OS Aqua

Open Sea Aquaculture in the Eastern Mediterranean

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Ευρωπαϊκό Ταμείο Περιφερειακής Ανάπτυξης

Κυπριακή Δημοκρατία

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της Ευρωπαϊκής Ένωσης στην Κύπρο

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Executive Summary

The current deliverable examines the possible socioeconomic and environmental impacts from the four open sea areas selected as potential Open Sea Allocated Zones for Aquaculture (OS AZAs) (Xylofagou, Larnaca, and Governor's Beach South of Cyprus, Aphrodite Hills in southwest Cyprus) for an OS aquaculture development. These areas are situated in depths up to 200 m, and they are relatively far from any anthropogenic activities. Their impact area was defined as the distance based on estimating the maximum radius of the expected influence on the surrounding area.

The worldwide increase in aquaculture has brought this industry into conflict with other users of the natural aquatic resource. Individuals and organizations are concerned about the temporal and long-term effects on the industry's environmental, economic, and social parameters.

Our study shows that only aquaculture wastes can potentially negatively affect the environment as showcased by models (see D10 & D11). The impact of the existing fish farm waste is mainly visible during the spring and autumn periods, characterized by relatively higher aquaculture waste. Environmental conditions during these periods appear good to moderate, even in the vicinity of the fish farms, suggesting that aquaculture waste is relatively low and effectively dispersed by ocean currents. During summer, environmental conditions are "good" in the entire area. Increased dinoflagellates in fish farms mainly characterize changes in the food web structure, generally considered an indicator for eutrophication. This increase was higher in the area's western bay (Akrotiri), which was only visible in Srining with the combination of 3,000 tonnes in Larnaca and 5,000 tonnes in Xylofagou.

The rest of the identified impacts, whether they were environmental or socioeconomic, pose a low negative impact or will, in many cases, exhibit a positive effect.

Sustainable aquaculture must maximize benefits and minimize the accumulation of detriments and other types of negative impacts on the natural and social environment. Consequently, sustainable aquaculture development must be advanced in a manner that is environmentally sustainable and protects the quality of the environment for other users. At the same time, it is equally essential for society to protect the quality of the environment for aquaculture.

Finally, this deliverable provides key recommendations, including the next suggested steps.

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List of Abbreviations

Term	Description
AZA	Allocated Zones for Aquaculture
AMA	Aquaculture Management Areas
AMSL	Above Mean Sea Lever
CMMI	Cyprus Marine and Maritime Institute
DFMR	Department of Fisheries and Marine Research
EEZ	Exclusive Economic Zone
FCR	Feed conversion ratio
FTE	Full time employ
HCMR	Hellenic Centre for Marine Research
MMJ	Mid-Mediterranean Jet
MeMARS	Meneou Marine Aquaculture Research Station
OC-UCY	Oceanography Center – University of Cyprus
OS	Open Sea
OSA	Open sea area
OSC AZAs	OS Cypriot allocated zones for aquaculture
SPA	Special protection area
SSE	South Southeast
SST	Sea surface temperature
SSW	South-Southwest
WNW	West Northwest
WSW	West Southwest

1 INTRODUCTION

Aquaculture can be tracked back as far as 4000 years in Egypt and more than 2000 years in China (Edwards, 2004; Lu and Li, 2006) and Europe (Buschmann and Muñoz, 2019).

The expansion of such systems was inevitable since the capacities of traditional aquatic environments could not sustain the human population growth (Costa-Pierce, 2002); thus, it turned into a social necessity. The rapid growth of the aquaculture sector by producing great quantities of diverse fish products for human consumption has been called the “Blue Revolution” (Costa-Pierce, 2002), which began during the 1960s in Asia and the West in the late 1970s and early 1980s (MacKay, 1983). Since then, the aquaculture sector has progressed towards new diversification and intensification (Ahmed and Thompson, 2018). The necessity for fish protein is growing, though capture fisheries production remains static or is diminishing (depending on the species in question) during the last decades (FAO, 2018). In 2018, aquaculture produced more than 30% of the total fish consumed worldwide (FAO, 2018).

Currently, with the increasing criticism on existing nearshore aquaculture facilities (lack of available nearshore production sites in heavily utilized coastal zones, community opposition to coastal conflict with other usages such as shipping, fishing, tourism, conservation and recreation), the need to move operations into different sites is becoming more vital (Fredriksson et al., 2004; Shainee et al., 2013b; Klebert et al., 2015). In response to the above, the fish farming industry started to look at sites that will yield sustainable fish production and make use of environmentally friendly operations more efficiently (Buck, 2004; Kapetsky et al., 2013; Kankainen and Mikalsen, 2014; Holm et al., 2017; Buck & Langan, 2020)

Open Sea aquacultures seem to be a good alternative, and the Commission is currently accelerating attempts to bring fish stocks to sustainable levels via the Common Fisheries Policy (CFP) where implementation gaps remain (e.g. by reducing wasteful discarding), strengthen fisheries management in the Mediterranean in cooperation with all coastal states and re-assess, by 2022, while addressing environmental impacts and the risks triggered by climate change. However, there is considerable debate whether OS aquaculture can be sustainable and environmentally friendly. Society has become increasingly concerned about anthropogenic activities' effects on the environment, the economy, and society.

As far as the environment is concerned, assessment of impacts on the environment and the socioeconomic sector from aquaculture farm activities is an ongoing process; however, it has not been examined extensively sufficient to cope with the growth of this industry (Bostock et al., 2009; Bohnes and Laurent, 2021).

In response to the above, scientists contemplate that, offshore sites are more spacious for fish farms, reduce contests with other sea space users, deeper water depth, and constant water flows (Tidwell, 2012; Kankainen and Mikalsen 2014; Holm et al. 2017). The offshore environment can help avoid the accumulation of fish waste (e.g. uneaten feed or faeces) under cages, thereby preventing the proliferation of parasites and diseases.

1.1 Purpose of the Deliverable

The current deliverable aims to identify the environmental and socioeconomic impacts that the development of **Open Sea (OS)** Aquaculture might pose. on the candidate AZAs (Xylofagou, Larnaka, Governor's Beach and Aphrodite Hills) selected in Deliverable 13: "Identification of AZAs and AMAs and estimation of their carrying capacity".

The description of the effects on the environment, society, and the economy is based on evaluating the important physical and socioeconomic background, the existing pressures and problems, and the expected influence of OS aquaculture operations. In more detail, the document focuses on the following:

- Description of the current state of the area (baseline information)
- Description of the direct and indirect impacts on the environment, the society and the economy if aquaculture is constructed and operated in the selected zones.

2 BASELINE INFORMATION

To date, marine aquaculture industry in Cyprus has concentrated its activities in the area of Vasilikos - Moni and to a lesser extent in the area of the port of Limassol, the Liopetri river (Ammochostos), Akrotiri (WSBA) and Kouklia (Pafos).

Sea cage and onshore facilities such as fish hatcheries, packaging plants, warehouses and docking stations have been developed in the areas mentioned above. Additionally, the construction of a port area exclusively for aquaculture purposes in Pentakomo is licensed and planned.

The area of Vasilikos - Moni is used for aquaculture in an intense competition with other users and activities such as sea navigation, energy planning, etc. In addition, the planned development of other activities in the Vasilikos area, especially under the Vasilikos Master Plan, (http://www.meci.gov.cy/MECI/hydrocarbon.nsf/page20_en/page20_en?OpenDocument) https://www.ebrd.com/what-we-do/project-information/environment-social-info-documents/1395289330357/LNG_Floating_Storage_and_Regasification_Unit_-_Cyprus_NTS.pdf?blobnocache=true) in combination with the spatial distribution of the existing aquaculture units, requires the exploitation of new suitable zones which will allow further development of existing units and the creation of new ones through integrated spatial planning. The identification of AZAs and AMAs and estimation of their carrying capacity" (described in D13) was performed through Marine Spatial Planning (MSP) using OS-AQUA GIS, the Geographical Information System (GIS) designed and developed for the project (see D16). The candidate zones/sites were further screened through a multi-criteria analysis to identify and exclude areas that do not meet basic techno-economic and environmental eligibility criteria (Table 1).

Table 1. The criteria for the multi-criteria spatial analysis to identify zones for aquaculture

STEPS	AREAS / INFRASTRUCTURE	Exclude areas that are within:	STEPS	AREAS / INFRASTRUCTURE	Exclude areas that are within:
1	Areas not controlled by the Republic of Cyprus (occupied part of Cyprus)	all	**10**	Posidonia oceanica meadows	500m dist.
2	Areas over 200m depth	all	**11**	Shipwrecks	500m dist.
3	Swimming Areas	1 km dist.	**12**	Desalination Stations	2 km dist.
4	Natura 2000 Network	1 km dist.	**13**	Artificial Reefs	1 km dist.
5	Port Infrastructure Areas (Ports, Port Works (Licensed-License Stage), Port Facilities)	1 km dist.	**14**	Existing Aquacultures Facilities	1 km dist.
6	Anchorages (Polygon)	1 km dist.	**15**	Military Material Depot Areas	2 km dist.
7	Ship Routes	1 km dist.	**16**	Sewage disposal points	2 km dist.
8	Disposal Pipes	1 km dist.	**17**	Protected Areas from Fishing	
9	Sea Shooting Ranges	1 km dist.	**18**	Airports	2 NM dist.

2.1 Candidate areas

The application of the MSP resulted in the selection of four optimal AZAs for Open Sea Aquaculture Areas implementation (Figure 1):

1. Xylofagou (Xylofagou West)
2. Larnaka
3. Governor's Beach (Governor's Beach Center East)
4. Aphrodite Hills

The analysis and description of the effects of the construction and operation of open sea fish farm in the aforementioned four areas take into account an estimation of the area influenced both in the sea and on land. For the purposes of this study this is referred to as the general study area for each of the selected locations. The Map in Figure 1 shows the location of the selected AZAs, while the Maps in Figures 2-5 present the surroundings of each AZA. In the following sections, the environmental and socioeconomic impact of the selected AZA's on the surrounding area of these zones will be described focusing on information related to the above criteria.

2.1.1 AZA 1. Xylofagou

This zone is at the east side of Larnaka Bay between Ormideia and Xylofagou, about 3 km from the shore and the nearest port facility in Xylofagou. Other near port facilities are in Ormideia (6km) in the West and Potamos Liopetriou (9km) in the East.

The depth of the sea ranges from 100m to 140m. The zone is within the boundaries of the Eastern Sovereign Base Area (ESBA), an area under British jurisdiction since the independence of the Republic of Cyprus in 1960.

2.1.2 AZA 2. Larnaka

This zone is at the west side of Larnaka Bay, in the east of the International Larnaka Airport and the city of Dromolaxia-Meneou, about 3.5km from the shore. The nearest port facility, the old port of Larnaka (Psarolimano), is 5.6 km away. The International Airport of Larnaka is about 4 km from the area. At a distance of about 6-8km is the city of Larnaka on the one side and Pervolia (area with holiday homes, tourist development and agriculture) on the other side. The sea's depth within the zone ranges from 100m to 200m. Even though the zone is located between ship routes, it is generally considered satisfactory based on the environmental and technical criteria used by the spatial planning study. The advantage of this zone is the presence of the port of Larnaka, which will be further developed in the near future, the possibility of exploiting the existing infrastructure of the city of Larnaka and the lack of existing aquaculture units in the area. However, it should be noted that a primary condition for the development and proper operation of the aquaculture zone is the provision of suitable facilities within the port of Larnaka.

2.1.3 AZA 3. Governor’s Beach

Governor’s Beach AZA is in the rural area between Larnaka and Lemesos. It is within the designated area for aquaculture development but in more considerable depths, ranging from 100m to 140m. The distance from the shore is about 5 km, and the distance from the nearest port is 5.3 km, in Pentakomo, a port explicitly built for supporting the aquaculture facilities of the area.

2.1.4 AZA 4. Aphrodite Hills

This zone is located to the east of the city of Paphos, in the waters of Aphrodite Hills and Kouklia Pafou, at a distance of 6 km from the shore and the Venus Rock Docking Station. The International Airport of Pafos is at 12 km. The sea's depth within the zone ranges from 100m to 140m.

