall then revert to its original use status prior to the change.
Failure to comply with the above provisions shall result in the penalties specified in paragraph 12, Article 45 of Law 998/1979, as currently in force.

**12.4.1.7.15** The installation of the project within the designated area shall be carried out following the issuance of an Installation Protocol, which shall be prepared by the Forestry

Directorate of Messinia. A copy of this protocol must be forwarded to the Directorate of Forest Coordination & Inspection of the Peloponnese Region.

**12.4.1.7.16** A prerequisite for the beneficiary's installation in the designated area is the submission of a reforestation or afforestation study, approved by the Forestry Directorate of Messinia, in accordance with paragraphs 8, 9, and 10 of Article 45 of Law 998/1979, as in force. This reforestation or afforestation shall be carried out by the beneficiary over an area equal in size to that of the intervention, in a location designated by the Forestry Directorate of Messinia.

**12.4.1.7.17** Upon installation, the beneficiary fully accepts the conditions of the intervention approval. Failure to comply with these terms shall automatically result in the revocation of the installation protocol, with all consequences provided for by Forestry Legislation.

**12.4.1.7.18** No intervention of any kind shall be considered lawful prior to the issuance of the installation protocol.

**12.4.1.7.19** The installation of the water conveyance pipelines must be executed under the following conditions:

- No detours or deviations of pointwise nature are allowed.
- No excavations shall be performed, nor shall forest vegetation be destroyed on either side of forested areas.
- The pipeline shall be laid above ground.
- All excess materials must be completely removed and disposed of only in approved sites.

**12.4.1.7.20** The intervention areas must be specifically and precisely defined on-site through the installation protocol to be prepared. Before commencing works, the final width of the road must be clearly marked by the beneficiary using visible and stable metal posts, to ensure compliance with the approved layout.
In all cases, the construction zone must be delineated in advance during the construction phase.

**12.4.1.7.21** No clearings, cleanings, thinnings, strip openings, dumping of debris, or similar actions shall be allowed on either side of the road, beyond the width defined by the metal posts.

**12.4.1.7.22** The operation of borrow pits or quarries for obtaining materials suitable for the project's construction, as well as the use of earthmoving machinery or other means, shall be carried out exclusively for the needs of the project, in accordance with Article 52, paragraph 2 of Law 998/1979, as in force.The commercial use or disposal of materials to third parties is strictly prohibited. Operation is allowed only after all preparatory steps and permits required by current legislation have been obtained.

**12.4.1.7.23** The operation period of the borrow pits and quarries shall not exceed the total duration of the project's construction.

**12.4.1.8** During both the construction and operation phases, communication between inhabited areas must be maintained and safeguarded, ensuring that access routes remain open and functional.

**12.4.1.9** Before the commencement of construction works, any existing installations located within the flooded basin area of the Minagiotiko Dam must be removed in coordination with the Project Owner.

**12.4.1.10** The environmental protection and restoration measures proposed in the project's Environmental Impact Study (EIS) shall remain valid and binding, provided that they specify or supplement the terms of this Decision and do not contradict any of its other provisions.

**12.4.1.11** The project owner is required to prepare all necessary studies — namely a Hydrogeological Study, Geological Mapping and Geophysical Survey, and Hydraulic Study of installations — to ensure the restoration of the water supply for the settlements of Vlassaika, Militsa, and Lachanada–Finikounta, whose springs and water supply facilities will be submerged by the reservoir.
These studies must be conducted after the approval of the final design studies and prior to the preparation of the project tender dossier, while the new water supply infrastructure must be fully operational before the commencement of dam construction works.

### 12.4.2 Construction Phase of the Project

#### 12.4.2.1 Use of Natural Resources and Energy Conservation

**12.4.2.1.1** The aggregate materials required for the construction of the project must be sourced from the project's designated borrow pits, giving priority to those located within the dam's inundation basin.

**12.4.2.1.2** The non-potable water needed for project-related purposes (such as road wetting, concrete mixing, and dust suppression) should, if not economically or technically feasible to be supplied via existing networks, be obtained either from legally operating local boreholes or from new boreholes, provided that the necessary permits for water abstraction and use have been secured.
Temporary water storage tanks (e.g., plastic or collapsible reservoirs) should be used unless existing permanent tanks are available.
The use of water abstracted for the project is strictly limited to construction and firefighting needs only. All water abstraction facilities must be removed once the corresponding construction stage they serve has been completed.

#### 12.4.2.2 Solid Waste Management

**12.4.2.2.1** The project contractor is responsible for maintaining cleanliness in all areas under their management. All types of waste, scrap materials, old spare parts, and unused machinery must be collected and removed from the project site in compliance with current legal provisions governing waste management.

**12.4.2.2.2** Excavation materials that cannot be reused in the project ("excess excavation materials") shall be managed according to the following priority order:

- Restoration of the project's borrow pits or other inactive quarries,
- Use in rural road construction or improvement, particularly for maintaining and resurfacing sections of the existing agricultural road network,
- Use in the construction of the new perimeter road around the reservoir,
- Supply of materials to other approved projects (with valid environmental permits) or for the rehabilitation of borrow pits of such projects,

- Use in restoration of uncontrolled waste disposal sites, provided the activity complies with approved environmental conditions.

**12.4.2.2.3** For the formation of the disposal areas proposed in the Environmental Impact Study (EIS), a Technical Environmental Study (ΤΕΠΕΜ) must be submitted and approved by the Environmental Licensing Authority (DIPA) prior to construction, in accordance with Article 7 of Law 4014/2011 and with at least the content specified in paragraph 11 of Article 11 of the same Law.The content of this Technical Environmental Study must comply with the terms of the present Decision and the environmental conditions of the hosting works or activities, and it shall be subject to the agreement of the respective managing entities of those areas. In cases where excess excavation materials are to be disposed of in inactive quarries or borrow pits located within forest areas, a rehabilitation environmental study must be prepared and submitted by the project owner, following a recommendation by the competent Forest Officer, and must be approved by the Secretary General of the relevant Decentralized Administration, as required under paragraph 4 of Article 7 of Law 4014/2011.

**12.4.2.2.4** Even temporary deposition of materials related to the project (either materials to be used in the project or resulting from earthworks) is prohibited outside the designated project zone, as well as in any part of the hydrographic network. In all cases, the temporary deposition of such materials is strictly forbidden within the active riverbeds of the area's watercourses.