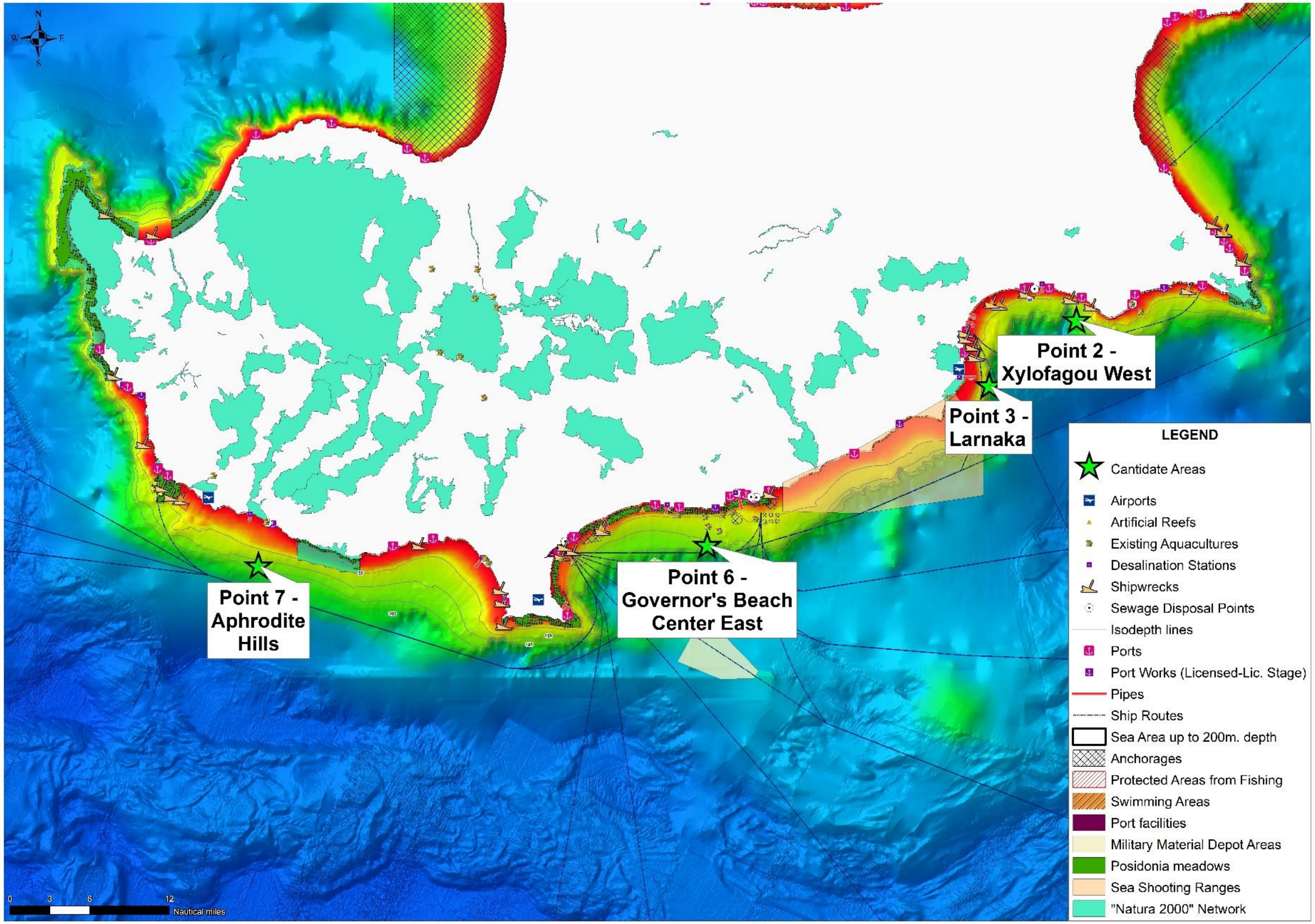

Figure 1. Map of the Selected AZAz

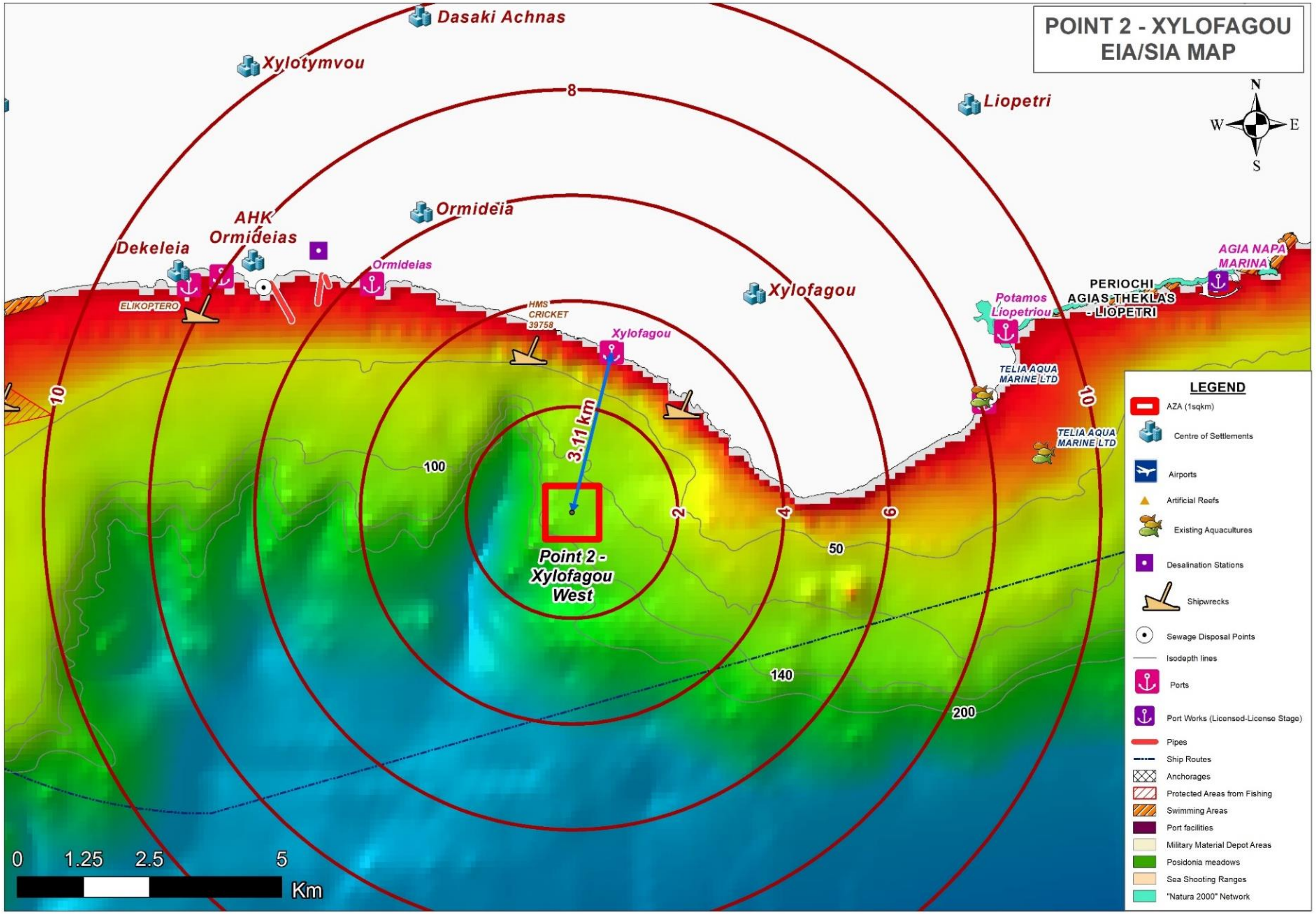

Figure 2. The surrounding area of Xylofagou AZA

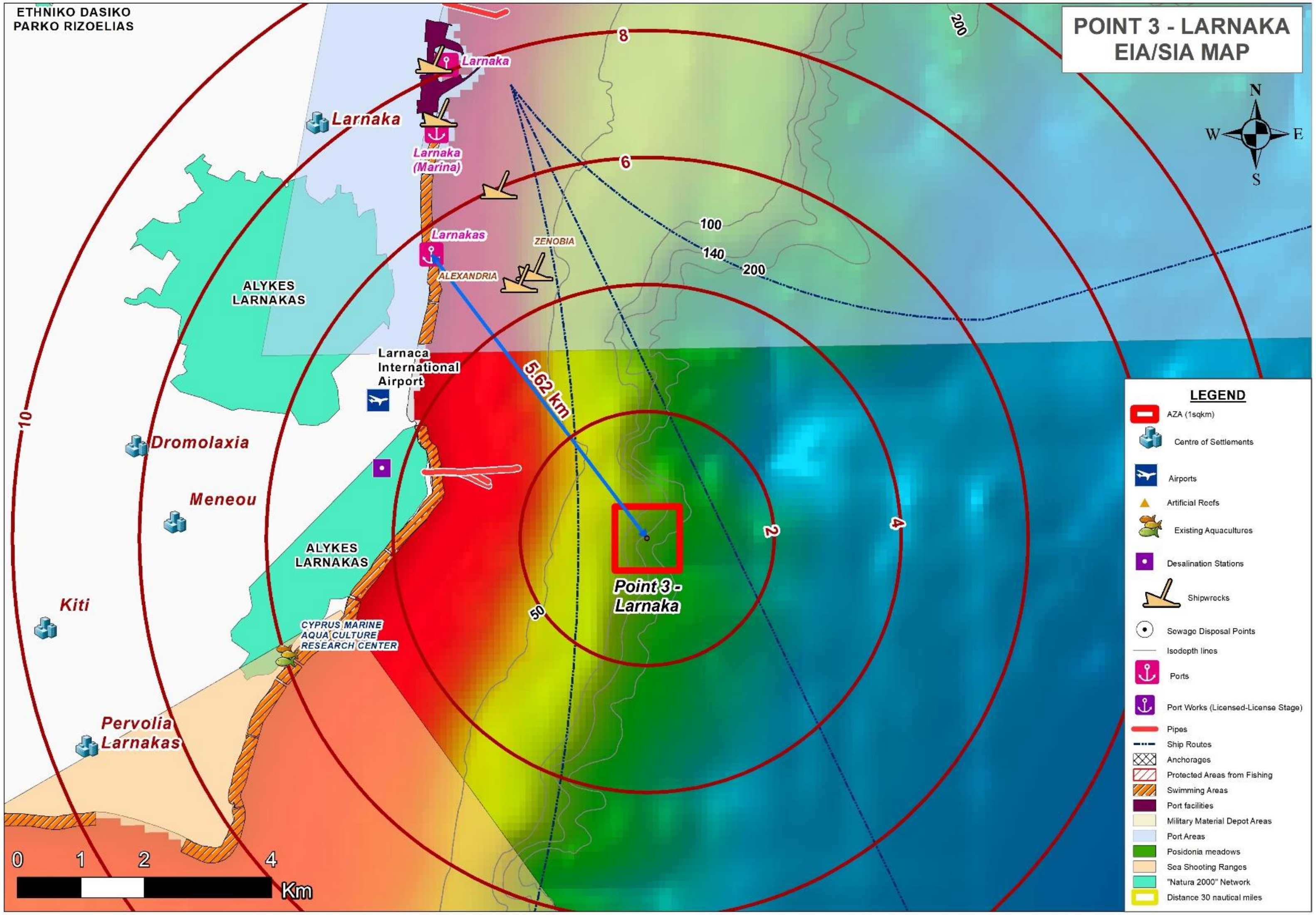

Figure 3. The surrounding area of Larnaka AZA

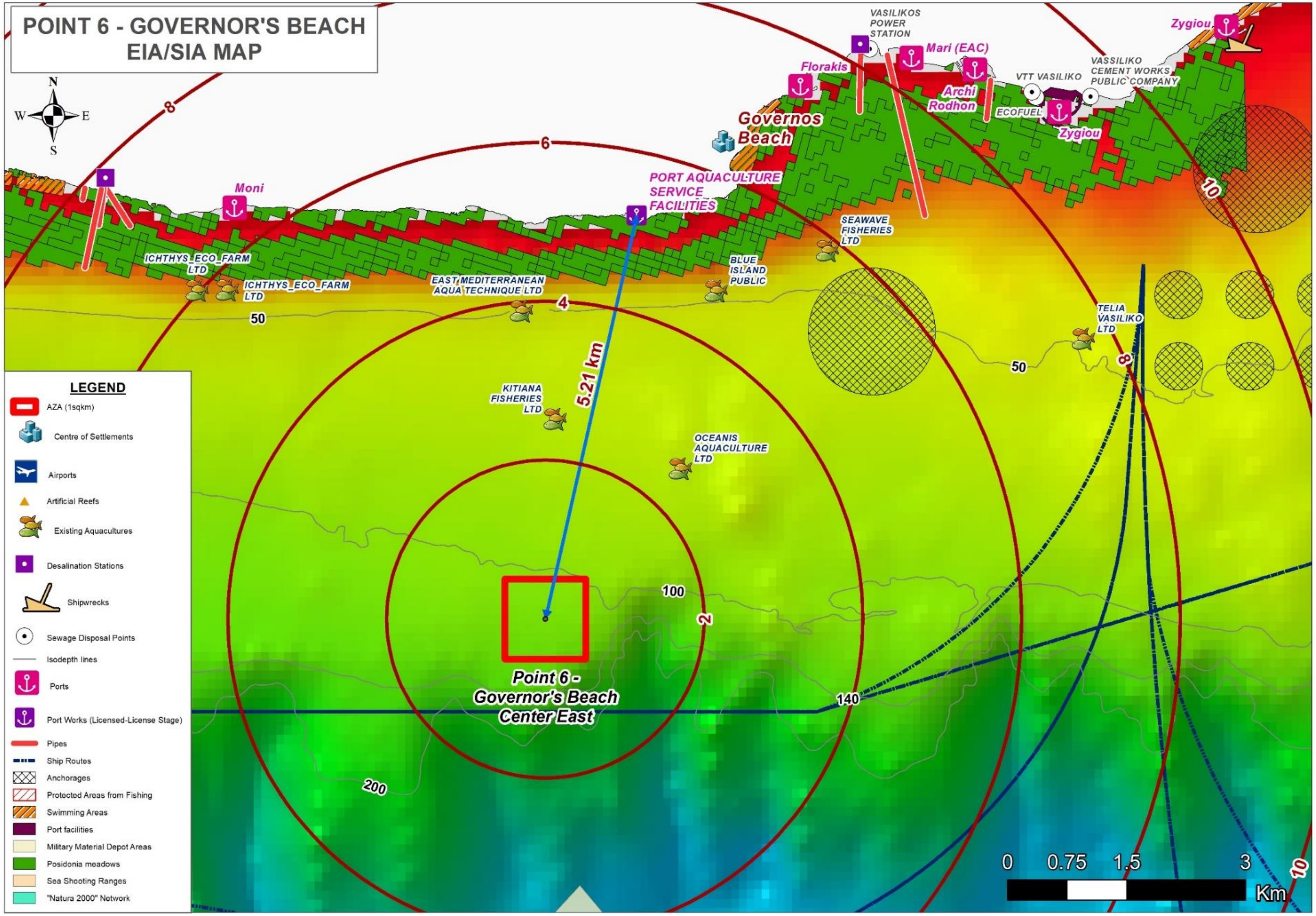

Figure 4. The surrounding area of Governor's Beach AZA

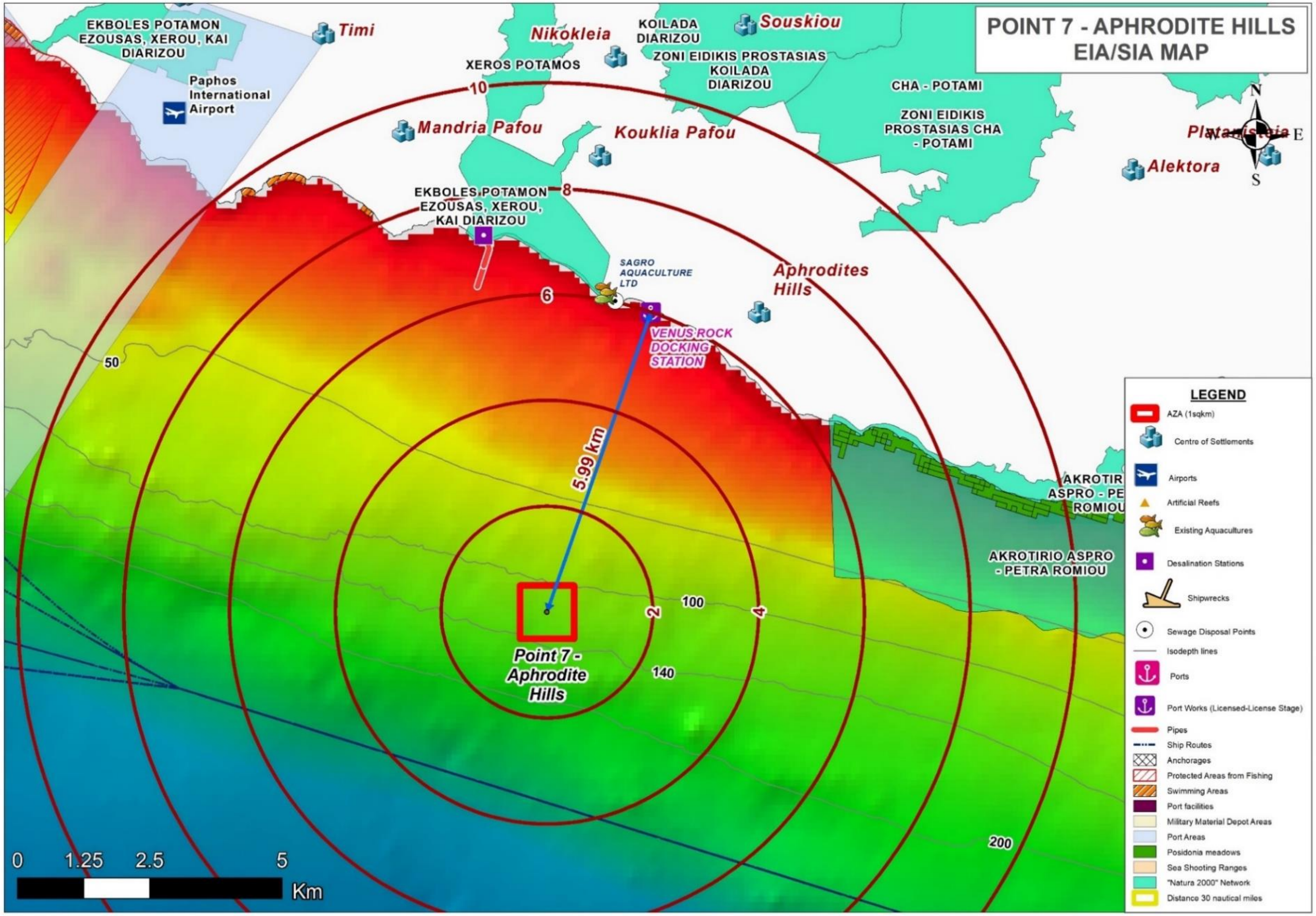

Figure 5. The surrounding area of Aphrodite Hills AZ

2.2 Climatic and Oceanographic Conditions

Cyprus has a Mediterranean climate with hot and dry summers from mid-May to mid-September and mild winters with low rainfall from November to mid-March. Autumn and Spring seasons are short in time, characterized by abrupt changes in weather conditions.

The average annual rainfall ranges from 450 mm on the southwestern windward slopes to almost 1,100 mm at the top of Troodos Mountain. The statistical analysis of the rainfall of Cyprus shows a tendency of limited rainfall in the last 30 years. Snowfalls occur every winter at altitudes above 1,000 meters and in some cases in the lowlands and semi-mountainous areas.

The temperature decreases by increasing altitude at a rate of about 5 ° C per 1,000 meters. In addition, the coasts of Cyprus are affected by sea currents that give cooler summers and warmer winters, especially for the west coast.

In the eastern Mediterranean, the surface winds generally have mainly western or southwestern direction in winter, while in summer, the surface winds have southwestern or northern direction in summer. The intensity is light or moderate, up to stormy in some cases.

In Cyprus, however, the winds are quite variable, with the direction being affected by the topography and the altitude. In addition, the difference in temperature between sea and land, especially during the summer, play a crucial role in creating significant coastal and terrestrial air currents.

The Bioclimatic Map of Cyprus (**Error! Reference source not found.**), prepared by the Department of Forests, shows that the AZAs of Xylofagou and Larnaka have mild dry weather, while the AZAs of Governor’s Beach and Aphrodite Hills have dry, hot weather.

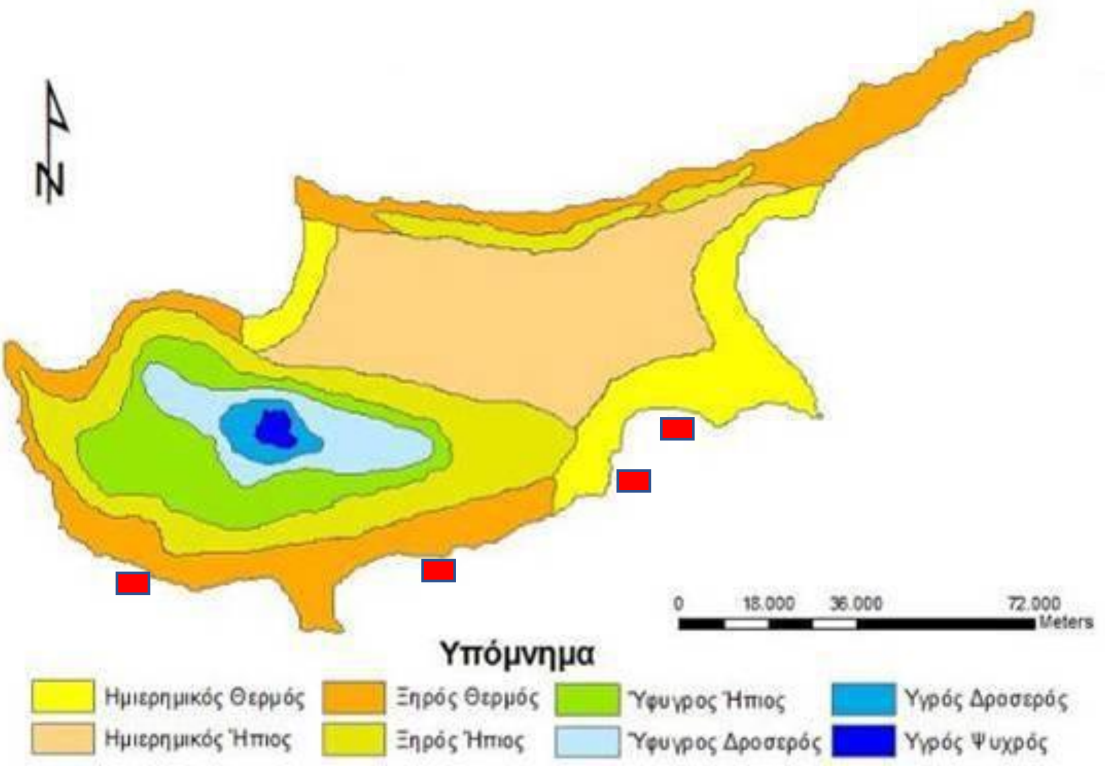

Figure 6. Bioclimatic Map of Cyprus. Source: "Wild flowers and other plants of the land of Cyprus" - Department of Forests

2.2.1 Air Temperature

All the selected AZAs are located within Climatic Zone 1, which covers all the coastal areas of Cyprus (Figure 7). The Mean Temperature per Month in Climatic Zone 1 is shown in Table 2.

Table 2. The Mean Air Temperature in Climatic Zone 1. Source: Department of Meteorology

Month	Mean Temperature (°C)	Month	Mean Temperature (°C)
January	12.8	July	27.7
February	12.1	August	27.5
March	14	September	24.5
April	17.1	October	21.7
May	19.6	November	16.8
June	24.6	December	14.1

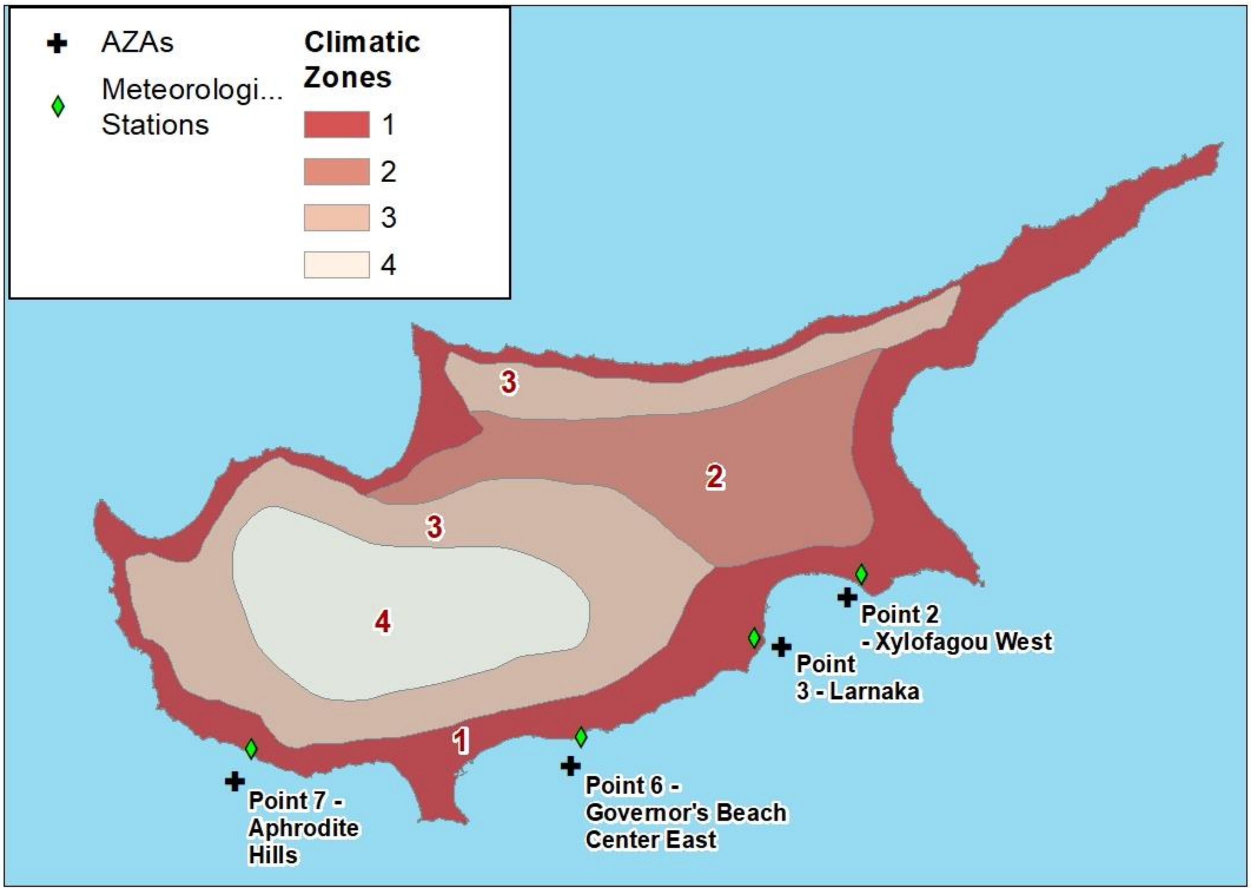

Figure 7. The Climatic Zones in Cyprus. Source: Department of Meteorology

As shown in Table 2, the maximum air temperature values are recorded mainly during the months of June, July and August, with August and February being the warmest and coldest months, respectively.

2.2.2 Rainfall

The graphs in Figures 8-11 show the rainfall as recorded by the Cyprus Meteorological Service for the years 2010-2018 in the nearest stations to the study areas (source: https://www.data.gov.cy/node/1618?language=en). In general, a decrease in rainfall has been observed in the last years, where the south and south-east coastal areas of Cyprus (Governor's Beach & Aphrodite Hills AZAs) have significantly more rainfall than the south-east areas (Larnaka & Xylofagou AZAs). In addition, the annual actual accumulative quantity is decreased as we move from the west to the east.

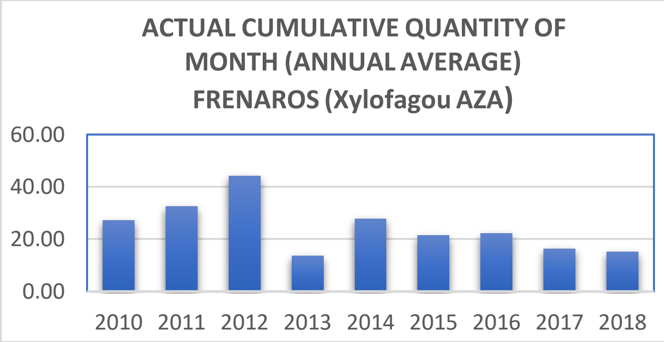

Figure 8. 2010-2018 Rainfall at the Frenaros Station, close to Xylofagou AZA

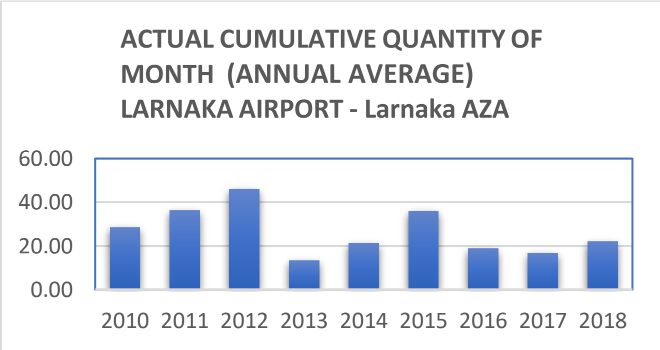

Figure 9. 2010-2018 Rainfall at the Larnaka Airport Station, close to Larnaka AZA

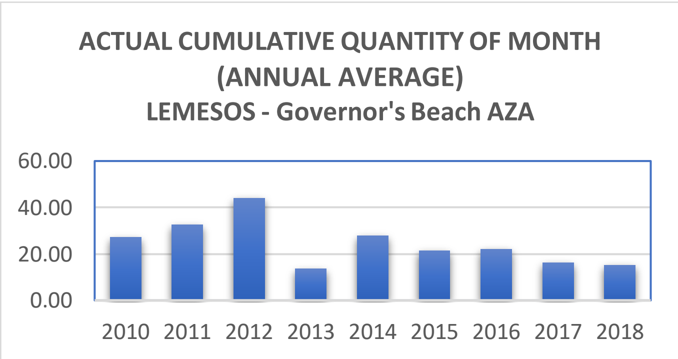

Figure 10. 2010-2018 Rainfall at the Lemesos Station, close to Governor's Beach AZA

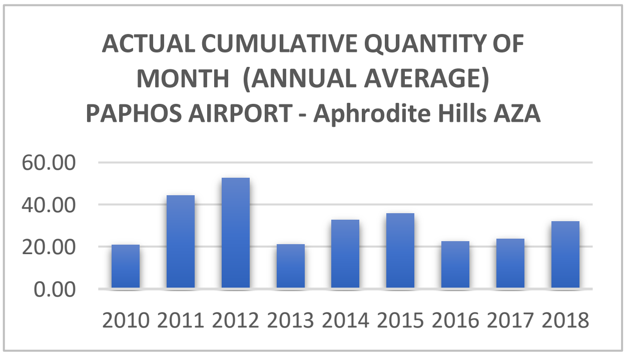

Figure 11. 2010-2018 Rainfall at the Paphos Airport Station, close to Aphrodite Hills AZA

2.2.3 Winds / Waves

The prevailing wind and waves in the selected areas (Figure 12-15) have been calculated by the OC-UCY. The wave dataset was retrieved from the WAM model of the University of Cyprus. The wave model domain covers the eastern part of the Mediterranean Sea with very high spatial resolution. The time span of the dataset is from 01/01/2001 to 31/12/2020, using 3hourly timesteps. The closed grid points to the selected locations were extracted for analysis from the dataset. A time series of every single point was constructed using the significant wave height and Wave direction (the **direction where wind/wave is coming from**), variables from the model. Those time series were plotted on a rose diagram (a circular histogram plot that displays directional data and the frequency of each wind speed/wave height class). The significant height class used are 0-0.5, 0.5- 1, 1-2, 2-3, 3-4 and 4-5 meters.

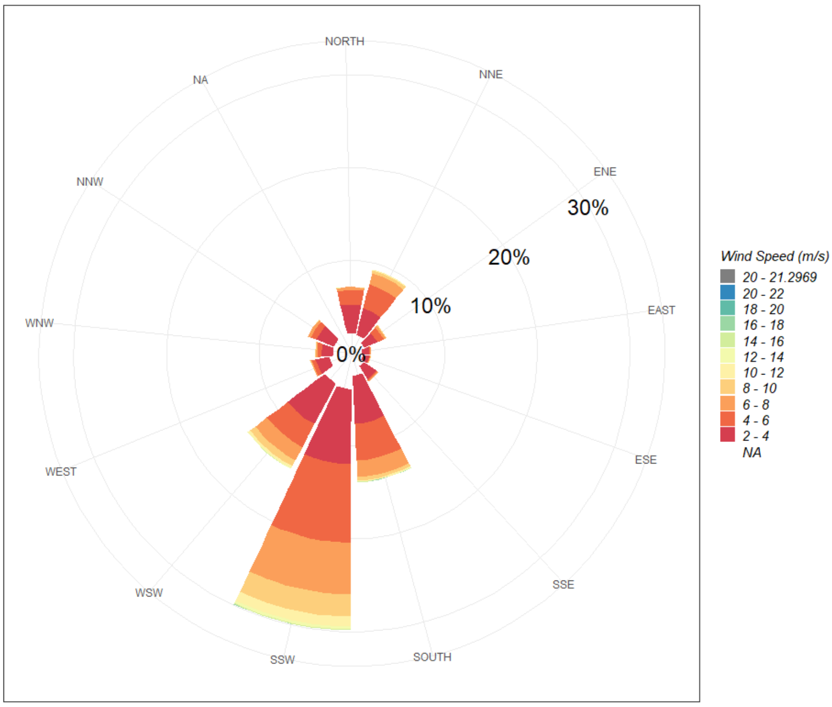

Figure 12. Wind direction for Xylofagou West (point 2) area. The dominant wind direction is from WSW to South. ***Source: OC-UCY***

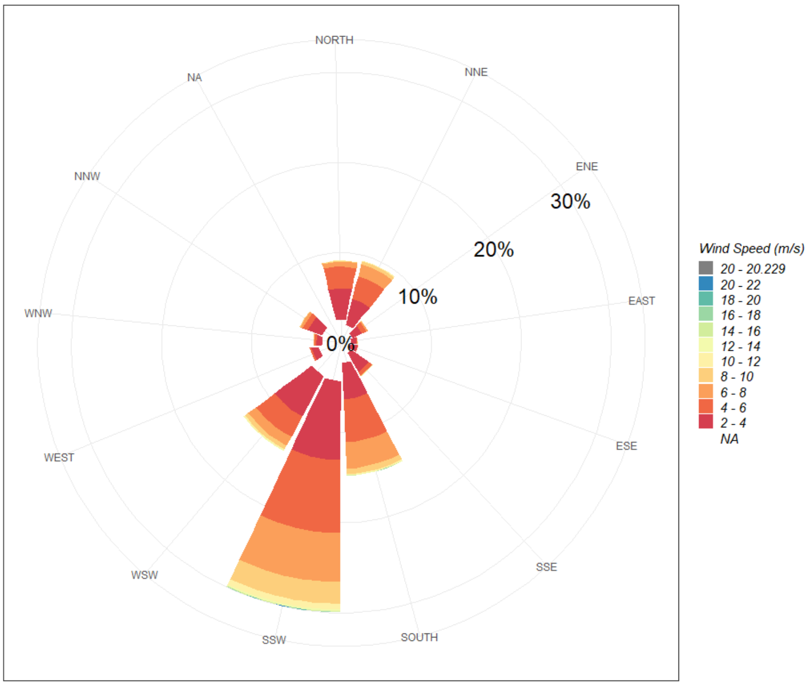

Figure 13. Wind Direction for Larnaka (point 3) area. The dominant wind direction is from WSW to South. *Source: OC-UCY*

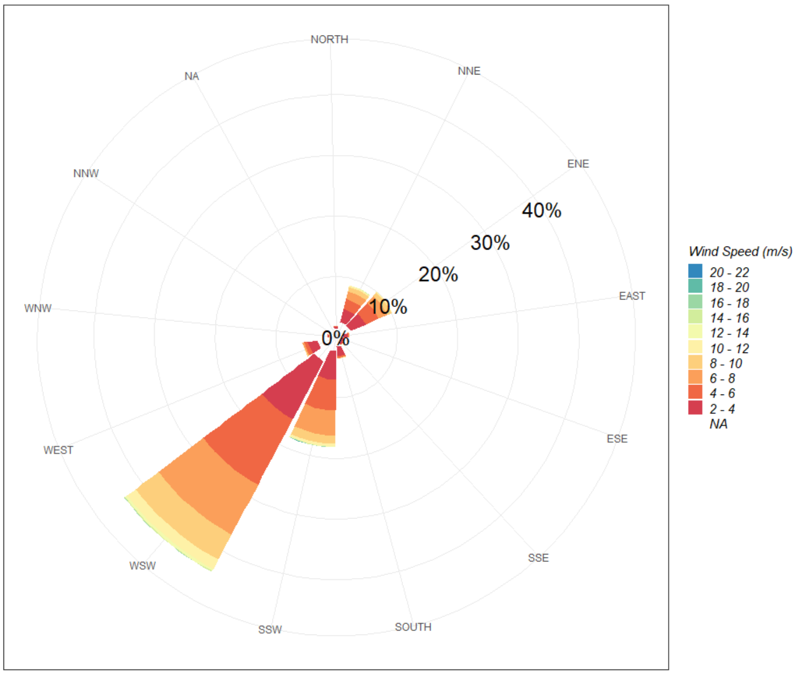

Figure 14. Wind direction for Governor's Beach (Center & East) (point 6) area. The dominant wind direction is from WSW. *Source: OC-UCY*

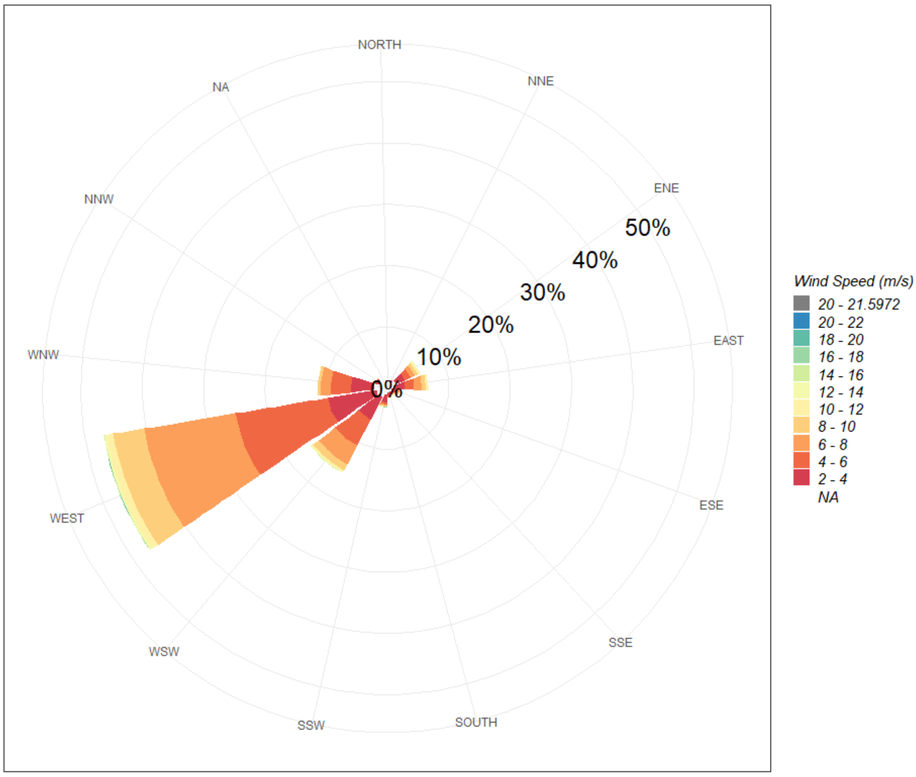

Figure 15. Wind direction for Aphrodite Hills (point 7) area. The dominant wind direction is from the West. *Source: OC-UCY*

2.2.4 Temperature and Salinity of the Sea

Cyprus has an exposed coastline with steep slopes next to a very narrow continental shelf. Hence, temperature and salinity of the coast is a good estimate of the corresponding values at the considered open sea areas.

In Cyprus, the daily average seawater temperature over the year ranges between 18-26 °C. In summer the seawater temperature ranges from 20 to 28 °C, considerably warmer than deeper waters (16–20 °C) (DFMR, 2014).

The mean monthly seawater temperatures for the candidate areas as shown in Table 3 were extracted from the mean satellite sea surface temperature (SST) data for the period 2015-2018.

Table 3. Mean monthly seawater temperatures from satellite SST data for 2015-2018. Sites OS1 is Xylofagou West, OS2 is Larnaca, OS3 is Governor's Beach and OS4 is Aphrodite Hills

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
OS1	17,61	17,01	17,23	18,29	20,62	23,90	26,91	28,04	27,64	25,73	22,71	19,72
OS2	17,61	16,99	17,22	18,22	20,33	23,46	26,55	27,72	27,47	25,72	22,70	19,78
OS3	17,72	16,99	17,22	18,19	20,26	22,92	25,99	27,20	27,19	25,63	22,64	19,93
OS4	17,74	17,00	17,08	18,15	20,58	23,63	27,04	27,99	27,05	25,38	22,87	20,15

The salinity values fluctuate seasonally and vertically between 38.6–39.5 PSU and do not affect the benthic maritime communities (Maritime Strategy Framework Directive (2008/56 /EC)).

2.2.5 Seawater circulation and Currents

For the last years, the Oceanographic Center of the University of Cyprus has been conducting voyages to study the surface currents of the Levantine Basin. Specifically, observations were made in a wide area that includes the EEZ of Cyprus, from more than 20 voyages conducted by the Oceanographic Center of the University of Cyprus in the last years. The results describe the approach of the MMJ (Mid-Mediterranean Jet, MMJ) from the southwest, it's branching into one stream that diverts north before reaching Cyprus and another that continues east, south of Cyprus (Zodiatis et al.,2005). The MMJ manoeuvres, circling anticyclonic warm core eddies to its south, such as the Cyprus Eddy (Zodiatis et al., 1998, 2005). To the north of the MMJ, and along the Cypriot coast, cyclonic eddies are often observed, and currents heading west along the southern coast of Cyprus.

More recently, additional monitoring programs (Hayes et al., 2011) have shown that the Cyprus Eddy and its interaction with the MMJ are the dominant features of the high seas south of Cyprus. May 2009 to May 2011 showed that the eddy remained but moved eastward.

Near the coast, smaller-scale features cannot be sufficiently observed, so other representative parameters are used, such as sea surface temperature or chlorophyll measured by satellites.

2.2.6 Physico-chemical Characteristics of the Marine / Coastal Areas

Information about the physico-chemical and ecological characteristics of the specific marine / coastal areas of the AZAs, is provided by CSCS in Deliverable 17.

2.3 Coastal Environment

2.3.1 Topography, Geomorphology and Geology

2.3.1.1 AZA 1. Xylofagou

The average altitude of the study area is 50m Above Mean Sea Level (amsl), and the point with the highest altitude (151m) is located in Pergamos village.

The coastline is alternating as both sandy and rocky areas, bathing shores and makeshift structures are observed in some places. In addition, along the coastline, there are geomorphological characteristics, which concern three coastal areas in Ormideia and Xylofagou communities, and in which there are sea caves.

The area's geomorphology is shown in the Geomorphological map of Figure 16.

The area's geology is Biostrome and limestone (Pakhna Formation), and calcarenites sands and gravels (Terrace deposits), as shown in Figure 17.

Regarding the trends of erosion and sediment deposition along the coast, according to data from the Department of Lands and Surveys, the measurements made during the period 1963-2008 show alternating. In Ormideia, the coastline in some places seems to have receded up to 20m, while in the same section, a deposit of 8-10 m is recorded.