**12.4.2.2.5** Solid wastes similar to municipal waste must be collected and disposed of in authorized facilities and through approved waste management systems (e.g., sanitary landfill (XYTA) or waste treatment and disposal sites (XYTY)). The management of non-hazardous waste shall comply with the provisions of JMD 50910/2727/2003 (Government Gazette 1909/B/2003) and Law 4042/2012 (Government Gazette 24/A/2012), as amended and in force.

**12.4.2.2.6** The management of waste subject to the provisions of Law 2939/2001 (Government Gazette 179/A/2001), concerning alternative waste management, must be carried out in accordance with the requirements and specifications of that law, the relevant regulatory acts, and the approved Alternative Management Systems recognized by the Ministry of Environment and Energy (ΥΠΕΚΑ).

**12.4.2.2.7** The management of any hazardous waste must be performed in full compliance with the provisions of the applicable national and EU environmental legislation.

#### 12.4.2.3 Management of Sanitary Sewage and Liquid Waste

#### 12.4.2.3.1 The toilets at the project construction sites must be of the chemical type (portable sanitary units with chemical treatment).

**12.4.2.3.2** It is strictly prohibited to pollute surface or groundwater with lubricants, oils, fuels, or any other substances, or to dispose of such materials onto the ground.

- Oils for use must be stored in closed containers within a covered, protected area.
- Used oils and any spill residues must be collected and disposed of according to the provisions of:
    - Presidential Decree 82/2004 (Government Gazette 64/B/2004),
    - JMD 13588/725/2006 (Government Gazette 383/B/2006),
    - JMD 24944/1159/2006 (Government Gazette 791/B/2006), and

- JMD 8668/2007 (Government Gazette 287/B/2007).

**12.4.2.3.3** Vehicle and machinery maintenance operations, including oil changes, are prohibited outside the main construction sites of the project. To prevent pollution of surface or groundwater from oil leaks or other liquid waste generated during maintenance of mobile mechanical equipment, temporary sealed collection tanks must be installed at appropriate locations to contain any spills.
Both new and used lubricants must be stored in sealed containers, placed in covered areas with impermeable flooring.
The management and disposal of used lubricating oils from all machinery, vehicles, and equipment associated with the project must comply with Presidential Decree 82/2004 (Government Gazette 64/A/2004), as currently in force.
The required waste oil identification forms, as stipulated in the aforementioned Decree, must be maintained on-site throughout the validity period of this Decision.
Additionally, the contractor must maintain a bound logbook with numbered pages, validated by the Department of Environmental Control, Measurements and Water Resource Management of the Regional Unit, recording details such as:

- type, date, quantity, and reason for oil purchase, withdrawal, or leakage;
- method of disposal for used oils and spill residues; and
- in case of leakage, a summary report on the remediation measures taken.

**12.4.2.3.4** Prevention of Soil and Water Pollution from Fuel or Lubricant Leaks
To prevent soil and water pollution from potential fuel or lubricant leaks, appropriate absorbent materials (e.g., sawdust, sand, or similar substances) must be used in the event of a spill. Such absorbent materials must be readily available within all construction sites. After use, the contaminated absorbents must be collected in watertight containers and subsequently managed in accordance with Presidential Decree 82/2004.

### 12.4.2.4 Limitation of Atmospheric Emissions, Vibrations, Noise, and Electromagnetic Radiation

**12.4.2.4.1** All vehicles, machinery, and equipment used in the project must be kept in good condition and maintained as required by their technical specifications, in order to minimize atmospheric emissions..

**12.4.2.4.2** To reduce dust emissions generated during construction activities, the following measures must be implemented:

i. Aggregate production units (crushing and screening plants), if used, must be equipped with dust suppression and wetting systems, and all conveyor belts must be covered.
ii. During transportation of bulk materials, the truck beds must be covered.
iii. Regular watering of aggregate piles and unpaved roads used by project vehicles must be ensured, especially between June and September.
iv. Excavation, construction, and material transport activities must be coordinated so as to minimize the time aggregates remain stored in piles.

**12.4.2.4.3** Open burning of any waste materials (e.g., tires, oils, lubricants, plastics, etc.) is strictly prohibited within the project area.

**12.4.2.4.4** Noise levels must comply with the limits established by Presidential Decree 1180/1981 (Government Gazette 293/A/1981) and all other relevant legal provisions, including:

- the use of CE-marked equipment displaying guaranteed sound power levels,
- compliance with quiet hours, and
- the use of temporary noise barriers when noise levels exceed acceptable thresholds.

**12.4.2.4.5** The average sound energy level of construction sites and related installations must remain within the permissible limits defined by Presidential Decree 1180/1981, as applicable to the specific area of work execution.

**12.4.2.4.6** All equipment used outdoors must comply with the noise emission limits established by Joint Ministerial Decision 37393/2028/2003 (Government Gazette 1418/B/2003) or any subsequent amendments. The use or presence of machinery on-site without an approved EEC noise compliance certificate is strictly prohibited.

**12.4.2.4.7** All unpaved roads used by transport trucks and all excavation material piles must be periodically watered, whenever weather conditions require it, to prevent dust dispersion.

#### 12.4.2.5 Limiting Impacts on the Natural Environment, Flora, and Fauna

In addition to the provisions of terms 12.4.1.7.1 through 12.4.1.7.22, the following also apply:

**12.4.2.5.1** Construction sites shall be established, wherever possible, on land without natural shrub or tree vegetation (e.g., fields, barren land, or grasslands), excluding areas located within the reservoir basin.

The installation of construction sites is prohibited:
- within streambeds,
- in wetland areas, and
- within a distance of less than 500 meters (500 m) from such areas, as well as within forested zones.

#### 12.4.2.6 Additional issues related to the construction phase

**12.4.2.6.1** Protection of Archaeological Sites and Historical Monuments

i. The project implementation authority must notify in writing, at least ten (10) days prior to the commencement of excavation works, the competent Ephorates of Prehistoric and Classical Antiquities, Byzantine Antiquities, and Modern Monuments. All excavation activities of the project (including its ancillary works) must be carried out under the supervision of representatives of the aforementioned Archaeological Services. In the case of phased construction of the project at different time periods, the notification must be repeated before the beginning of works in each section. The contractor or supervising engineer is responsible for informing the Ephorates in the event of any accidental discovery of antiquities, at any stage of the project, in accordance with Law 3028/2002 ("Protection of Antiquities and Cultural Heritage in General").

ii. If, during construction, archaeological remains are discovered, work at the specific location must immediately cease, and a rescue excavation must be conducted, in accordance with the provisions of Law 3028/2002. The continuation of the project at that section will depend on the findings of the excavation and the decision of the competent Councils of the Ministry of Culture and Sports.