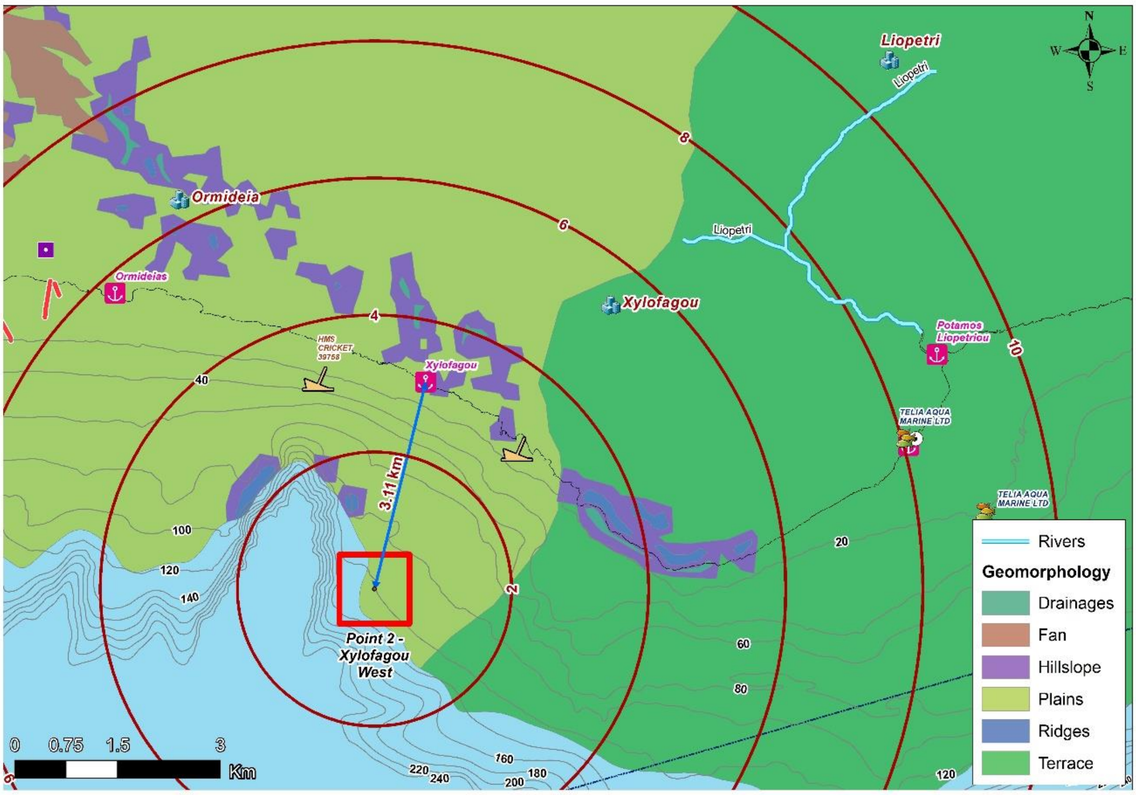

Figure 16. Geomorphological Map in Xylofagou AZA area ***Source: Cyprus Geological Survey Department***

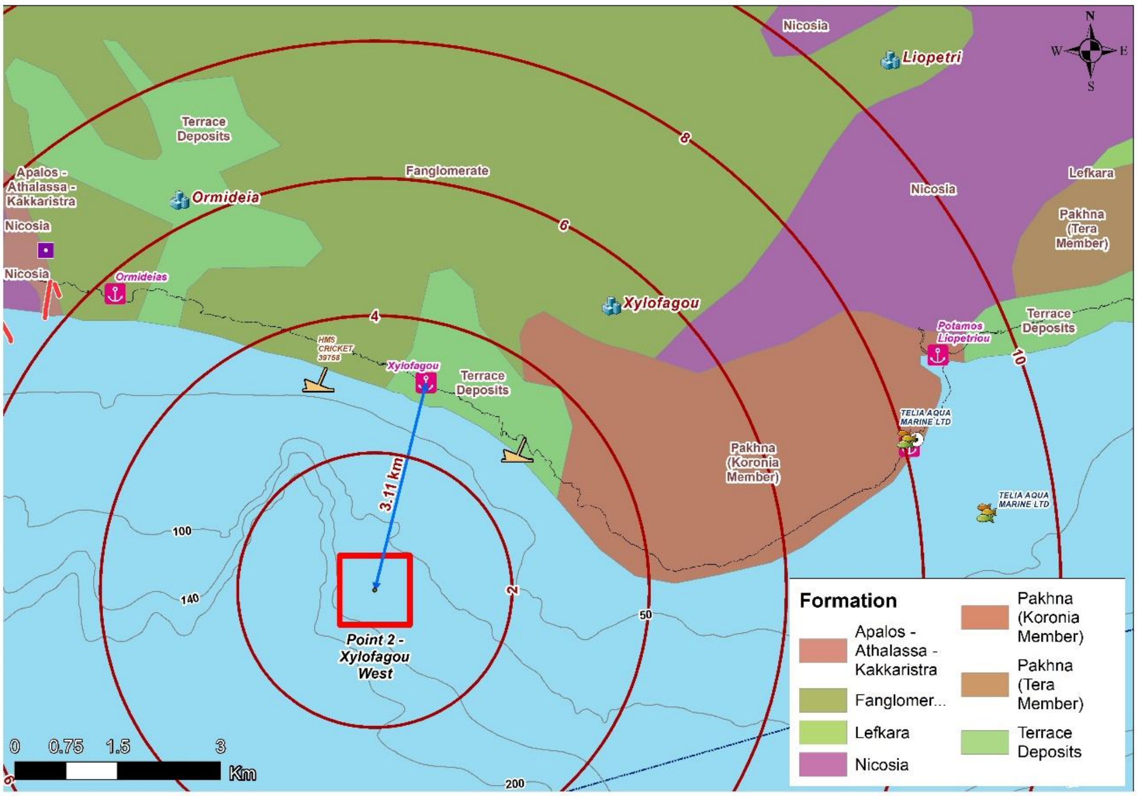

Figure 17. Geological Map in Xylofagou AZA area *Source: Cyprus Geological Survey Department*

2.3.1.2 AZA 2. Larnaka

The topography in the study area is characterized as flat with an altitude of about 4m above the Average Sea Level (amsl). The coastline is mainly sandy beaches. Most of them are swimming areas (only around the airport, swimming is prohibited).

The broader area of Larnaka is part of the zone of indigenous sedimentary rocks. These rocks are pelagic deposits of sediments, main marls and chalks during the period of the Upper Maastricht until the end of the Holocene. Geologically, the coastal front of the Larnaka area, which starts from the port of Larnaka to the administrative boundaries of the communities of Oroklini-Pyla, consists of alluvial deposits. These deposits consist of river deposits of sand, cobblestones and sludge. During the Pleistocene, these deposits were deltas and creeks. They were below sea level and much further inland than they are today. The materials carried by the rivers were deposited in the river-bays, blocked and filled, creating the plains we have today.

The area's geomorphology is shown in the following Geomorphological map (Figure 18).

The area's geological formations are mainly Alluvium – Colluvium, Terrace deposits, and Salt Lake, as shown in Figure 19.

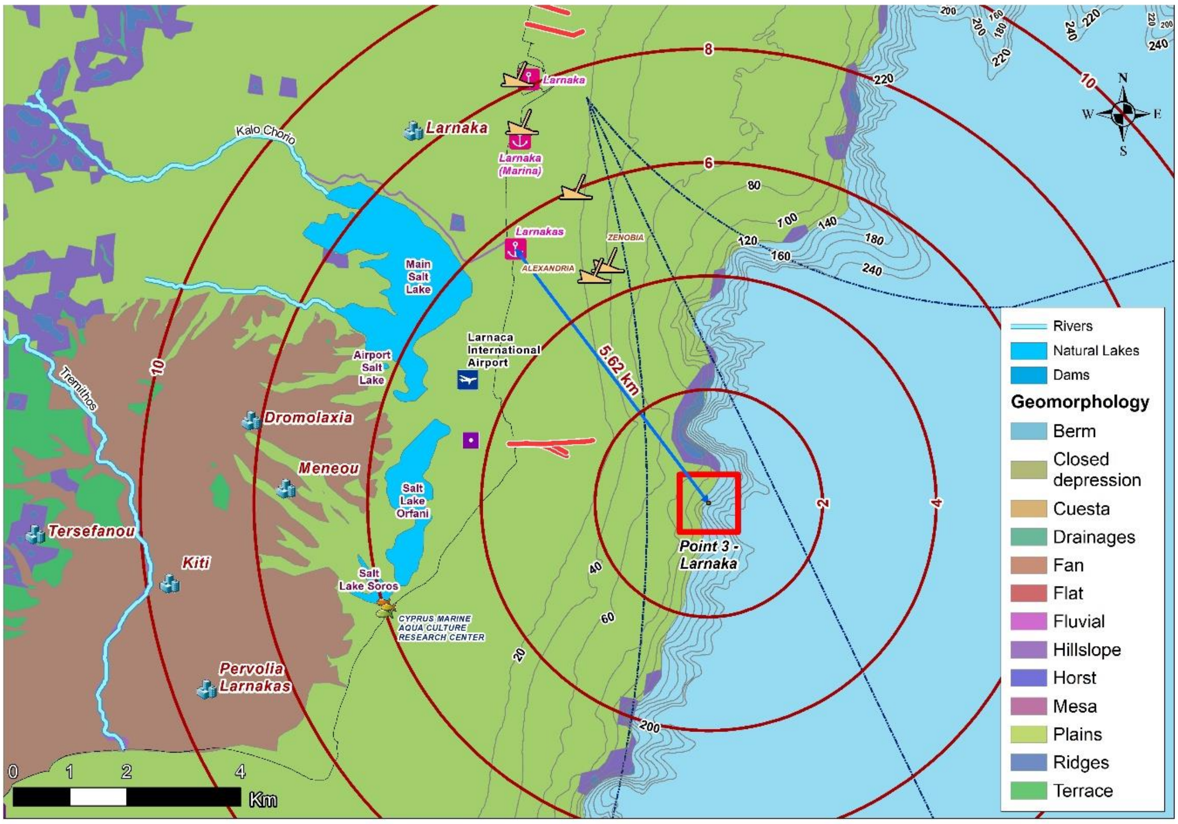

Figure 18. Geomorphological Map in Larnaka AZA area ***Source: Cyprus Geological Survey Department***

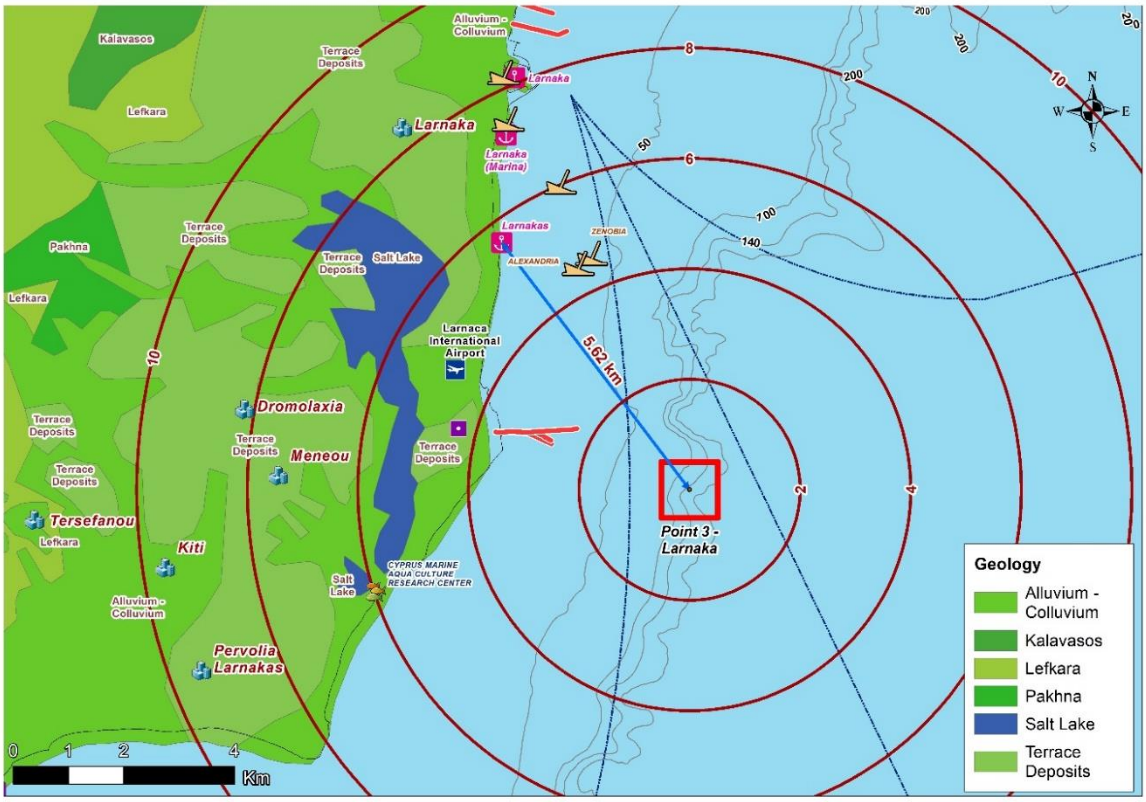

Figure 19. Geological Map in Larnaka AZA area ***Source: Cyprus Geological Survey Department***

2.3.1.3 AZA 3. Governor’s Beach

Geologically this AZA belongs to the category of indigenous sedimentary rocks. The coastlines' artificial interventions, especially in Vasilikos bay, have significantly modified the coastline by creating ports, the EAC facility, the Naval Base, etc. Due to the modification of the coastline of Vasilikos bay, some areas can be considered important from an aesthetic point of view. However, west of the bay, closer to the AZA, where anthropogenic activities are absent, the coastline is of particular interest with calcareous bedrock, cliffs, sandy beaches, pebble beaches, and sea caves.

Furthermore, the shoreline, primarily east of Vasilikos Bay, shows significant erosion. An on-site survey by the Geological Survey Department in the summer of 2010 in the Governor’s Beach area identified a severe erosion problem at the coastal front from the restaurant "Akti Sofroniou" to the restaurant "Adamos" where it was observed among others: a) detachment of rocks and their falling at the southern end of the coastal front, b) accumulation of large quantities of small boulders, cobbles and gravel coming from the sea that for years before did not exist, and c) erosion of the sand and reduction of its width by at least 4m in the last year and over 30m in the last 20 years with simultaneous raise of the sea water.

The area's geomorphology is shown in the Geomorphological map of Figure 20, while the geological map is shown in Figure 21. The latter map shows that the main formations of the area Lefkara, Alluvium – Colluvium, Terrace deposits and Moni.

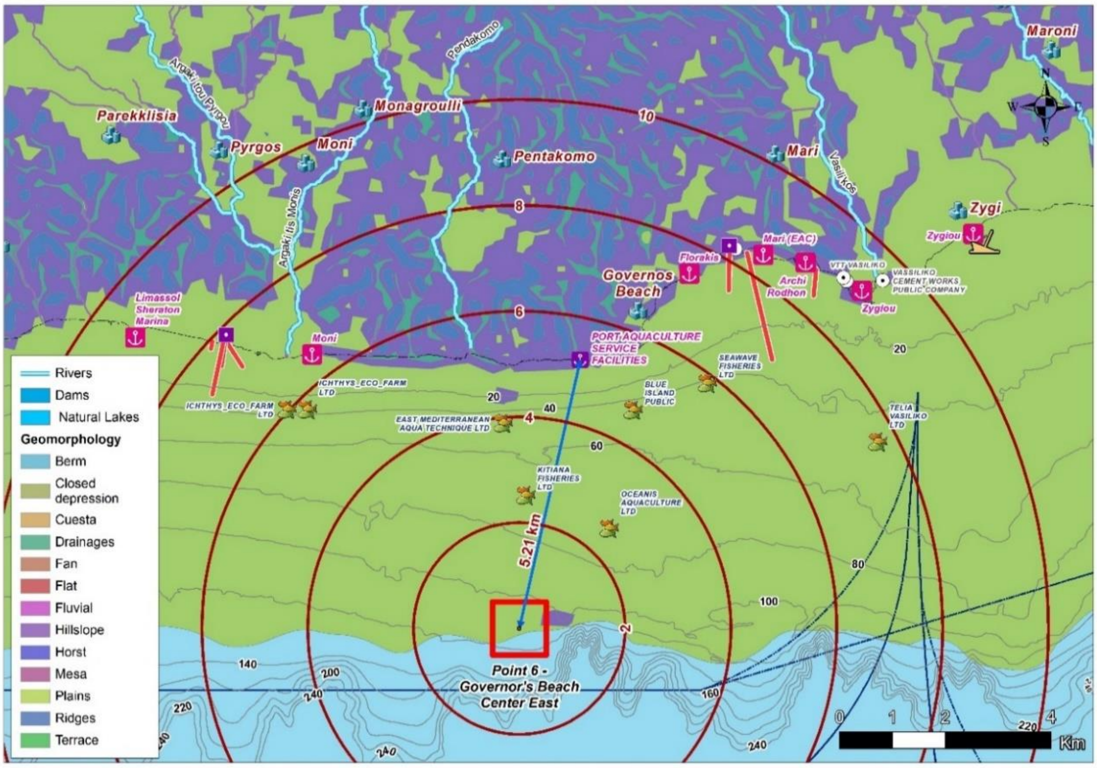

Figure 20. Geomorphological Map in Governor’s Beach AZA area *Source: Cyprus Geological Survey Department*

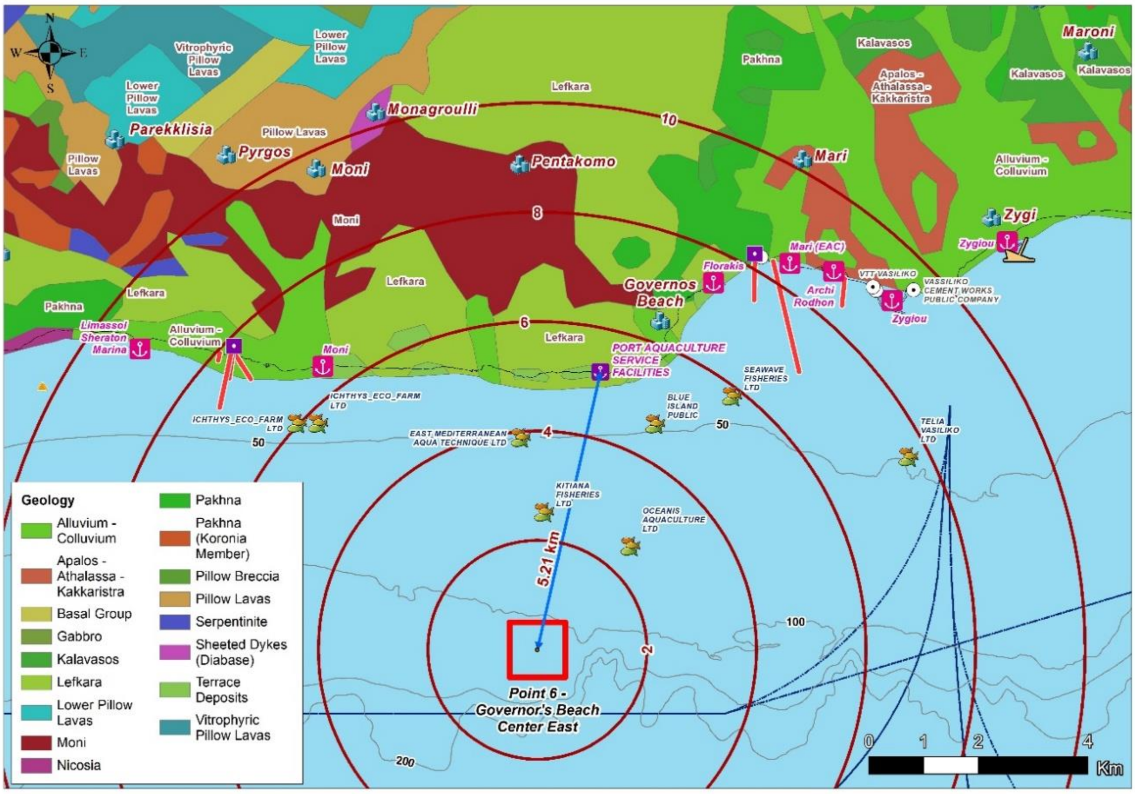

Figure 21. Geological Map in Governor's Beach AZA area. ***Source: Cyprus Geological Survey Department***

2.3.1.4 AZA 4. Aphrodite Hills

The seafront within the Aphrodite Hills AZA area has an altitude of 2m (amsl) and continues with a steep slope to the north

The area's geomorphology is shown in Figure 22, while the geological map is shown in **Error! Reference source not found.**. The area's geological formations are Pakhna, Alluvium – Colluvium, Terrace deposits, and Nicosia.

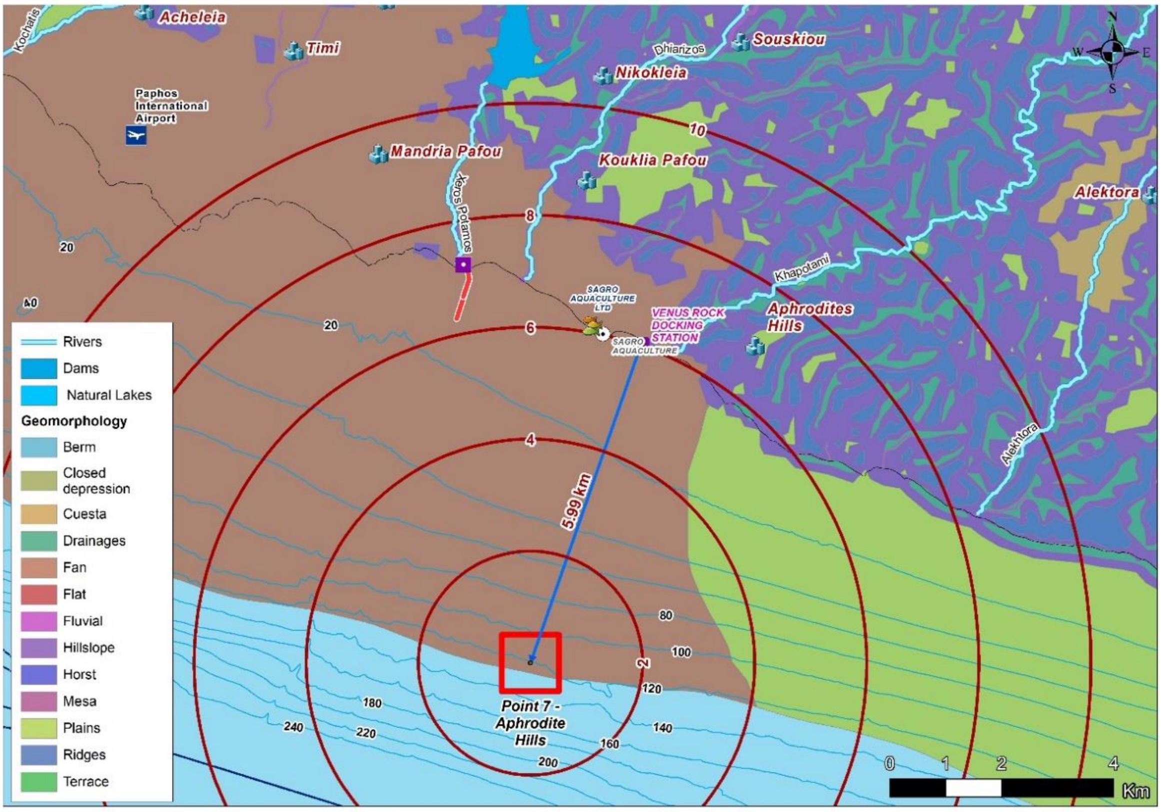

Figure 22. Geomorphological Map in Aphrodite Hills AZA area. ***Source: Cyprus Geological Survey Department***

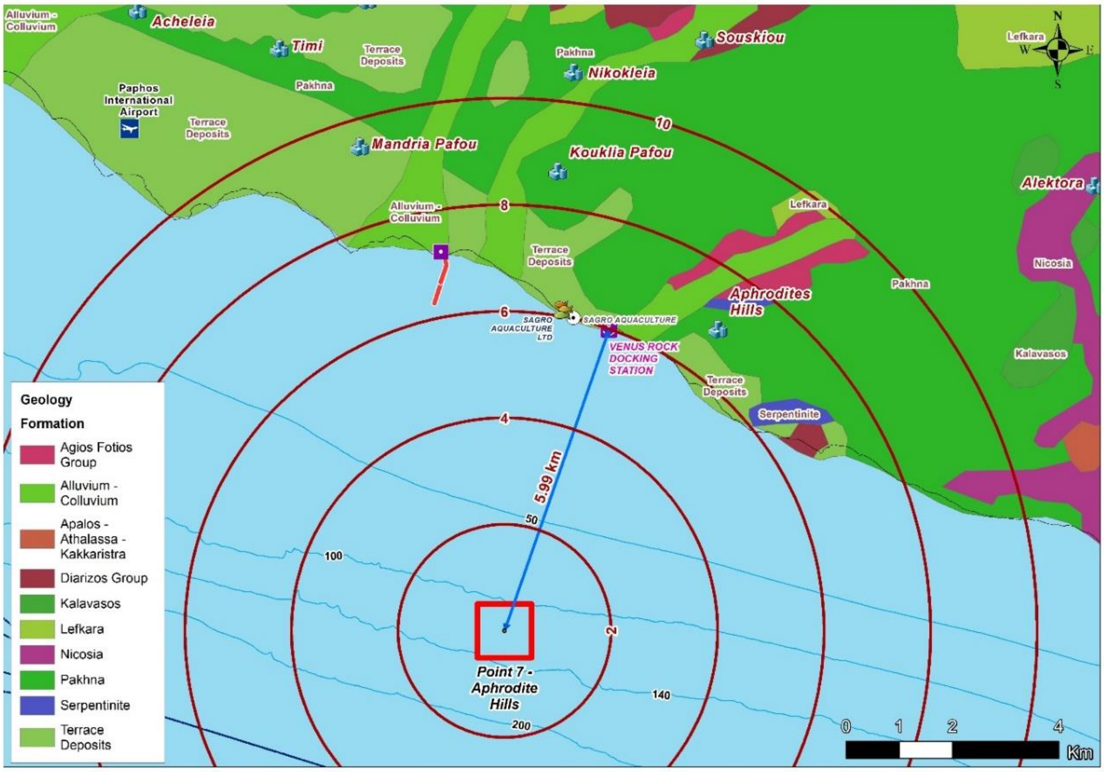

Figure 23. Geological Map in Aphrodite Hills AZA area ***Source: Cyprus Geological Survey Department***

2.3.2 Hydrology and Bathymetry

All the Geomorphological Maps presented in the previous section display the rivers that flow into the AZAs, dams, and natural lakes. The depth contour lines of the areas are displayed as well.

In the Xylofagou AZA area, the Liopetri river flows into the sea east of Cape Pyla at the Port of Potamos Liopertriou.

The main hydrological features in the Larnaka AZA area are the Salt Lakes around the International Larnaka Airport.

In the Governor's Beach AZA area, many rivers flow in the sea: Pendakomo river, Argaki tis Monis river and Vasilikos river.

The same exists for the Aphrodite Hills AZA, where the rivers Kha Potami, Alekhtora, Dhiarisos and Xeros Poramos exist, rivers of special ecological interest, with biodiversity and interesting wetland habitats.

2.3.3 Flora and Fauna

Cyprus is the third largest island in the Mediterranean Sea. It is situated at the northeastern end of the East Mediterranean basin. Cyprus is considered a biodiversity hotspot because of variations in temperature, altitude, rainfall, location, and geomorphology. The mean yearly rainfall of the area is 422 mm (see below figure). Its bioclimate ranges from hot semi-desert in the central plain of Mesaoria to wet and cool on the top of Troodos, creating high biodiversity with a considerable number of endemic species. The percentage of Cyprus endemism is 7.39% of all taxa. It has one of the richest flora in the Mediterranean region concerning its size. Compared to other Mediterranean countries, Cyprus is rich in endemics considering its small size. Furthermore, Cyprus is in a migratory flyway and is visited by millions of birds every year.

2.3.3.1 AZA 1. Xylofagou

The most representative habitat types of the wider area are (Habitat Directive, 92/43/EEC):

- Phrygana vegetation (Habitat type 5420),
- Embryonic shifting dunes (Habitat type 2110)
- Vernal pools (Habitat type 3170) on the rocky shore

The coastline easter from the Cape Pyla towards Potamos Liopetriou mainly consists of the rocky shore practically interrupted by the small estuary, called Liopetri River, which is characterized by beds of the seagrass *Cymodocea nodosa* (Habitat type 1110). The rocky shore is characterized by a Vermetus shelf (Habitat type CY04) at the littoral zone and by extensive limestone reefs which stretch down to the sea, forming a shallow underwater shelf characterised by *Cystoseira barbata* meadows (Habitat type 1170). *Cystoseira barbata* and *Cystoseira compressa* are characteristic species of the area. At Cape Pyla, the rocky shore drops into progressively deeper waters, and partly submerged caves (Habitat type 8330) are formed.

The monk seal *Monachus monachus* (included in Annex II of the Directive 92/43/EEC and the Annexes of other international conventions such as the Bern Convention and the Special protection areas (SPA) Protocol of the Barcelona Convention) is occasionally observed in this area. One of the most important species, the seagrass *Posidonia oceanica* (Habitat type 1120), is presented in deeper water.

Xylofagou AZA is next to the Special Preservation Zone of Cape Pyla (Figure 24). The area of Cape Pyla is a rare coastal ecosystem, which includes habitats of Annex I of the Law on Protection and Management of Nature and Wildlife. The area's flora includes many endemic species, orchids, and five species of the Red Book. Important species of reptiles and invertebrates supplement the fauna. Important mammal species are the Mediterranean Seal *Monachus monachus*, bats and rodents. A total of 32 bird species have been recorded in the area and are listed in Annex I of the Wild Birds Protection Act, while there are 92 other important bird species listed in Annex III of the Berne Convention.

Figure 24. Special Preservation Zone of Cape Pyla

2.3.3.2 AZA 2. Larnaka

In the wider area of the proposed site, in the area of Larnaka Bay, the percentage of vegetation cover is not high. The area's flora consists mainly of species that refer to landscape art. The vegetation area is mainly limited to some parts of the port and the sidewalks of the perimeter streets, while most areas of flora consist of low vegetation; in Finikoudes Avenue, there is a large number of individual trees of the species *Washigntonia filifera* and *robusta*.

Table 3. Terrestrial flora of Larnaka AZA study area

Terrestrial flora of Larnaka AZA study Area
Acacia salinga
Eucalyptus torquata
Washingtonia Filifera
Phoenix dactilifera
Cupressus macrocarpa
Hibiscais rosa-sinensis
Ficus microcarpa
Myoporum tenuifolium
Arundo donax
Phragmites austalis
Rosa demoscene
Bougainvillea glabra

In general, the fauna of the Larnaκa Bay area does not have any special characteristics. The fauna found in the urban environment of Cyprus is found in the area. The following summary tables present the different species of fauna found in the study area.

Table 4. Fauna in the land of Larnaka AZA study area

Terrestrial fauna of Larnaka AZA study area
Mammals
Hemiechinus auritus dorotheae
Mus musculus
Rattus rattus
Birds
Corvus corone
Fringilla coelebs
Passer domesticus
Passer hispaniolensis
Delichon urbica
Pica pica

	Larus cachinans
Reptiles	
	Acanthodactylus schreiberi
	Chalcides ocellatus
	Chameleo chameleon
	Hemidactylus turcicus
	Laudakia stellio cypriaca
	Mabuya vittata
	Ophisopse elegans

2.3.3.3 AZA 3. Governor's Beach

The land within the AZA study area supports a relatively homogenous species composition typical to Cyprus with a low density and abundance of species. The area's ecological value is generally not considered high, due to the downgrading of the habitat over the years brought on by area's industrial use. Areas of higher ecological value can be found along the rivers and watercourses in the greater Vasilikos Area.

Common taxa found in rivers in the area include *Platanus orientalis* (platanos), *Acacia salinga* (akakia), *Eucalyptus gomphocephaia* (efkaliptos), *Cupressis sempervirens* (kyparissi) and *Olea europea* (elia) and *Ceratonia siliqua* (teratsia). Common taxa of shrubs occupy the area, including *Lavandula stoechas* (agriolevanta), *Helichrysum conglobatum* (psyllina / klamata tis Panagias) and *Capparis spinasa* (kappari). In addition, opuntia *Ficus-barbarica* (papoutsosykia) is also found. Parrenial taxon of *Arundo dona*x (kalami) is also very common within streams.

A number of endemic species have been recorded in the area; however, these are common throughout Cyprus. The Department of Forests has confirmed that one rare plant species, *Erodium crassifolium*, exists in the area.

No protected or important animal species are identified in the area. The area's boundaries are restricted to common lizards, weasels and mice, as well as common invertebrates.

The habitats identified from a small to a large range in the sea area within the AZA are;

- 1120 - *Posidonia oceanica* meadows
- 1170 – Reefs
- 8330 - Submerged or partially submerged caves

2.3.3.4 AZA 4. Aphrodite Hills

The wider study area falls partially in the Northeast (Cape Aspro-Petra tou Romiou CY5000005), in the North (Cha – Potami CY4000002) and the Northwest (Ekboles Potamon Ezousas, Xerou, Kai Diarizou CY4000018 – for wild birds) in areas included in the “Natura 2000” network and define in large extent the flora and the fauna of the study area. In the following section (2.3.4), a brief description of the aforementioned Special Protected Areas is made, and details about flora and fauna .

Additionally, the seagrass *Posidonia oceanica* (Habitat type 1120) can be found in shallow waters on the southeast side of the study area.

2.3.4 Protection Areas

2.3.4.1 AZA 1. Xylofagou

A) SPZ Cape Pyla SBA/SAC/04/(2015)

The area of Cape Pyla covers a coastal ecosystem with a mosaic of habitats, which are included in Annex I of the Law on Protection and Management of Nature and Wildlife, and is one of the most important coastal areas in Cyprus. Habitat types such as coastal cliffs, allophilic and allotrophic clumps, thina systems, Phrygana with Sarcopoterium spinosum, invisible shrubs and Mediterranean seasonal lakes are among the habitats found in the area. 32 species of birds of Annex I of the Law on Prey and Wild Birds have also been recorded in the area.

National Forest Park of Liopetri River

The National Forest Park of Liopetri River has been announced as a Special Preservation Zone in 2021. The priority measures for this zone are the following:

- Conservation of habitats in excellent condition: 3170Mediterranean temporary ponds, 5210 Arborescent matorral with Juniperus spp, 5420 Sarcopoterium spinosum phryganas (Cisto-Micromerietea).
- Conservation and / or improvement of habitat conservation status: 1210 Annual vegetation of drift lines, 1240 Vegetated cliffs and rocky shores of the Mediterranean (Limonium spp. Endemic) and 2110 Embryonic shifting dunes.
- Conservation of the species C*repis pusilla, Miniopterus schreibersii, Myotis blythii, Myotis emarginatus, Rhinolophus blasii, Rhinolophus ferrumequinum* and *Rhinolophus hipposideros* in excellent condition.

B) Submerged wrecks

Three kilometres away from the AZA is the HMS Cricket shipwreck, an old British battleship that rests upside down on the seabed at 27 metres. 8 kilometres away, another wreck, the Elikoptero, a British army helicopter that sank 16 feet below sea level in 1966. Both wrecks are great attractions, especially for divers.

2.3.4.2 AZA 2. Larnaka

The area included in the Natura 2000 network of the study area of Larnaka AZA is the Larnaka Salt Lakes, “Alykes Larnakas” in Greek (see Map of Figure 2). The site “Alykes Larnakas” includes two salt lakes and the adjacent wetland and is situated to the south of Larnaka and the east of Dromolaxia-Meneou municipality. The International Airport, the Larnaka Wastewater Treatment Plant and a Desalination plant are located. The site covers an area of about 1560 ha, of which 670 ha is water (when fully flooded), and nearly 300 ha is natural halophytic scrubland.

The soils in the area are either alluvial deposits consisting of sands, silts, clays and gravels or terrace deposits consisting of calcarenites, sands and gravels. Salinity and its fluctuation are major factors concerning the function of the ecological system of the lakes. Three species are regularly present in these salts lakes, and they are important for the ecosystem function due to their role in the food web: *Dunaniella salina* (unicellular algae), *Artemia salina* (brine shrimp*)* and *Branchianella spinosa* (fairy shrimp).

Alykes Larnakas consist of one of the largest wetland systems of Cyprus but also one of the most severely stressed by human activities. The two "Alykes" (salt-lakes) of Larnaka are the second in size and importance in Cyprus after the salt lake of Akrotiri in Lemesos. The following elements indicate the ecological quality and importance of the site:

1. The variety of extended and representative halophilous wetland habitat types. These habitats occur at a few sites in Cyprus.
2. The avifauna of the site with more than 100 bird species (31 of them listed on Annex I 79/409/EEC or new additions to the Annex) is important at the national and international level, especially for migratory and for water birds. For this reason, the site was recently designated a Ramsar area. The salt lakes consist of a few Cyprus' locations where migrating birds can be seen when stopping over to feed and rest. Most famous is *Phoenicopterus ruber* (flamingo), which stays there from November till the end of March. A rich local and migrating avifauna can also be seen during the winter. *Phoenicopterus ruber* has a large population on the site and it is here that in 2001 was observed breeding for the first time in Cyprus. The site is very important for migrating C*haradrius alexandrinus and Himantopus himantopus, Philomachus pugnax, Tringa stagnatilis* and *Tringa nebularia.* Other important migratory birds are Herons, Slender - billed gulls, Larks, Pipits, Wheatears and Warblers.
3. The rest of the vertebrate fauna of the site includes 19 species of amphibians and reptiles, while the invertebrate fauna includes 63 important insects, 35 of them endemic and 8 endemic land snails.
4. A very small population of Ophrys kotchyi (an accepted new addition to Annex II 92/43/EEC) grows on the site.

<u>Shipwrecks</u>

Larnaka AZA study area contains two of the most important shipwrecks, the Zenobia and the Alexandria. These wrecks are about 4.5 km from the centre of the AZA. Rated one of the top ten wrecks dives globally, the Zenobia is a real treat for experienced divers. It lies on her port side with 108 articulated lorries which can still be seen alongside the wreck. MS Zenobia was a Swedish built Challenger-class RO-RO ferry launched in 1979 that capsized and sank in the Mediterranean Sea in June 1980 on her maiden voyage. The Alexandria wreck or 'Alex' is an old fishing trawler that sank in an upright position in 2006. The story goes that it was on its way to be scrapped and whilst being towed from Larnaca to Limassol a storm broke out and the vessel sank.

2.3.4.3 AZA 3. Governor's Beach

The study area does not include any protected area in the Natura 2000 network. The nearest protected area is 20km away to the east and is Potamos Pentaschinos (CY6000008), the valley of Pentaschinos river which ends in the coastal area of Agios Theodoros.