In such cases, the entire cost of the excavation, including the remuneration of the necessary scientific and technical staff appointed by the competent Ephorates of Antiquities, as well as the costs of conservation, study, and publication of the findings, shall be borne by the project budget, in accordance with Article 37 of Law 3028/2002.

iii. In the event of design modifications or changes to the construction schedule, the competent Archaeological Ephorates must be informed in advance.

**12.4.2.6.2** During earthworks, all necessary measures must be taken to prevent any leakage or dispersion of construction materials and to avoid increasing water turbidity in nearby water bodies due to the transport of loose materials.
In cases of heavy rainfall, when the likelihood of such phenomena is heightened, earthworks must be suspended until favorable conditions for safe and environmentally sound operations are restored, except for works required immediately for safety or environmental protection reasons.

**12.4.2.6.3** If excavated materials are washed to be reused as aggregates in the project, the wastewater produced must first pass through a settling basin or trench to allow sedimentation before being discharged into a water recipient.

**12.4.2.6.4** The movement of project vehicles through settlements must, as far as possible, be carried out outside of designated quiet hours, to minimize disturbance to residents.

**12.4.2.6.5** During project implementation, special care must be taken to avoid damage to existing infrastructure within the wider area.
If the project requires any modification or intervention to existing infrastructure (e.g., road crossings or connections with existing networks), such works must be executed according to the instructions of the competent infrastructure authorities, ensuring the continued and safe operation of the affected facilities.
The restoration of affected infrastructure must be completed immediately upon technical feasibility for each independent construction segment of the project.

**12.4.2.6.6** The installation of non-mobile mechanical equipment, including portable units without self-propulsion capability (such as crushing and screening plants, aggregate sieves, concrete batching plants, etc.), is strictly prohibited outside the designated construction site areas.

**12.4.2.6.7** The project implementation authority must, at least one (1) month prior to the scheduled installation of equipment at any construction site, submit for approval to the Environmental Licensing Directorate (DIPA) of the Ministry of Environment and Energy (ΥΠΕΚΑ) a Technical Environmental Study (TEPEM). This study, submitted in at least three (3) printed and digital copies, must cover the entire construction site organization, including:

- the equipment to be used,
- mobile offices or auxiliary structures,
- material storage areas, and
- the overall site layout.

It must also specify the environmental protection measures that will be implemented to ensure compliance with this Decision, including:

- the location and characteristics of settling tanks or trenches for wastewater from aggregate washing,
- the management of lubricating oils,

- the estimated duration of site operation, and
- the restoration plan for the area following completion of works.

Installation works at each site may only commence after the approval of the corresponding TEPEM by DIPA.

**12.4.2.6.8** If multiple contractors are appointed or more than one construction site is used (either simultaneously or successively), a separate TEPEM may be submitted for each site, as applicable.

**12.4.2.6.9** Following their approval by DIPA, the TEPEM studies for all construction sites must also be submitted to the Directorate of Environment and Spatial Planning of the Decentralized Administration of the Peloponnese, to facilitate environmental inspections conducted by the Environmental Quality Control Units (ΚΕΠΠΕ).

**12.4.2.6.10** Within six months after the completion of works in any independent section of the project, the project owner must ensure the removal of all construction-related installations (offices, workshops, machinery, etc.) and any remaining materials. All non-reusable materials must be transported to authorized disposal sites.

**12.4.2.6.11** Under this Decision, the construction of temporary access routes within the project area boundaries is permitted solely for the purpose of facilitating construction activities.

**12.4.2.6.12** Sections of asphalted roads used by project vehicles or machinery must be regularly cleaned to remove any aggregate residues, such as mud, gravel, or materials falling from truck beds.

**12.4.2.6.13** The parking of project vehicles or machinery during non-working hours must take place outside the wide riverbeds or floodplains of the area's watercourses.

**12.4.2.6.14** All necessary measures must be taken to protect pedestrians and drivers passing through the project area from potential hazards associated with construction or operation activities.

These measures include:

- the placement of warning signs at all construction site exits leading to public roads,
- additional signage at points with frequent heavy vehicle movement, and
- the securing of the site perimeter to prevent accidents.

**12.4.2.6.15** During both the construction and operational phases, all fire protection measures must be implemented to minimize the risk of fire outbreaks or spread to adjacent areas.

**12.4.2.6.16** At all pipeline crossings of streams or torrents, appropriate technical works must be constructed to:

- prevent the accumulation of sediments and debris, and
- ensure the unobstructed natural flow of water through the affected watercourses.

### 12.4.3 Operation Phase of the Project

#### 12.4.3.1 Use of Natural Resources and Energy Conservation

Under this decision, the storage of surface water from the Minagiotiko stream at the Minagiotiko Dam is permitted, with the dual purpose of:

- providing irrigation water for the newly established agricultural networks in the region, and
- ensuring the maintenance of the ecological flow downstream of the stream.

This regulated use of water resources aims to achieve a balance between agricultural productivity and the preservation of local ecosystems, minimizing environmental stress while promoting sustainable water management practices.

#### 12.4.3.2 Waste Management

The project operation authority is responsible for the implementation of the provisions of Decision 8197/90920/13 and the National Action Plan for the rational use of agricultural pesticides, including the organization and effective management of packaging waste systems. This process shall comply with Law 2939/2001 (Government Gazette 179/A/2001) concerning alternative waste management systems.

As part of these obligations, the project operator must:

- inform and educate farmers on best practices for pesticide use, and
- establish a management system for empty plastic pesticide containers.

The operator shall install collection bins of a distinct color (recommended: red), distributed throughout the project area, and especially at pesticide mixing and filling stations (10 points in total).

This measure aims to prevent environmental contamination from agricultural chemicals and to enhance the circular management of packaging waste.

#### 12.4.3.3 Limitation of Atmospheric Emissions, Vibrations, Noise, and Electromagnetic Radiation

The operational phase must comply with the same environmental standards and limitations described in terms 12.4.2.4.4 to 12.4.2.4.6 of this Decision. This includes adherence to noise thresholds, equipment certification (CE-marked), and overall operational practices that minimize environmental nuisance and pollution.