2.3.4.4 AZA 4. Aphrodite Hills

The study area of Aphrodite Hills AZA includes 6 Special Protected Areas of "Natura 2000" Network. Area, which are:

- CY5000005 AKROTIRIO ASPRO - PETRA ROMIOU
- CY4000018 EKBOLES POTAMON EZOUSAS, XEROU, KAI DIARIZOU
- CY4000002 CHA – POTAMI
- CY5000010 ZONI EIDIKIS PROSTASIAS CHA - POTAMI
- CY4000020 ZONI EIDIKIS PROSTASIAS KOILADA DIARIZOU
- CY4000007 XEROS POTAMOS

The first two are the ones that are located to the coastline of the AZA area and are described in details below:

CY5000005 AKROTIRIO ASPRO - PETRA ROMIOU Akrotiril Aspro - Petra tou Romiou is located at the southwestern coast of Cyprus, on the boundary of Lemesos and Pafos districts. Cape (Akrotirio) Aspro is the easternmost part of the site and Petra tou Romiou the westernmost end, Pissouri village is located north of the site. The terrestrial part of the site is 381.7 ha (15.43%). The highest point is about 250 m above sea level and the lowest part the coastline, which runs all along the south part of the site. There are gravelly beaches and impressive, steep, unvegetated sea cliffs extending at about 70 % of the coastline. The site includes the following geological formations:

1. Circum Troodos Sedimentary Succession (Nicosia formation, Pakhna formation, Apalos, Athalassa, Kakkaristra formation). It is located at the western part (Petra tou Romiou).
2. Troodos Terrane (Troodos Ophiolite) is located at the western end (Petra tou Romiou).

3. Mamonia terrane:Dhiarizos group. Partially recrystallized reefoidal limestone breccia occurring as large detached blocks (Petra tou Romiou Formation). It is located at the western part (Petra tou Romiou).

The marine part has an area of 2,091.5 ha (84.57%). It includes scattered but extensive rocky patches with some Cystoseira and Padina growth (habitat type 1170). The terrestrial vegetation is typical of Mediterranean coasts, with maquis and low coastal garigue. Its physiognomy is shaped by overgrazing at a great extent while trees, over most of the site, are wind-shaped (low, prostrate) due to the strong winds prevailing in the area. Olea and Ceratonia forest (habitat type 9320) and phrygana (5420) constitute the dominant vegetation. *Ceratonia siliqua* dominates at the higher parts of the site, whereas *Olea europaea* and *Pistacia lentiscus* dominate at the lower parts. At the western part of the site there is a strip of *Pistacia lentiscus* low and thin scrub (habitat type 9320). *Genista fasselata ssp.* fasselata and phrygana vegetation occupy the openings between the higher shrubs. Phrygana (Habitat type 5420) occur all over the site, in different forms. *Sarcopoterium spinosum* dominates locally in communities with Asphodelus aestivus and, sporadically, *Genista fasselata, Calycotome villosa and Pistacia lentiscus. Cistus creticus* and Thymus capitatus are also common along with many other shrubs and subshrubs like *Lithodora hispidula ssp. versicolor, Asperula cypria, Phagnalon rupestre, Fumana spp. Teucrium micropodioides, Thymelaea tartonraira ssp. argentea* etc. On poor eroded ground near Cape Aspro there is a distinctive phrygana composed of *Sarcopoterium spinosum, Lycium schweinfurthii, Fumana spp., Genista fasellata, Pistacia lentiscus* (very low, coastal form), *Phagnalon rupestre, Thymelaea hirsuta, Asperula cypria, Convolvulus oleifolius* etc. The herb layer of the phrygana includes many herbaceous plants like *Erodium crassifolium, Taraxacum aphrogenes, Salsola inermis, Cynara cornigera etc. Pinus brutia* forest (Habitat type 9540) occurs at the eastern part of the site; single trees are also scattered among other vegetation.*Juniperus phoenicea maquis* (Habitat type 5212) occur in large or small patches on slopes. Near the seashore the shrubs attain a prostrate form not exceeding 30 cm in height (wind-shaped). Pebble and shingle beach vegetation with *Taraxacum aphrogenes, Sarcopoterium spinosum, scarce Zygophyllum album* and *Limonium virgatum* (habitat type 1210a, a special type of 1210) occurs at a few places along a narrow belt of the seashore. Along the banks of a small stream at the western part of the site are *Tamarix gallerie*s (habitat type 92D0).

The elements composing the ecological quality and importance of the site are the following:

1. The site includes 7 Annex I habitat types. The marine habitats are well conserved while the terrestrial ones have suffered degradation.
2. The avifauna includes at least 95 species, 25 Annex I 79/409/EEC species or new additions to the Annex. The site is one of the few that provide nesting habitats (sea cliffs) for some threatened and important birds of prey such as *Falco eleanorae and Falco peregrinus*. The latter, which breeds at the Meditteranean islands, has 50% of its Cyprus population nests here (W.F.Corris). Another species that uses the area's sea cliffs as a breeding habitat is *Apus melba*. Also, the site provides abundant nesting places to the

endemic songbirds of Cyprus, *Sylvia melanothorax* and *Oenanthe cypriaca* (new additions to Annex II 92/43/EEC).

3. The site's fauna includes *Rousettus aegyptiacus* (an accepted new addition to Annex II 92/43/EEC) and another 3 endemic mammals as well as 13 species of amphibians and reptiles. Invertebrates are not fully studied but 32 insect species including 17 endemics and 11 endemic land snails have been identified.

Apart from its ecological value, the site also has historic and cultural value. Petra tou Romiou is a famous location as the mythological birthplace of Aphrodite, the goddess of love and beauty. Aphrodite's mythical birthplace 'Petra tou Romiou' is a fascinating geological formation of huge rocks along one of the most beautiful coastlines on the island, located on the southwest coast of the Pafos district and within the AZA study area. This formation is one of the most important sightseeing locations in Cyprus.

CY4000018 EKBOLES POTAMON EZOUSAS, XEROU, KAI DIARIZOU The site EKBOLES POTAMON EZOUSAS, XEROU, KAI DIARIZOU consists of two parts of the narrow Paphos coastal plain. The first part of the site includes the lower reaches and mouth of the Ezousa river and an area of flat agricultural land to the West. The village of Akhelia is just north of the site and Paphos airport to the South. The second part of the site is about 5 km to the East of the first and includes the lower reaches and mouths of the Xeros and Diarizos rivers and areas of flat agricultural land between these two rivers and the East Diarizos river. The site includes the small pools below Asprokremnos dam which is just to the North of the site) that are fed by outflow from the reservoir.

The village of Mandria lies between the two parts of the site.

EKBOLES POTAMON EZOUSAS, XEROU, KAI DIARIZOU is Cyprus' important migration site. It is particularly notable for attracting large concentrations of the Annex I raptor *Falco vespertinus* and large concentrations of the non-Annex I migrant *Merops apiaster*. BirdLife International identified the whole of the Paphos plain area as an Important Bird Area (IBA) based on the concentrations of these two migrants. It is estimated that between 1,100 and 2,000 *F.vespertinus* and between 15,000 and 25,000 *M.apiaster* pass through the Paphos plain each autumn (representing at least 1% of the European flyway for both species). Passage is not as heavy in the spring, but is still significant.

Though the PEDIADA PAFOU EKVOLES POTAMON sites do not cover the entire Paphos IBA, it takes in the most important portions of the area (covering the more natural vegetation within the three river beds crossing the area, extensive areas of farmland adjacent to these and the pools below the Asprokremnos Dam, while leaving out more built-up areas such as those around Mandria village). Some 65 migratory species occur regularly at the sites (42 of these listed in Annex I). An additional two Annex I migrants occur more rarely at the site.

PEDIADA PAFOU EKVOLES POTAMON is particularly important for Annex I members of the heron family on migration. The sites are also important for wintering migrant birds: 22 species occur regularly during winter months (10 are listed in Annex I). The following table (Table 5) shows some of the species (birds) of this Special Protection Zone referred to in Article 4 of Directive 2009/147 / EC and located in Annex II to Directive 92/43 / EEC.

Table 5. Species (birds) reported in this SPA CY4000018 (C: common, R: rare)

Scientific Name	Category
Accipiter nisus	R
Burhinus oedicnemus	R
Buteo rufinus	R
Calandrella brachydactyla	C
Calidris minuta	R
Clamator glandarius	C
Clamator glandarius	R
Coracias garrulus	C
Egretta garzetta	C
Emberiza caesia	C
Emberiza hortulana	C
Falco columbarius	R
Ficedula albicollis	C
Ficedula hypoleuca	C
Ficedula semitorquata	R
Gelochelidon nilotica	R
Grus grus	R
Hieraaetus fasciatus	R
Hieraaetus pennatus	R
Hippolais icterina	R
Hoplopterus spinosus	R
Lanius collurio	C
Lanius minor	C
Lanius nubicus	C
Larus fuscus	R

CY4000002 CHA - POTAMI Cha-Potami is situated at the southeast boundary of Pafos District. About 78% of the site lies within Pafos district and the rest in Lemesos district. The river-course (Cha-Potami) is mostly curvy and at many places the riverbed is fairly narrow with steep and very high sides. The length of the site is about 12.5 km and the area 2626.55 ha.

Cha-Potami has variable geology. It comprises the following formations:

1. Circum Troodos Sedimentary Succession: (Alluvium - Colluvium formation, Pakhna formation, Lefkara formation, Kannaviou formation)
2. Mamonia terrane: (Ayios Photios group, Episkopi Formation, Marona Formation, Vlambouros Formation).

Olea and Ceratonia forest (Habitat type 9320) is the dominant vegetation on the slopes along the river. *Olea europaea* is the dominant species, *Ceratonia siliqua* and *Pistacia lentiscus* are common but nowhere dominant. There are also scattered shrubs of *Quercus coccifera* ssp. *calliprinos* and *Genista fasselata* ssp. *fasselata* while phrygana vegetation occupies the space among the high shrubs. *Quercus coccifera* ssp. *calliprinos* forms dense or open maquis vegetation especially on sloppy ground. The understorey vegetation comprises *Olea europaea*, *Ceratonia siliqua*, *Pistacia lentiscus, Quercus coccifera ssp. calliprinos and Genista fasselata ssp. fasselata*. *Pinus brutia* sometimes mixes with *Cupressus sempervirens*. The upper part of the riverbed is dominated by Oriental plane woods (Habitat type 92C0). The lower part, which is much narrower and gorge-like, alternates between riparian plane forest and *Nerium oleander* and Tamarix (Habitat type 92D0). In this SPA there are 109 different species of birds, some of which are located in Annex I of the Directive mentioned above and some of them are shown in the table below (Table 6). In the study area there is also the archaeological site of Palaipafos located in the near village of Kouklia. Palaipafos ('old Pafos' in Greek) was one of the most important city-kingdoms of Cyprus and the first Cypriot site to be included in the World Heritage List of UNESCO in 1980. The other significant monuments of Palaipafos (source: https://www.visitcyprus.com/) are:

- The Sanctuary of Aphrodite, the most famous of the Ancient Greek Goddess' sanctuaries, and its ancient remains date back to the 12th century BC, whilst it remained a place of worship until the 3rd - 4th centuries AD.
- the House of Leda;
- the northeast gate of the defensive wall;
- the city wall and the Palace of Hadji Abdulla;
- the Church of Panagia Katholiki;
- the Lusignan Manor House;
- the cemeteries, and the
- Lusignan sugar-cane refinery in the coastal plain.

Table 6. Species (birds) reported in this SPA CY4000002

Scientific Name	Category (C: common; R: rare)
Accipiter nisus	R
Alauda arvensis	C
Buteo buteo	R
Buteo rufinus	R
Caprimulgus europaeus	C
Carduelis spinus	R
Clamator glandarius	C
Coccothraustes coccothraustes	C
Coracias garrulus	R
Coturnix coturnix	C
Delichon urbica	C
Emberiza caesia	C
Erithacus rubecula	C

Falco vespertinus	C
Ficedula albicollis	C
Ficedula hypoleuca	C
Fringilla coelebs	C
Gallinula chloropus	C
Gyps fulvus	C
Hieraaetus fasciatus	V
Hippolais pallida	C
Hirundo daurica	C
Hirundo rustica	C
Jynx torquilla	R
Lullula arborea	C
Luscinia megarhynchos	C
Luscinia svecica	V
Merops apiaster	C
Miliaria calandra	C
Monticola solitarius	R
Nycticorax nycticorax	R
Oenanthe isabellina	C
Oriolus oriolus	C
Passer hispaniolensis	C
Pernis apivorus	C
Regulus regulus	R
Rousettus aegyptiacus	P
Saxicola rubetra	C
Saxicola torquata	C
Scolopax rusticola	C
Streptopelia turtur	C
Sylvia atricapilla	C
Upupa epops	R

2.3.5 Coastal Infrastructure

2.3.5.1 AZA 1. Xylofagou

On the East side of the AZA, beyond the Cape Pyla, the port of Potamos Liopetriou can be found. This small fishing harbour is characterized by the traditional fishing boats on the river, measuring 42 hectares. The diverse geological environments and the ragged Mediterranean flora of the area form an undoubtedly unique landscape. Redevelopment plans aim to transform the old river harbour into a more appealing harbour that will provide further services to its current users? and increase the number of visitors. The redevelopment plans include a new shipyard and platforms, a fishing training centre, a repairing boat site, a multifunctional area including a conference centre, restaurants, a children's playground and a river bridge. The establishment of a national environmental park will offer bicycle and pedestrian paths, a bicycle renting facility, and gardens with shelters for visitors offering a comprehensive experience surrounded by pure nature. The main environmental consideration for this infrastructure is to minimise damage to the surrounding natural environment, such as the nearby forest and EU Natura2000 protection zone.

The Aquaculture infrastructure of Telia Aqua Marine Ltd can be found on the west side of Potamos Liopetriou in both sea and land.

On the east side of the AZA there are three ports: Ormideia Port, Xylotymvou Port and Pyla Port. The Desalination Station of Ormideia has two pipes disposing waste into the sea. Waste is disposed into the sea by the EAC Dekeliea Electricity Station, a major facility within the AZA.

Swimming areas exist east of Potamos Liopetriou port and next to Pyla port.

2.3.5.2 AZA 2. Larnaka

The International Airport, the Larnaka Wastewater Treatment Plant and a Desalination plant are located within the Nature 2000 Site "Alykes Larnakas", opposite the Larnaka AZA. Numerous pipes disposing of waste in the water exist either where the Desalination Station is located or where the oil & gas storage facilities exist north of the Larnaka Port

The Larnaka AZA is closest to the old port of Larnaka (Psarolimano) but is also close to Larnaka Marina and the Port of Larnaka, at a distance of 8 km.

Organized swimming areas and especially blue flag beaches exist all along the coastline.

The Larnaka AZA is between two ship routes connecting Larnaka Port with destinations abroad. The distance of the AZA from the ship routes is 0.5 km.

It is worth mentioning that the Cyprus Marine Aquaculture Research Center (CyMARC) is located in Meneou at 6 km from Larnaka AZA. The CyMARC is the only research station committed to marine aquaculture research in Cyprus. It participates in numerous European and other research programs and promotes research and development in the sector of marine aquaculture as part of the DFMR. Specifically, the research programs of the Meneou Marine Aquaculture Research Station (MeMARS), are mainly focused on the reproduction and farming of the so called "new species" i.e. greater amberjack (*Seriola dumeri*li), meagre *(Argyrosomus regius*), red bream (*Pagrus pagrus*), Japanese red bream (*Pagrus major)*, rabbitifsh (*Siganus rivulatus)*, octopus (*Octopus vulgaris*) and pandora (*Pagellus erythrinus*). Additionally, experiments are conducted on new technology to produce live food such as rotifers and artemia.

2.3.5.3 AZA 3. Governor's Beach

The following paragraphs account for the material assets found in the Governor's Beach AZA.

Material Assets can most simply be defined as those assets in the environment that have an economic value such as can be bought/sold or otherwise charged for use or required an investment of money or effort to create. Examples include roads, buildings, infrastructure, installations, quarries, mineral resources, etc.

The Material Assets of the area include the following major categories:

- Electricity production facilities
- Industrial installations
- Marine infrastructure
- Military Installations
- Fisheries and Aquaculture
- Transport infrastructure
- Electricity Transmission and Distribution Networks
- Water Supply Network and Desalination Plants
- Sewage Network
- Rain and Surface Waters network
- Telecommunications Network
- Quarries and Mineral Resources
- Other Facilities (which can be defined as material assets)

Comprehensive information regarding the above facilities and Infrastructure has been provided in the Vasilikos Master Plan Report, here the most important are mentioned:

- Electricity Production Facilities
    - EAC Vasilikos Power Station
- Industrial Installations
    - Vassiliko Cement Works (VCW)
    - Oil and LPG facilities (VTTV Ltd, Petrolina)
    - LNG zone
    - EAC Desalination Plant
- Military Installations
    - Evangelos Florakis Naval Base with port
- Marine Infrastructure
    - Single Mooring Point (SMP) (to import fuel to the Vasilikos power station)
    - Vasilikos Port
    - Archirodon Port
- Fisheries
    - Local fisheries shelters are found at the existing Vasilikos Port and the Archirodon Industrial Port
    - Zygi Port
    - Moni Port
- Aquaculture
    - Aquaculture Farms:
        - OCEANIS AQUACULTURE LTD
        - KITIANA FISHERIES LTD
        - ICHTHYS_ECO_FARM LTD
        - ICHTHYS_ECO_FARM LTD
        - EAST MEDITERRANEAN AQUA TECHNIQUE LTD
        - BLUE ISLAND PUBLIC

        - SEAWAVE FISHERIES LTD
        - TELIA VASILIKO LTD
    - Port at Pentakomo for Aquaculture Service

In the specific area, there re found15 swimming areas. According to the data available for the 2004 –2012 period (where applicable), the bathing water quality of the above sites was excellent.

2.3.5.4 AZA 4. Aphrodite Hills

The aesthetics of the coastline is high, and the uses at the coastline of the area are related to swimming and leisure activities as during the summer months, it operates on the beach of the Department of Forests. However, the beach's erosion has suffered and continues to undergo reduces its aesthetic value and ease of use by the swimmers.

Moving from the west to the east the following infrastructure can be found along the coast:

- Industrial Installations
    - Desalination Station of Pafos at the shore of the SPA CY4000018 “Ekboles Potamon Ezousas, Xerou, Kai Diarizou “. At tne same site there is also a pipe disposing of waste in the sea
- Marine Infrastructure
    - Venus Rock Docking Station
- Aquaculture
    - Aquaculture Farms:
        - SAGRO AQUACULTURE LTD (on land)

It is worth mentioning that the shipping routes are 3.5 km south of the AZA.

2.4 Socioeconomic Characteristics

2.4.1 Settlements

The 2011 population census from the Cyprus Statistical Service shows the following population and employment data for the municipalities and communities closest to the four AZAs (Tables 5 - 12).