#### 12.4.3.4 Minimizing Impacts on the Natural Environment, Flora, and Fauna

To ensure ecological integrity and biodiversity protection during the operational phase:

- The ecological flow of the Minagiotiko stream downstream of the dam must be continuously maintained to sustain aquatic and riparian ecosystems.
- If significant bird populations develop in the reservoir area, additional protective and habitat enhancement measures must be designed following a special environmental study.
- A game refuge should be established within a 1,000-meter buffer zone around the reservoir area to protect bird species and other wildlife attracted to the habitat.
- Good Agricultural Practice (GAP) standards must be strictly followed in farming activities to prevent negative impacts on local ecosystems from fertilizer or pesticide use.

- Expansion of cultivated areas through the clearing of forested land is strictly prohibited, to protect the region's biodiversity and maintain ecological balance.
- Any landscaping and planting works must be properly maintained, as these contribute not only to ecological restoration but also to the aesthetic enhancement of the project area.

#### 12.4.3.5 Other Issues Concerning the Operational Phase

The environmental conditions specified for the construction phase of this Decision also apply to maintenance and repair activities carried out during the operational phase (e.g., structure repairs, restoration works, cleaning, etc.).
In addition, the following terms apply:

**12.4.3.5.1** The project operating authority must develop a preventive maintenance and repair program for all mechanical and electromechanical equipment, and prepare a comprehensive Operation and Maintenance Plan for both the dam and the water conveyance pipeline. Throughout the operational period, the operator is required to carry out all necessary maintenance and functional works to ensure the continuous and efficient operation of the infrastructure, in accordance with its design specifications, to meet the irrigation demands of the project's agricultural service area.

**12.4.3.5.2** The activities carried out during the operational phase of the project may be conducted under the current approval, i.e., without the need for a new environmental permit, provided that:

- they are performed within the spatial limits defined during the implementation phase, and
- they do not entail any modification of the approved project design.

If these conditions are not met, the operating authority must submit a Modification File to the competent Environmental Licensing Authority responsible for the overall project, and obtain a new environmental approval before the commencement of any such works.

**12.4.3.5.3** During the operation of the project, all fire protection measures must be implemented to prevent and control the spread of fires to adjacent areas. This includes the maintenance of firefighting infrastructure, readiness of fire safety equipment, and staff training in emergency response procedures.

**12.4.3.5.4** The minimum ecological flow downstream of the dam must be secured and maintained continuously throughout the year, at a rate of 235,252 $m^3$ per year, as defined by the project's hydraulic design. This volume is in addition to the spillway discharges and natural runoff downstream of the dam.
If, at any time, irrigation demand temporarily exceeds available water resources, the issue must be addressed by:

- reducing the irrigated area and/or
- limiting irrigation volumes,
  and under no circumstances by reducing the quantity of water allocated for ecological flow.

Furthermore, to assess the future hydrological conditions downstream of the dam (up to the river's estuary), due to the retention of surface water, the project implementation authority must conduct a special Hydraulic Study.
This study shall include:

- a hydraulic modeling of the downstream river basin, and

- the sediment transport (solid discharge) calculations necessary to determine the total hydraulic and sediment flow.

This Hydraulic Study must be prepared upon the finalization of the dam's parameters at the subsequent stages of the technical design process.

**12.4.3.5.5** The project operating authority is responsible for the systematic monitoring of water quantities through appropriate recording equipment, specifically measuring: a) inflows into the reservoirs, b) withdrawals for irrigation, c) spillway discharges, d) ecological flow releases, and e) the stored volume at any given time.

The ecological flow discharge must be continuously monitored, while other quantities and parameters (e.g., reservoir and spillway levels) must be measured at a frequency sufficient to allow the monthly preparation of a comprehensive water balance (inflow–outflow) for the reservoirs.

**12.4.3.5.6** The operating authority must also ensure continuous monitoring of the irrigation network supplied by the dam, using recording systems installed at key control points. These systems must track:

- the total volume of water abstracted for irrigation, and
- the distribution of water volumes among various network sectors.

This data will provide a comprehensive picture of water use across the network and will allow for the early detection of irregularities, such as excessive losses or unjustified consumption levels.

**12.4.3.5.7** To prevent water quality degradation within the reservoir, systematic water quality monitoring must be conducted at regular intervals.

The project implementation authority must prepare a Water Quality Monitoring Report, specifying:

- the sampling locations for all project-related water bodies,
- the parameters to be analyzed (e.g., physicochemical and biological indicators), and
- the sampling and analysis frequency.

This report must be submitted to the competent Water Directorate at least six (6) months prior to the start of the project's operation and must receive formal approval before operations commence.

The purpose of this continuous monitoring is to ensure compliance with environmental standards, early detection of potential pollution, and safeguarding of the ecological integrity of the reservoir and its downstream ecosystems.

**12.4.3.5.8** All water quality analyses specified in the above-mentioned report must be carried out by accredited laboratories that comply with the ELOT EN ISO/IEC 17025 standard (or an equivalent accreditation). This requirement aligns with the Joint Ministerial Decision No. Η.Π. 38317/1621/Ε103/6-9-2011 (Government Gazette 1977/Β), which ensures accuracy, reliability, and traceability of environmental measurements.

**12.4.3.5.9** If water quality degradation in the reservoir is detected, the project operating authority must take all necessary corrective measures within its competence to eliminate the causes of such deterioration. If the causes lie beyond its jurisdiction, the authority must formally notify and recommend action to the competent governmental bodies for the implementation of remedial measures and issuance of relevant regulatory provisions.

Among its obligations, the operator must:

- Regulate the reservoir's water level to avoid drops that could lead to water quality deterioration or the proliferation of harmful insects, and

- Take immediate action in any case of confirmed degradation of water quality to restore acceptable conditions.

**12.4.3.5.10** The operating authority must promptly inform the competent environmental authority of any environmental damage or immediate threat of such damage occurring within the project area, in accordance with environmental liability and protection legislation.

**12.4.3.5.11** The irrigation networks and water conveyance pipelines must be regularly inspected by the operator. Any malfunctions, damages, or leaks detected must be immediately repaired to ensure the system's efficiency and integrity, as well as to prevent water losses or contamination.

**12.4.3.5.12** The quality of water extracted for irrigation must be systematically monitored throughout its use to confirm its suitability for agricultural purposes and to detect early signs of qualitative degradation. The parameters to be measured, sampling frequency, and acceptable thresholds shall be determined in collaboration with the Water Directorate of the Peloponnese Region. At a minimum, water quality sampling must occur before and after each irrigation season, using samples from the regulation tanks of the irrigation networks.
If significant deterioration in water quality is observed in these tanks, the sampling program must be intensified, both in frequency and geographical coverage—extending to water intake points—to identify the source of contamination and mitigate the problem effectively.

**12.4.3.5.13** The operating authority must also monitor soil quality systematically across all irrigated areas served by the project, to identify any degradation trends resulting from agricultural practices (e.g., salinization, chemical accumulation, or nutrient depletion). This ensures the long-term sustainability of the cultivated land and prevents environmental degradation due to overuse or mismanagement.

**12.4.3.5.14** All monitoring results related to water and soil parameters must be recorded and archived at the project operator's headquarters.
To facilitate data management and transparency:

- A comprehensive database must be established, containing all monitoring data, including both continuous and periodic measurements.
- An annual report summarizing and interpreting the monitoring results must be submitted after each irrigation season to:
  - the Water Directorate of the Peloponnese Region, and
  - the Departments of Environment and Water Management of the Regional Unit of Messinia.

Additionally, the operator must:

- Ensure authorized access to primary monitoring data upon official request, and
- Facilitate on-site inspections and sampling by competent authorities, providing full cooperation and technical assistance as needed.

**12.4.3.5.15** The project operating authority, in collaboration with the competent services of the Ministry of Rural Development, must implement training and awareness programs for local farmers.
These programs shall promote:

- Environmentally responsible agricultural practices,
- Rational use of fertilizers and pesticides, and
- Efficient irrigation water management.

The goal is to enhance environmental protection, ensure sustainable agricultural productivity, and maintain the long-term ecological balance of the region influenced by the irrigation scheme.

**12.4.3.5.16** The water quality of the reservoirs shall be protected under Health Regulations to be issued by the Water Directorate of the Decentralized Administration of Peloponnese, concerning the discharge of water and treated wastewater into surface receptors. The project construction authority must prepare and submit, at least one (1) year before the start of the project's operation, a draft Health Regulation Plan. This plan shall be submitted for approval to the Water Directorate of the Decentralized Administration of Peloponnese and to any other competent authority as required by the applicable legislation.

**12.4.3.5.17** In the event of applications for new projects or activities that are either located within the catchment areas of the reservoirs or discharge their effluents into these areas, the environmental permitting authorities must evaluate their compatibility with the intended use of the reservoir's water. Any incompatible project or activity must be prohibited.
It is strictly forbidden to dispose of any type of waste, whether treated or untreated, directly into the reservoir. This prohibition aims to preserve the water quality and ensure the sustainability of irrigation and ecosystem functions.

**12.4.3.5.18** During agricultural operations, farmers must comply with the provisions of the Cross-Compliance Regime, as defined by:

- Decision No. 324032/2004 (Government Gazette 1921/B/24.12.2004), ratified by Article 18 of Law 3399/2005 (Government Gazette 255/A/17.10.2005), and
- Ministerial Decision No. 262021/2005 of the Ministry of Rural Development and Food (Government Gazette 538/B/21.04.2005), which further specifies the applicable conditions.

These regulations ensure that agricultural practices remain compatible with environmental protection, soil conservation, and sustainable water management.

**12.4.3.5.19** Upon the commissioning of the project, all existing irrigation wells currently used within the area to be covered by the dam's irrigation capacity must be permanently decommissioned. This measure prevents overexploitation of groundwater and ensures that irrigation demand is met exclusively through the regulated water supply system of the project.

**12.4.3.5.20** Any landscaping or development of the area surrounding the reservoir for daytime recreation or outdoor leisure must comply with the relevant legal provisions in force at the time of planning and implementation.
Such developments must be environmentally compatible, non-intrusive, and ensure the protection of the hydrological and ecological functions of the reservoir and its surroundings.

**12.4.3.5.21** When designing and implementing recreational, leisure, or sports activities in the reservoir area, the following principle must be strictly observed:
The protection of irrigation water quality and the safe operation of the dam systems shall take absolute priority over any form of recreational or secondary use.
Thus, the management of these activities must always ensure the preservation of the reservoir's functionality, hydraulic safety, and ecological stability.

### 12.4.4 Restoration, Partial, Gradual, or Permanent Cessation of Project Operation

The termination of the project's operation is not foreseen, since the dam's function is essential for meeting the irrigation needs of the region.
However, if:

- land-use changes occur within the irrigated areas, or
- issues arise affecting the groundwater abstraction points, then modifications to certain project components may be necessary.

In such cases, the modification procedure outlined in Article 6 of Law 4014/2011, as amended, shall apply. Regarding the decommissioning of auxiliary installations (such as construction sites or temporary works areas), the relevant conditions are defined in Section 12.4.2 of this Decision.

### 12.4.5 Emergency Incidents of Pollution or Environmental Degradation

**12.4.5.1** The project operating authority must prepare a Monitoring, Operation, and Maintenance Plan (MOMP) for the Minagiotiko Dam, which shall include, at a minimum:
a) A regular inspection and maintenance program, covering all dam structures and auxiliary facilities, and
b) A special emergency response program, addressing extraordinary events such as earthquakes, heavy rainfall, or other natural disasters.
Additionally, a Comprehensive Operational Regulation must be drafted, specifying:

- all necessary technical procedures for routine and emergency situations, and
- the duties and responsibilities of personnel involved in monitoring, maintenance, and safety management.

This ensures that the project operates in full compliance with environmental and safety standards, while providing a structured response framework for any potential environmental or structural emergencies.

**12.4.5.2** Under the joint responsibility of the civil protection authorities and the project owner, a Dam Emergency Action Plan (EAP) must be developed to address potential dam failure scenarios. This plan shall be based on the findings of the Minagiotiko Dam Breach and Flood Wave Propagation Study, which will be conducted prior to operation.
The Emergency Action Plan must:

- Define the necessary procedures for alert and notification,
- Establish the chain of command and response mechanisms, and
- Detail the mobilization plan of the emergency response system, covering all areas expected to be affected by a potential flood wave downstream of the dam.

**12.4.5.3** The Dam Risk Assessment and Flood Wave Propagation Study must be submitted, before the dam's commissioning, to the urban planning authority responsible for the area surrounding the dam. This submission ensures that the findings and flood risk zones are integrated into future land-use and urban planning regulations, preventing unauthorized development in areas that may be flood-prone in the event of dam failure.