Table 7. Population data for the communities in Xylofagou AZA. Source: Cyprus Statistical Service

Municipality Community	Population			Total Population Density	Living Quarters	Households
	Total	Male	Female			
Ormideia	4,189	2,026	2,163	197.10	1,722	1,419
Xylofagou	6,231	3,057	3,174	173.95	2,722	2,086

Table 8. Employment data for the communities in Xylofagou AZA (NACE is Statistical classification of economic activities in the European Community). Source: Cyprus Statistical Service

Municipality Community	Total economically active population	Total number of unemployed persons	Total number of employed persons	Total number of employed persons (NACE A-B)	Total number of employed persons (NACE C-F)	Total number of employed persons (NACE G-U)
Ormideia	1,985	250	1,735	119	359	1,230
Xylofagou	3,065	348	2,717	183	614	1,906

Table 9. Population data for the municipalities and communities in Larnaka AZA. Source: Cyprus Statistical Service

Municipality Community	Population			Total Population Density	Living Quarters	Households
	Total	Male	Female			
Larnaka Municipality	51,468	24,613	26,855	1753.73	26,619	19,649
Dromolaxia-Meneou	6,689	3,263	3,426	270.51	2,857	2,192
Perivolia Larnakas	3,009	1,531	1,478	352.76	3,149	1,135

Table 10. Employment data for the municipalities and communities in Larnaka AZA. Source: Cyprus Statistical Service

Municipality Community	Total economically active population	Total number of unemployed persons	Total number of employed persons	Total number of employed persons (NACE A-B)	Total number of employed persons (NACE C-F)	Total number of employed persons (NACE G-U)
Larnaka Municipality	24,968	3,605	21,363	146	3,975	16,920
Dromolaxia-Meneou	3,250	417	2,833	125	655	1,999
Perivolia Larnakas	1,422	191	1,231	53	326	836

Table 11. Population data for the municipalities and communities in Governor's Beach AZA. Source: Cyprus Statistical Service

Municipality Community	Population			Total Population Density	Living Quarters	Households
	Total	Male	Female			
Mari	158	83	75	14.40	88	59
Pentakomo	644	318	326	32.49	358	238
Monagroulli	536	260	276	30.36	242	177
Moni	622	321	301	76.16	336	212

Table 12. Employment data for the municipalities and communities in Governor's Beach AZA. Source: Cyprus Statistical Service

Municipality Community	Total economically active population	Total number of unemployed persons	Total number of employed persons	Total number of employed persons (NACE A-B)	Total number of employed persons (NACE C-F)	Total number of employed persons (NACE G-U)
Mari	69	1	68	24	21	23
Pentakomo	268	26	242	7	62	160
Monagroulli	230	21	209	2	27	131
Moni	238	22	216	6	30	139

Table 13. Population data for the municipalities and communities Aphrodite Hills AZA. Source: Cyprus Statistical Service

Municipality Community	Population			Total Population Density	Living Quarters	Households
	Total	Male	Female			
Pissouri	1,819	922	897	45.20	2,059	820
Kouklia Pafou	892	432	460	20.62	1,315	343
Mandria Pafou	893	456	437	116.43	883	362
Timi	1,220	603	617	105.10	499	403

Table 14, Employment data for the municipalities and communities Aphrodite Hills AZA. Source: Cyprus Statistical Service

Municipality Community	Total economically active population	Total number of unemployed persons	Total number of employed persons	Total number of employed persons (NACE A-B)	Total number of employed persons (NACE C-F)	Total number of employed persons (NACE G-U)
Pissouri	707	85	622	42	68	491
Kouklia Pafou	418	65	353	41	67	243
Mandria Pafou	380	69	311	49	41	216
Timi	571	89	482	29	90	361

In addition to the above, according to the DFMR, the employment in the aquaculture sector from 2012 to 2020 is as presented in Table 15 (http://www.moa.gov.cy/moa/dfmr/dfmr.nsf/All/1ACC9778FB94E43542257F220047FC9E?OpenDocument), while hundreds of jobs are created in related / similar professions (**Error! Reference source not found.**).

Table 15. Employees in the field of production and trade of aquaculture products

EMPLOYEES IN THE FIELD OF PRODUCTION AND TRADE OF AQUACULTURE PRODUCTS						
	2012		**2013**		**2014**	
	Employees	**Full-time Equivalent (FTE)**	**Employees**	**Full-time Equivalent (FTE)**	**Employees**	**Full-time Equivalent (FTE)**
WOMEN	80	72	127	117	122	107
MEN	215	189	253	210	272	238
TOTAL	**295**	**261**	**380**	**327**	**394**	**345**
	2015		**2016**		**2017**	
	Employees	**Full-time Equivalent (FTE)**	**Employees**	**Full-time Equivalent (FTE)**	**Employees**	**Full-time Equivalent (FTE)**
WOMEN	97	97	104	104	59	59
MEN	293	282.25	313	313	255	255
TOTAL	**390**	**379.25**	**417**	**417**	**314**	**314**
	2018		**2019**		**2020**	
	Employees	**Full-time Equivalent (FTE)**	**Employees**	**Full-time Equivalent (FTE)**	**Employees**	**Full-time Equivalent (FTE)**
WOMEN	49	47.75	59	57.5	64	62
MEN	242	231.25	269	260.5	272	253.5
TOTAL	**291**	**279**	**328**	**318**	**336**	**315.5**

The total aquaculture production in 2020 reached 7.343 tonnes of table size fish including 16 tonnes of shrimp, 33 tonnes of trout and 2.5 tonnes of sturgeon. In addition, 18.1 million fish fry were produced. The total value of aquaculture products in 2020 reached EUR 39.7 million.

2.4.2 Economic Activities and Land Use

2.4.2.1 AZA 1. Xylofagou

According to the CORINE 2012 Land Use Map (Figure 24), the largest area is covered by permanently irrigated land, while smaller areas are covered by non-irrigable arable land. Moreover, smaller areas are covered by complex farming systems with scattered houses, hardwood vegetation, industrial and commercial units and discontinuous urban construction (Xylofagou, Ormideia, Dekeleia, etc.). The advantage of this area is that it is far from these nearby residential areas and has substantial tourist developments. There are good dispersal conditions and an existing road network outside the cities.

The primary sector, i.e. agriculture, livestock and fisheries, play an essential role in the local economy. Although there has been a significant reduction in the number of people employed in agriculture in recent years, this remains an important part of the inhabitants' employment, especially in potatoes, pomegranates, and vegetables (see Table 4).

However, the contribution of other economic sectors to the development of the community is important. About 18% of the active population of the community is engaged in the secondary production sector. In addition to the EAC Dekeleia Power Station and the Desalination Station, there are many craft units in the community, including machine shops, furniture factories and ironworks. It is estimated that more than half of the active population of the community is involved in the tertiary production sector. Furthermore, apart from the employees working in the government and in the stations mentioned above, many residents are engaged in the various tourist units of the wider area of Kokkinochoria and Larnaka.

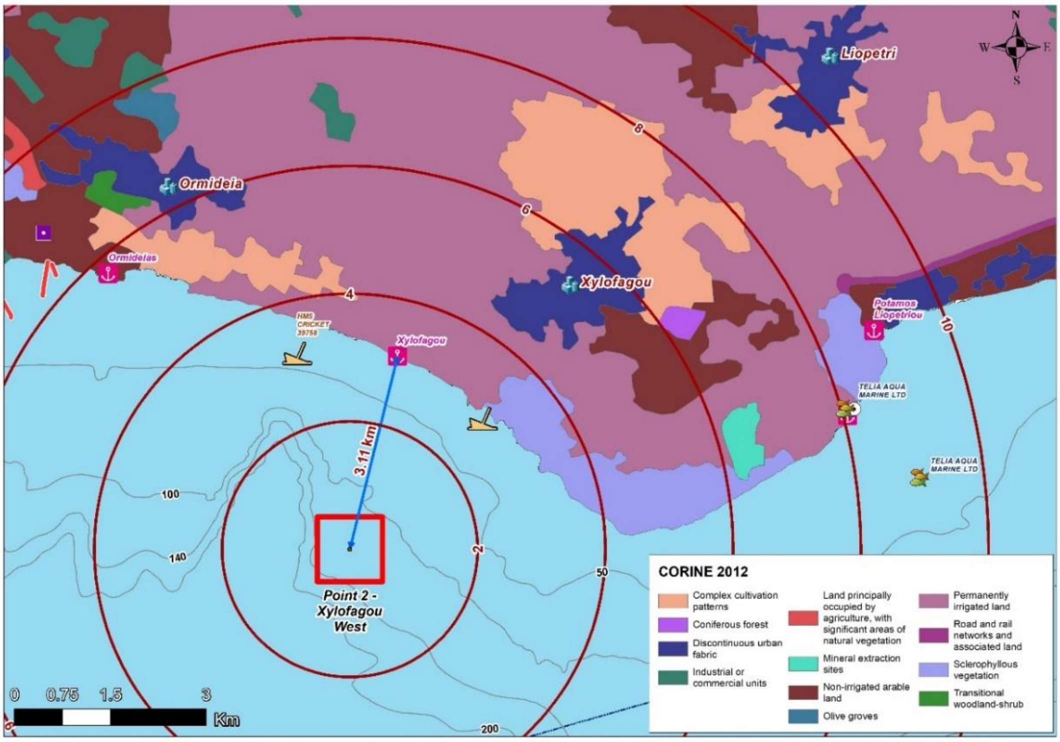

Figure 25. CORINE Land Use Map 2012 – Xylofagou AZA

2.4.2.2 AZA 2. Larnaka

The city of Larnaca represents about 40% of the district, or 55% if the closest suburban municipalities of Aradippou and Livadia are included. The town itself is the third-largest city in Cyprus after Lefkosia and Lemesos. Its traffic position is probably the best of all towns in Cyprus considering the central position between the other two coastal towns, Lemesos and Pafos, the shortest distance to the capital Lefkosia in the hinterland and especially due to the location of the highest volume International Airport in Cyprus.

Interestingly, Larnaka District is the least important coastal district of Cyprus in tourism terms despite such location. It represents only 8% of tourist overnights, whilst the smallest district, Ammochostos, represents 40% and Pafos 34%. The pressure on the coastline is also the lowest in Larnaka District – it is 11 times lower than in Ammochostos and 3 times than in Pafos District. The small number of visitors to the city of Larnaka is mainly due to the delay of the city in major development projects in recent years, such as the transfer of oil storage facilities from the coastal Area of Oroklini, the construction of Larnaka Marina, and more tourist accommodation within the town. Nevertheless, Larnaka offers a pleasant destination providing a wealth of options for guests.

Larnaka district is affluent in cultural heritage, especially from the ancient period. There are 33 ancient monuments of the first schedule (or first and second schedule) in the district and 107 monuments of the second schedule. From the tourist point of view, the most important monuments of the first schedule are the site and remain of the ancient town and necropolis of Kition (including the fortifications) and the Fort in Larnaca and the site and remain of a Neolithic settlement at Vouni in Choirokoitia (UNESCO World Heritage Site).

Some other monuments also have great importance from the tourist point of view – the best examples are the Church of Agios Lazaros in Larnaka, Stavrovouni Monastery in the nearby mountains and two monuments in the study area - The Mosque of Hala Sultan Tekke (as one of the most important in Moslem World) and Abu Bekir Aqueduct near Dromolaxia. Besides those two monuments, there is also a very important church (Panagia Aggeloktisti) and medieval bridge and wall in Kiti, and remains of a Roman period settlement and medieval tower in Perivolia.

Larnaka has been an important nucleus of Cyprus's maritime and commercial life thanks to its strategic importance. This has influenced the evolution of Larnaka as a cultural hub for centuries, with its unique mix of cosmopolitan and traditional elements. This rich history has contributed to Larnaka's thriving economic development. Today it continues to influence Europe and the Middle East with its competitive edge in business, industry and tourism. Cyprus Marine and Maritime Institute (CMMI), a centre of excellence for marine and maritime research, innovation and technology development based in the city of Larnaca, is with no doubt an important investment in Larnaka for maritime research and development.

As seen from the CORINE 2012 Land Use Map (Figure 25), Larnaka AZA is close to the airport and the salt lakes of Larnaka and the large urban area of Larnaka (discontinuous urban fabric). Moreover, the land is also primarily covered by non-irrigable arable land.

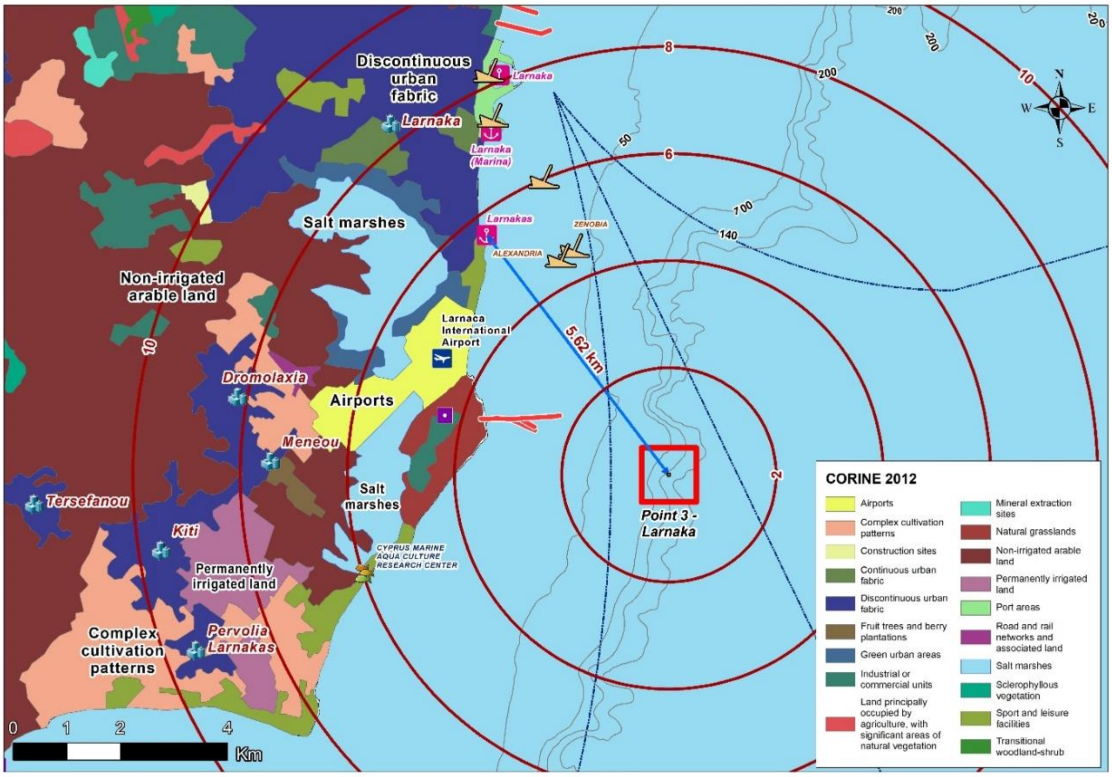

Figure 26. CORINE Land Use Map 2012 – Larnaka AZA

2.4.2.3 AZA 3. Governor's Beach

As can be seen from the CORINE 2012 Land Use Map (Figure 27), the surrounding land is covered by sclerophyllous vegetation, complex cultivation patterns, non-irrigated arable land, but with also industrial or commercial units at the communities of Zygi (east) and Moni (west). A large part of the total area of the surrounding villages (approximately 40%) is covered by Natural Vegetation (shrubs, olive trees, Calicotome villosa, and thyme). Approximately 40% of the area is used for agricultural purposes (permanent and annual crops) because of the high soil fertility of the area and the existing irrigation infrastructure.

Residential developments are mainly located in the traditional settlements of the villages and the new residential areas. Also, a small number of residential developments are located scattered outside designated development zones. Finally, developments related to the tourism sector (restaurants, holiday homes, tourist apartments) are located in coastal areas within the Tourism Zones (Pentakomo, Zygi).

Regarding tourism and agrotourism, in particular, the wider area of Vasilikos has an important role concerning the development of tourism in Cyprus. Many tourist accommodations, especially agrotourism accommodation and other supplementary facilities such as restaurants and coffee shops, have been operating for years in most communities. Also, in the Governor's Beach area, there is a camping site with high occupancy during the summer season.

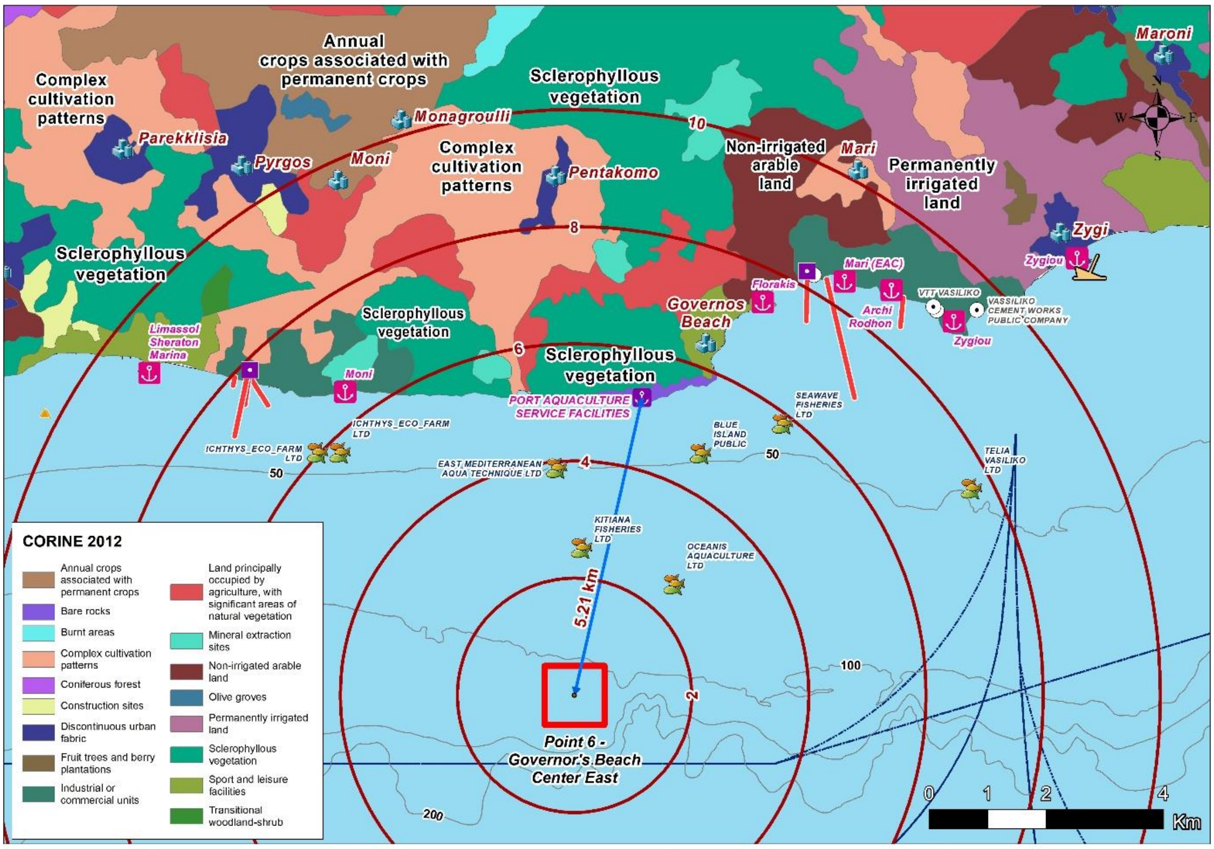

Figure 27. CORINE Land Use Map 2012 – Governor's Beach AZA

The main features that contributed to the tourism development in the area are the organized beaches, the preservation of the traditional character of the settlements, and residents' initiative to operate tourist services.