**12.4.5.4** The project owner is responsible for the installation of monitoring and early-warning systems designed to:

- Continuously track the dam's structural behavior, and

- Automatically alert civil protection authorities in case of failure or abnormal readings, in accordance with the specifications defined in both the Monitoring, Operation and Maintenance Plan (MOMP) and the Emergency Action Plan (EAP).

The operating authority must ensure these systems remain fully functional and regularly maintained, and must proceed with upgrades or modernization whenever required by new legal or technical standards.

#### 12.4.5.5 The project operator bears the following obligations:

i) To systematically inspect the dam's structural condition and take immediate corrective measures whenever potential risks to its integrity are detected, adhering at least to the procedures defined in the MOMP.

ii) To notify civil protection authorities without delay whenever there is an imminent risk to public safety, and to undertake preventive actions to mitigate the hazard in accordance with the MOMP and standard engineering practices.

iii) To employ adequately trained personnel for dam safety monitoring and for the implementation of all provisions contained in the MOMP and EAP. Furthermore, on-site supervisory personnel must be present at the dam and its auxiliary facilities in at least two daily shifts, with:

- Access to the primary monitoring instruments, and
- Secure and immediate communication capability with civil protection authorities.

**12.4.5.6** All operations and emergency response activities must comply with the provisions of Law 4042/2012, which governs environmental protection, pollution control, and waste management, ensuring proper coordination between safety and environmental regulations.

### 12.4.6 Additional Environmental Terms, Measures, and Restrictions for Activities within Natura 2000 Areas

Given that no designated nature protection areas (under the Natura 2000 network) are present within the immediate project area, no additional specific environmental conditions are required beyond those already stipulated.

The previously defined provisions that ensure ecological and environmental protection remain fully applicable, including:

- The protection of flora, fauna, and ecosystems (Condition 12.4.3.4),
- The maintenance of ecological flow and surface runoff (Condition 12.4.3.5.4),
- The monitoring of reservoir and network water quality (Condition 12.4.3.5.12), and
- The control of stored and utilized water volumes (Condition 12.4.3.5.5).

These conditions collectively safeguard the ecological balance of the region and ensure that project operations remain environmentally sustainable.

### 12.4.7 Monitoring Program and Reporting Requirements

**12.4.7.1** If noise levels around the construction sites are estimated to exceed acceptable limits, measurements must be conducted using a portable sound level meter operated by qualified personnel. These measurements will ensure compliance with legal noise thresholds and provide data for corrective actions aimed at reducing acoustic pollution and maintaining a safe and tolerable environment for nearby communities.

**12.4.7.2** The quantity and type of secondary products or residues generated at the project's construction sites must be recorded and categorized according to their respective EWC

(European Waste Catalogue) codes, along with the final recipient of each waste stream. This ensures full traceability and compliance with waste management legislation and facilitates monitoring by environmental authorities.

**12.4.7.3** The project operating authority must carry out annual monitoring of the overall condition and performance of all project components.
This includes:

- The effectiveness of each infrastructure element,
- The efficiency and operational reliability of the irrigation networks and the water conveyance pipeline,
- The availability of the required water quantities, and
- The quality of the irrigation water supplied.

This systematic monitoring guarantees the long-term functionality and environmental sustainability of the project.

### 12.5 Duration of the Environmental Terms Approval (ΑΕΠΟ) – Conditions for Renewal or Modification

**12.5.1** The environmental terms stipulated in this Decision shall remain valid for ten (10) years from the date of issue, provided that they are fully and accurately implemented throughout the period of validity.

**12.5.2** Before the expiration of this permit, if the project owner wishes to continue the operation of the project, they must submit a renewal request to the competent environmental authority in due time, in accordance with Article 5 of Law 4014/2011, to ensure the uninterrupted legal validity of the project's operation.

**12.5.3** This Decision remains temporarily valid after its expiration until a new renewed or amended decision is issued, provided that the project owner has submitted the renewal or modification request at least two (2) months before the expiration date, together with all required documentation.

**12.5.4** Any modernization, improvement, extension, or modification of the project activity—beyond what is defined in the approved Environmental Impact Study (EIA) and this ΑΕΠΟ—requires adherence to the modification procedure outlined in Article 7, paragraph 6 of JMD 167563/2013 (Government Gazette 964/B). Each individual condition of this Decision may also be amended if, during the construction or operation phases, it is determined that the environment is not adequately protected.

**12.5.5** If, during the technical design stages following the issuance of this Decision, design modifications are necessary for compliance, the project owner may submit a Final Design Compliance File (Φάκελος Συμμόρφωσης Τελικού Σχεδιασμού) prior to the start of construction. This procedure shall follow Article 7 of Law 4014/2011 and Article 8 of JMD 167563/2013, ensuring that design changes remain consistent with the approved environmental framework.

**12.5.6** If regular or extraordinary environmental inspections reveal serious environmental degradation or unforeseen impacts not accounted for in the EIA or this ΑΕΠΟ, additional environmental terms may be imposed, or existing ones modified, pursuant to Article 2(9) in conjunction with Article 6 of Law 4014/2011.

This may also include the imposition of compensatory measures or environmental fees under Article 17(1) of Law 4014/2011.

### 12.6 Other Provisions

**12.6.1** This Decision does not cover issues of safety relating to major industrial accidents or occupational health and safety of personnel. It also does not exempt the project owner from obtaining other required permits provided by applicable legislation.
Furthermore, this Decision:

- Is issued without examination of property ownership titles for the project area,
- Does not address building restrictions or land-use conditions, and
- Does not legalize any unauthorized existing structures, which remain subject to the current legislation on illegal constructions.

**12.6.2** This Decision shall remain valid provided that it does not conflict with urban planning or other special regulations that may prevail over it. In such cases, the stricter or higher-ranking legal provisions shall apply.

**12.6.3** This Decision does not exempt interested parties from their obligation to obtain permits from other competent public authorities, whenever such authorization is required by applicable law. It is the responsibility of the project owner to ensure full compliance with all relevant sectoral, environmental, and administrative regulations beyond the scope of this Decision.

### 12.7 Monitoring and Compliance with the Environmental Terms of this Decision

**12.7.1** This Decision and the accompanying approved Environmental Impact Assessment (EIA) must be available on-site at all times. The project owner/operator is required to present these documents to any authorized inspection authority upon request, in accordance with applicable environmental legislation. This ensures transparency, regulatory oversight, and accountability in the project's environmental performance.

**12.7.2** The responsible project entity must comply with the following obligations:

- Maintain documentation (e.g., invoices, contracts, technical logs, waste management records, and other supporting documents) that demonstrates compliance with the environmental conditions of this Environmental Terms Approval (ΑΕΠΟ). These records must be kept on-site and available for inspection at any time.
- Allow access to all authorized inspection bodies and environmental control officers.
- Provide all required information and data promptly upon request by any competent inspection authority.
- Facilitate inspections and comply with recommendations or instructions issued by environmental control authorities, ensuring full adherence to the provisions of current environmental legislation.

This framework establishes a continuous monitoring mechanism and enables the authorities to verify compliance effectively.

**12.7.3** Any issues that arise during the implementation of this ΑΕΠΟ and are not explicitly covered by its terms shall be resolved according to the applicable national and EU legislation. This ensures that the project remains compliant with broader environmental policy frameworks and European environmental standards.

**12.7.4** In the event of:

- Pollution incidents,
- Environmental degradation, or
- Violations of the terms of this ΑΕΠΟ,

the responsible parties shall face the sanctions and penalties stipulated in Articles 28, 29, and 30 of Law 1650/1986, as amended by Law 3010/2002, Law 4014/2011, and Law 4042/2012, and as currently in force.
These may include administrative fines, suspension or revocation of permits, and criminal liability, depending on the severity of the environmental violation.

### 12.8 Publication of this Decision

The mandatory publication of this Environmental Terms Approval (ΑΕΠΟ), as required by law, shall be carried out through its posting on the official digital platform of the Ministry of Environment and Energy, at the following address: ☞ www.aepo.ypeka.gr This procedure follows the provisions of Article 19a of Law 4014/2011 (Government Gazette 209/A) and Joint Ministerial Decision 21398/2012 (Government Gazette 1470/B). The online publication guarantees public accessibility, transparency, and accountability of environmental decisions and ensures citizens' right to information regarding environmentally significant projects.

### 12.9 Right to Appeal this Decision

An application for annulment (αίτηση ακύρωσης) may be filed against this Decision before the Council of State (Συμβούλιο της Επικρατείας) within the standard time limits prescribed by current legislation. This legal recourse provides procedural safeguards and ensures judicial oversight of administrative environmental decisions, reinforcing the rule of law and the principle of environmental justice.

# 13. ADDITIONAL INFORMATION

## 13.1 Specialized Studies

For the preparation of the present Environmental Impact Assessment Study (EIA), a series of technical and thematic studies were examined. These provided essential data for determining the institutional, natural, and environmental characteristics of the study area, as well as for assessing the potential impacts arising from the implementation of the proposed project. These studies constitute the technical and scientific foundation for the evaluation of the design, construction, and operation parameters of the Minagiotiko Dam and its irrigation networks.

**Technical Project Studies**

1. Introductory Report (March 2015)
2. Topographic Study (September 2015)
3. Agro-Economic and Technical Study of the Minagiotiko Dam & Final Study of the Irrigation Network (September 2015 – March 2017)
4. Hydrological Study (September 2015)
5. Geological Study (October 2016)
6. Geotechnical Works and Evaluation of Geotechnical Investigation Results (October 2016)
7. Preliminary Hydraulic Design of the Dam (December 2016)
   Thematic Studies and Reference Frameworks
8. National Strategic Plan for Rural Development 2007–2013.
9. Rural Development Program 2014–2020
10. Regional Spatial Framework for Spatial Planning and Sustainable Development of the Peloponnese Region (Government Gazette 1485/B/10-10-2003)
11. Proposal for the Revision of the Regional Spatial Framework for the Peloponnese (Draft Ministerial Decision, March 2015)
12. Local Spatial Plan (SCHOAP) of the Municipality of Methoni (pending approval)
13. Local Spatial Plan (SCHOAP) of the Municipality of Aipeia (Government Gazette 456/TAACPTH/17-12-2013)
14. Local Spatial Plan (SCHOAP) of the Municipality of Koroni (Government Gazette 421/TAACPTH/28-11-2013)
15. Operational Program of the Municipality of Pylos–Nestor (2015–2020)
16. Operational Program of the Municipality of Messini (2014–2019)
17. Special Environmental Study of the Islands of Sapientza and Schiza, Cape Akritas, and the Marine Area of the Methoni Strait
18. River Basin Management Plan of the Western Peloponnese Water District
    Establishes principles for the sustainable management, protection, and utilization of water resources, in line with Directive 2000/60/EC.
19. Implementation of Directive 2007/60/EC – Preliminary Flood Risk Assessment (December 2012) Analyzes flood risks and contributes to the design of flood control works related to the reservoir.

## 13.2 Problems Encountered

During the preparation of the present study, no significant difficulties were encountered. The compatibility of the project with the characteristics of the area, as well as with the institutional and regulatory framework governing land use and water management, contributed to the smooth completion of the EIA process.

From a technical standpoint, it is noted that an update of the Environmental Terms (A.E.P.O.) will be required at a later stage, as the project parameters will be further refined during the final design phase. Such an update is essential to accurately reflect the technical specifications of the dam, water conveyance pipelines, and auxiliary installations.

At the time of preparing the EIA, the following studies were available:

- the Preliminary Design of the Minagiotiko Dam, and
- the Introductory Study of the Irrigation Network.

For the purposes of the present study, additional analysis of the irrigation system was carried out, focusing on:

- the alignment and cross-sections of the main water conveyance pipelines,
- the location and storage capacity of the regulating reservoirs, and
- the extent and boundaries of the irrigated area.

The finalization of the project's dimensions and parameters at the next stage of technical design will enable a more detailed and accurate assessment of the environmental impacts, ensuring technical soundness, coherence of planning, and alignment with the principles of sustainable development and environmental protection in the region.

# 14. PHOTOGRAPHIC DOCUMENTATION

# 15. MAPS AND DRAWINGS

## A. ENVIRONMENTAL CONTENT DRAWINGS

| No. | DATE | TITLE | SCALE | PREPARED BY |
|---|---|---|---|---|
| ΜΠΕ-1 | July 2017 | Orientation Map | 1:50,000 | ADK |
| ΑΠ-1 | July 2017 | Human Environment Data (Sheet 1 of 2) | 1:10,000 | ADK |
| ΑΠ-2 | July 2017 | Human Environment Data (Sheet 2 of 2) | 1:10,000 | ADK |
| ΑΠ-3 | July 2017 | Local Spatial Plans (SCHOAP) Data | 1:25,000 | ADK |
| ΕΠΜ-Χ2 | July 2017 | Map of NATURA 2000, TKE and SPA Network | 1:200,000 | ADK |
| ΕΠΜ-Χ13-1 | July 2017 | Vegetation and Habitat Map | 1:50,000 | ADK |
| ΕΠΜ-Χ17-1 | July 2017 | Map of Defined Protection Zones | 1:50,000 | ADK |
| III-1 | Sept. 2015 | Land Use Map (Hydrological Study) | 1:20,000 | ADK |
| ΧΕ-1 | July 2017 | Impact Map | 1:5,000 | ADK |

## B. TECHNICAL STUDY DRAWINGS

### B.1. GEOLOGICAL STUDY

| No. | DATE | TITLE | SCALE | PREPARED BY |
|---|---|---|---|---|
| ΓΜ-1 | Oct. 2016 | Hydrogeological Map of the Drainage Basin | 1:20,000 | G. Emanouilidis |
| ΓΜ-2 | Oct. 2016 | Geological Map of the Catchment Basin (Sheet 1 of 3) | 1:2,000 | G. Emanouilidis |
| ΓΜ-2 | Oct. 2016 | Geological Map of the Catchment Basin (Sheet 2 of 3) | 1:2,000 | G. Emanouilidis |
| ΓΜ-2 | Oct. 2016 | Geological Map of the Catchment Basin (Sheet 3 of 3) | 1:2,000 | G. Emanouilidis |
| ΓΜ-11 | Oct. 2016 | Map of Borrow Pits – Excavation Sites | 1:20,000 | G. Emanouilidis |
| ΓΜ-12.1 | Oct. 2016 | Map of Borrow Pits in the Catchment Basin with Borehole Investigation Data (Sheet 1 of 2) | 1:2,000 | G. Emanouilidis |
| ΓΜ-12.1 | Oct. 2016 | Map of Borrow Pits in the Catchment Basin with Borehole Investigation Data (Sheet 2 of 2) | 1:2,000 | G. Emanouilidis |

### B.2 DAM DRAWINGS

#### General Layouts

| No. | DATE | TITLE | SCALE | PREPARED BY |
|---|---|---|---|---|
| 1-1 | Dec. 2016 | Project site location and drainage basin. | 1:20,000 | ADK |
| 1-2 | Dec. 2016 | Catchment basin and locations of exploratory boreholes. | 1:500 | ADK |

**Earthfill Dam with Clay Core**

| No. | DATE | TITLE | SCALE | PREPARED BY |
|---|---|---|---|---|
| 2-1 | Dec. 2016 | Earthfill Dam with Clay Core – General Arrangement. | 1:500 | ADK |
| 2-2 | Dec. 2016 | Earthfill Dam with Clay Core – Typical Section. | 1:250 | ADK |

| | | | | |
|---|---|---|---|---|
| 3.2.1 | Dec. 2016 | Earthfill Dam with Clay Core – Cross-sections. | 1:500 | ADK |

**Gravity Dam with Rigid Fill**

| No. | DATE | TITLE | SCALE | PREPARED BY |
|---|---|---|---|---|
| 3.1.1 | Dec. 2016 | Gravity Dam with Rigid Fill – General Arrangement. | 1:500 | ADK |
| 3.2.1 | Dec. 2016 | Gravity Dam with Rigid Fill – Typical Cross-section at Spillway Location. | 1:250 | ADK |
| 3.3 | Dec. 2016 | Gravity Dam with Rigid Fill – Longitudinal Section along Axis and Foundation. | 1:1,000 | ADK |
| 3.5 | Dec. 2016 | Gravity Dam with Rigid Fill – Reservoir and Foundation Basin. | 1:200 | ADK |
| 3.6 | Dec. 2016 | Gravity Dam with Rigid Fill – Spillway, Basin, and Cross-sections. | 1:200 | ADK |
| 3.7 | Dec. 2016 | Gravity Dam with Rigid Fill – Diversion–Discharge–Subdrainage System. Operation Building, Cross-section, Longitudinal Section. | 1:200 | ADK |
| 3.8 | Dec. 2016 | Gravity Dam with Rigid Fill – Diversion–Discharge–Subdrainage System. Cross-sections. | 1:200 | ADK |
| 3.9 | Dec. 2016 | Gravity Dam with Rigid Fill – Diversion–Discharge–Subdrainage System. Intake Structure, Longitudinal Section. | 1:200 | ADK |
| 3.10 | Dec. 2016 | Gravity Dam with Rigid Fill – Diversion–Discharge–Subdrainage System. Operation Building, Longitudinal Section. | 1:100 | ADK |
| 3.16 | Dec. 2016 | Gravity Dam with Rigid Fill – Road Network. Typical Cross-sections and Layout. | Various | ADK |

## B.3 IRRIGATION NETWORK DRAWINGS – MAIN CONVEYANCE PIPELINES

| No. | DATE | TITLE | SCALE | PREPARED BY |
|---|---|---|---|---|
| ΓΟ-1.1 | July 2017 | General Layout of Works (Sheet 1 of 8) | 1:5,000 | ADK |
| ΓΟ-1.2 | July 2017 | General Layout of Works (Sheet 2 of 8) | 1:5,000 | ADK |
| ΓΟ-1.3 | July 2017 | General Layout of Works (Sheet 3 of 8) | 1:5,000 | ADK |
| ΓΟ-1.4 | July 2017 | General Layout of Works (Sheet 4 of 8) | 1:5,000 | ADK |
| ΓΟ-1.5 | July 2017 | General Layout of Works (Sheet 5 of 8) | 1:5,000 | ADK |
| ΓΟ-1.6 | July 2017 | General Layout of Works (Sheet 6 of 8) | 1:5,000 | ADK |
| ΓΟ-1.7 | July 2017 | General Layout of Works (Sheet 7 of 8) | 1:5,000 | ADK |
| ΓΟ-1.8 | July 2017 | General Layout of Works (Sheet 8 of 8) | 1:5,000 | ADK |
| ΤΣ | July 2017 | Typical Excavations – Cross Sections of Water Conveyance Pipelines | 1:500 | ADK |