Because of the heavy tourist development in the area, Tourist Zones were established according to the Policy Statement along the coastal section of Pentakomo, Zygi, Psematismenos and Maroni.

Two areas that stand out are the Zygi area and the Governor‘s Beach area in Pentakomo, with a high concentration of tourist attractions. Special reference should be made to the latter, located to the northeast of the study area. In this area, there are organized beaches, a large number of restaurants, an organized camping site and a large number of holiday homes.

Other key land uses of the Study Area are:

- The quarry activities, which are located in Pentakomo.
- Military Bases are located in Mari, Zygi and Asgata.
- Animal Husbandry Premises are located in the defined Animal Husbandry Zones of Mari.

It should also be noted that within the administrative area of Pentakomo, an Integrated Waste Management Unit for the District of Lemesos is scheduled for construction. The unit will cover a total area of 380 decares.

The Vasilikos Power Station, the Vassiliko Cement Works, and the Vasilikos Port used for the import are the current uses within the Vasilikos Area Heavy Industry Zone.

Aquaculture

Vasilikos Bay is very important to the Cypriot aquaculture sector as it hosts the largest concentration of fish farms focusing on seabream and seabass. The total aquaculture production in the Vasilikos area totals 6800 tonnes, with production in the region and the movement of vessels servicing the units expected to increase in the coming years. Aquaculture's expansion and development in the Vasilikos area are covered in the report ―Prospects for Marine Aquaculture in Cyprus 2006.

The aquaculture cages are situated inshore and offshore between Vasilikos Port and west of Cape Dolos and Moni. The production of the units in the region represents 65% of the total aquaculture production in Cyprus and about 35% of the total fisheries production in Cyprus. In total (directly and indirectly involved), about 300 jobs are dependent on fish farming. Future expansion of fish farming will increase both production and the number of people employed. This activity must be accommodated in the offshore waters without interference with shipping movements associated with the LNG, VTTV and other marine operations.

2.4.2.4 AZA 4. Aphrodite Hills

The economic activities in the region's communities focus on hotels, restaurants, trade, and private households employing domestic staff (see

Table 14). Corresponding to the Cyprus Statistical Service data, another occupation of the inhabitants of the wider study area is agriculture. It is important to emphasize that many economically active people have agriculture as their second occupation.

As can be seen from the CORINE 2012 Land Use Map (Figure 1), the surrounding land is covered by sclerophyllous vegetation and complex cultivation patterns, while the Paphos International airport is at a distance greater than 10km from the proposed AZA.

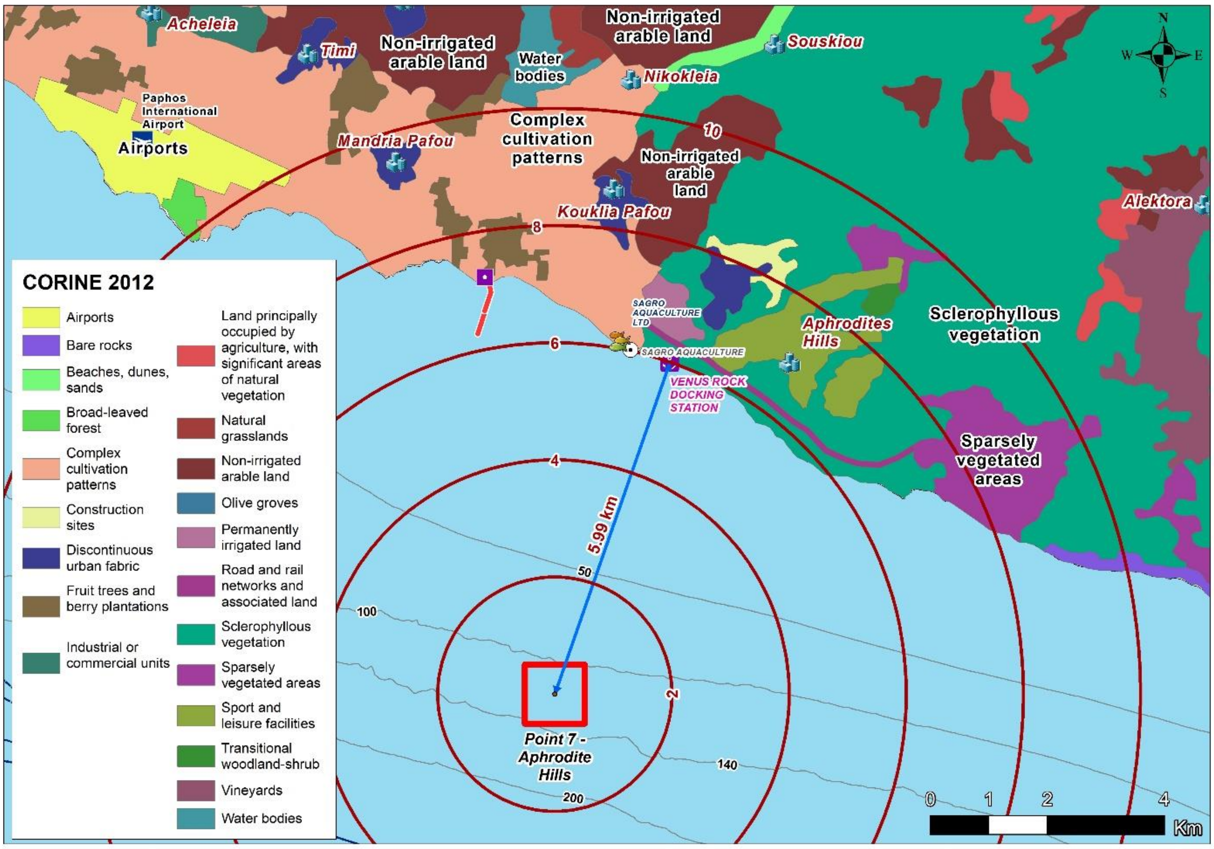

Figure 28. CORINE Land Use Map 2012 – Aphrodite Hills AZA

2.5 Ambient Air Quality and Noise

The monitoring and management of the air quality in Cyprus are performed through the provisions of the Atmospheric Air Quality Law of 2010 (Law 77 (I) / 2010) and a series of Regulations that determine the limits of atmospheric air quality for specific pollutants.

The Air Quality and Strategic Planning Sector of the Department of Labour Inspection of the Republic of Cyprus deals with the continuous monitoring of the concentration of pollutants in the atmosphere. The department uses the measurements to assess air quality and propose measures to protect the health and welfare of workers, citizens, the protection of the vegetation and the environment in general.

The Air Quality Monitoring Network in Cyprus was established in 2006 to protect and inform the public regarding the air quality in Cyprus and includes nine (9) stations. This network is operated according to Cypriot and the European Legislation. The network stations are equipped with modern devices built on the standards of the corresponding European networks. Based on the air quality legislation concerning the measurement area the stations in Cyprus are categorized as follows:

- Traffic Stations which are stations representative of areas with high traffic (Nicosia, Limassol, Larnaka, Pafos and Paralimni),
- Residential Stations, which are stations representative of residential areas (Nicosia),
- Industrial Stations which are stations representative of industrial areas (Zygi and Mari) and
- Background Stations are stations representative of background conditions (Ayia Marina Xyliatou).

These monitoring stations can obtain measurements from different pollutants, such as nitrogen oxides (NO, NO_2, NOx), ozone (O_3), sulphur dioxide (SO_2), carbon monoxide (CO) and benzene (C_6H_6). Samples for Particulate Matter (PM2.5, PM10) are also collected and analysed in certified laboratories. Furthermore, the essential meteorological parameters are being monitored, such as wind direction (W/D), wind speed (W/S), ambient temperature (T), relative humidity (R/H), barometric pressure (B/P) and solar radiation (S/R), by using automatic instruments for continuous measurements.

The European Union Directives define the quantitative criteria, and they are used to assess environmental pressures and exceedances concerning the permissible number of exceedances of the limit values.

The non-urban areas of Cyprus generally present good air quality for most pollutants (Sulfur Dioxide (SO2), Carbon Monoxide (CO), Nitrogen Dioxide (NO2), Benzene (C6H6), Lead (Pb) and other heavy metals (As, Cd, Ni, Hg)) not only is there no exceedance of the limit values set in the Cypriot and European Legislation but there is also a tendency to reduce these concentrations. Especially after the accession of Cyprus to the European Union, air pollutants were significantly reduced.

Exceptions to this trend are Suspended Particles - PM10 (PM10), where 24-hour and annual limit values are exceeded, mainly due to natural dust sources (dust storms initiating from the Sahara Desert and Middle East), including marine salt and cross-border transport of pollutants. The primary local sources are the roads and uncovered dirt surfaces from where drought, high temperatures and winds assist the swing. An exception is also Ozone, for which there are excesses in non-urban areas while deterioration is expected due to increased cross-border pollution and climate change.

2.5.1.1 AZA 1. Xylofagou

The nearest station to both Xylofagou and Larnaka AZA is the one in Larnaka. Measurements of the air pollutants show excesses in the values of PM10, which are within the permissible excesses per year, while in the case of benzene, excesses were recorded in the Larnaka station in the last years.

The primary sources of air pollution in the area are the EAC Dekeleia Power Station and the Larnaka-Paralimni highway.

2.5.1.2 AZA 2. Larnaka

The area's air quality can be studied and evaluated through data measured by the Larnaca Traffic Station. The primary sources of gaseous pollutants in thenear-roadway air pollution (NRP) are:

The presence of dust, which results from natural phenomena, as well as from human activities,

- Exhaust gases from the movement of vehicles, from commercial – tourist activities and heating systems of the settlements.

According to the results of the atmospheric air quality measurements for the period 2016-2018, it appears that the study area is not burdened with high concentrations of gaseous pollutants. Concentrations of gaseous pollutants do not exceed the pre-defined quality limits of the relevant legislation. There is only a slight excess of the annual average PM10 values, of the order of about 1%.

2.5.1.3 AZA 3. Governor's Beach

The most representative monitoring station in terms of location for this study is the Zygi Industrial Station located near the Vasiliko Power Plant and Cement Factory. The station measures $PM_{2.5}$, SO_2, NO_2, PM_{10}, and O_3 and a number of meteorological indicators.

According to the measures at this station for the period 2007-2010, it was observed:

- The suspended particles in the atmosphere exceeded the permissible limits set by the European Union.
- The number of exceedances of sulfur dioxide (SO_2) in 1 hour averaging period was 1 (the permitted is 3) while in 24 hours averaging period the number of exceedances was 8 (the permitted is 24)
- NO_2 and O_3 pollutants were within the permissible value limits set by the European Union.

In general, there is a gradual decrease in NOx emissions and sulfur dioxide (SO_2), possibly linked to the improvement in fuel gas quality (DLI, 2020). However, in general, there are no particular issues of concern in the study area except for a few cases where the recorded values of $PM_{2.5}$ and PM_{10} exceeded the established limits (for 24 hours), though unknown if the exceedances were due to dust or any industrial activity. Overall, pollution levels in the area are low according to the classification.

2.5.1.4 AZA 4. Aphrodite Hills

The quality of the atmosphere in the broader study area can be considered to be within the permissible limits set by the legislation. The above assumption is based on the fact that there are no significant sources of gaseous pollutants in the area. The main sources of gas pollution in the NRP are:

- PMs/dust either come from natural sources or human activities, e.g. earthworks, ploughing fields, traffic within dirt roads, etc.
- The emission of gaseous pollutants from the movement of vehicles on the leading dirt road network of the area and the B6 and A6 motorways located near the area.
- The incineration of organic matter from agricultural and livestock activities was conducted within the wider study area.

It is noted that there is no presence of important industrial processes that emit significant amounts of gaseous pollutants.

The quality of the atmosphere in the study area is presented in the study of UNOPS "Preliminary Assessment by Ambient Air Quality in Cyprus" of 2004. According to the findings of this study, the concentrations of gaseous pollutants in the NRP appear to be at relatively low levels compared to average concentrations.

2.5.2 Noise

2.5.2.1 AZA 1. Xylofagou

The leading cause of noise in the study area is the Larnaka-Agia Napa highway which crosses the area. The operation of both airports and helipads in the Sovereign Base Area (SBA) also causes an increase in noise levels in the area during their operation. In addition, military activities such as firing ranges contribute to increased noise levels and the operation of quarries located within тhe SBA.

2.5.2.2 AZA 2. Larnaka

The main cause of noise in the study area is air traffic ofthe International Airport of Larnaka. As the area is close to the sea shooting range bounded by the Ministry of Defence, the military activities increase noise levels.

2.5.2.3 AZA 3. Governor's Beach

In the coastal areas of the study area, the main natural source of sound is the movement of water and the breaking of waves on the rocks. During the summer, the appearance of swimmers and vacationers is an additional noise source. In addition, it is known that the industrial sector is emerging in the area, especially in Vasiliko Bay. The movement of heavy vehicles and the processes carried out in the context of the Vasilikos Power Station operation; the Vassiliko Cement Works (VCW), the LNG zone, the quarries, the ports as well, as the movement of fishermen may cause an increase in noise levels. In addition, occasional vibrations from other works in the area facilities are likely to contribute to the observed noise levels (e.g. military drills, naval explosions). Finally, the noise levels may increase when relocating the oil storage facilities from Larnaka to Vasilikos will be completed and by the expected construction and operation of the future Vasilikos Energy Centre (VEC).

2.5.2.4 AZA 4. Aphrodite Hills

Within the study area, no land uses are observed, which contribute to high levels of noise pollution, and the main sources of noise are the natural movement of the sea waves. The secondary road network of the main road Pafos – Lemesos exists in the area; higher noise levels occur while traffic is the main source of the noise.

3 IDENTIFICATION OF IMPACTS

3.1 Introduction

A key challenge for the agriculture sector is to sustain an increasing global population whilst at the same time reducing the environmental impact and preserving natural resources for future generations in a cost-efficient and sustainable way.

While aquaculture shows a great possibility to reduce overfishing and provide income and food for impoverished areas, numerous documented environmental concerns are associated with various aquaculture practices. These include ecosystem degradation and the risk of pollution, introduction of new species or pathogens into natural habitats, and soil, water, and air degradation. Aquaculture can also positively impact the environment by adopting sustainable farming practices, creating new jobs while preserving valuable marine resources.

Recently, open sea aquaculture uses high technologies to avoid escapes and avoids the risk of environmental degradation by using current flows to disperse contaminants (Tidwell, 2012; Kankainen and Mikalsen 2014; Holm et al. 2017). Additionally, the offshore sites are more spacious, reduce contests with other sea space users, have deeper water depth, and constant water flows (Tidwell, 2012; Kankainen and Mikalsen 2014; Holm et al. 2017). The offshore environment can help avoid the accumulation of fish wastes (e.g. uneaten feed or faeces) under cages, thereby preventing the proliferation of parasites and diseases. The current section assesses the potential environmental and socio-economic impacts of the construction and the operation of an OS fish farm by taking into account the description of the four candidate AZA areas as mentioned in Chapter 2.

3.2 WFD and MSFD EU Directives

In 2016 Commission issued a Communication on the application of the Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD) in relation to aquaculture (COM, 2016). The overall aim of this document was to offer practical guidance which will facilitate the implementation of the WFD and MSFD in the context of the development of sustainable aquaculture. More specifically:

- to provide regulatory good practice and suggestions to national authorities about the requirements of the Directives in relation to aquaculture, to facilitate their implementation;
- to provide industry good practice and suggestions to aquaculture producers on what is expected of them and what they can expect from the implementation of the Directives;
- to provide information about the sustainability of EU aquaculture production and its compliance with relevant EU environmental legislation (COM, 2016).

The WFD aims to improve and protect the chemical and ecological status of surface waters and the chemical and quantitative status of groundwater bodies throughout a river basin catchment. Article 4 of the WFD requires Member States to prevent deterioration of the ecological and chemical status of surface waters, and to restore polluted surface waters and the ecological conditions necessary to achieve good status in all surface waters. and also requires Member States to take all the necessary measures to progressively reduce pollution from priority substances and to cease or phase out the emissions, discharges and losses of priority hazardous substances.

The aim of the EU ambitious MSFD is to protect more effectively the marine environment across Europe. Its scope of application extends to coastal waters on aspects of environmental status which are not already addressed by the WFD or other Community legislation, as well as the full extent of Member States territorial waters over which they have or exercise jurisdictional rights (MSFD, Article 3.1)

The Commission adopted a report on the first implementation cycle of the MSFD in June 2020. This report shows that while the EU's framework for marine environmental protection is one of the most comprehensive and ambitious worldwide, it needs to be beefed up to be able to tackle predominant pressures such as overfishing and unsustainable fishing practices, plastic litter, excess nutrients, underwater noise and others types of pollution.

The new **EU Biodiversity Strategy for 2030** (adopted in May 2020) aims to strengthen the protection of marine ecosystems and to restore them to achieve "good environmental status", including through the expansion of protected areas and the establishment of strictly protected areas for habitats and fish stocks recovery. It stresses the need for an ecosystem-based approach to the management of human activities at sea.

3.2.1 MSFD and Aquaculture pressures and impact

The role of the MSFD is becoming increasingly important to ensure that aquaculture activities provide long-term environmental sustainability. At the same time the "Blue Growth" (COM, 2012) communication foresees the expansion of aquaculture activities including i.a. through the farming of new species or moving further offshore, also known as Open Sea Aquaculture.

To help achieve good ecological status, eleven descriptors of the state of the environment have been defined.

- Biodiversity (D1),
- non-indigenous species (D2),
- commercial fish and shellfish (D3),
- Food webs (D4),
- eutrophication (D5),
- seafloor integrity (D6),
- hydrographic conditions (D7),
- contaminants (D8),
- fish and seafood contaminants (D9),
- marine litter (D10) and
- energy including underwater noise (D11).

Different aquaculture systems may impact the MSFD Descriptors in different ways. However, such effects are dependent on factors such as the hydrological conditions at each aquaculture facility, the type of species being cultured, the production method and management practices. In broad terms, potential environmental impacts include habitat loss and degradation including changes to the biological communities, contamination, nutrient and organic matter enrichment, and species disturbance, displacement and mortality.

These MSFD descriptors have been taken into account in the following environmental impact analysis of the candidate areas either in construction phase or the operational phase.

3.3 Construction Phase Impacts

The first phase of aquaculture development is the Construction of the farms, i.e. the installation of the aquaculture enclosures to their designated location.

The impacts that can be identified during the construction phase of the fish farms are related to the three stages of the construction:

1. the construction and assembly of the cages, mooring system and other technologies on land,
2. the transport and sinking of the mooring system, and
3. the attachment of the fish enclosure to the fish cage system.

3.3.1 Environmental and Socioeconomic Impacts

Destruction of Flora and Displacement of Fauna

Stage 1

The mooring system assembly and the fish cages' construction will land. If this is completed in an appropriate location/facility, then no flora destruction and fauna displacement are expected at this construction stage. After this stage, the used space will be cleansed, and all unused materials will be removed for future reuse.

Stage 2

The mooring system will be transported and immersed in the sea area by a specialized vessel. At this stage, the benthic biocommunities will be affected at the location where the concrete blocks will be placed. The impact is expected to be negligible and will not significantly affect the biodiversity of the wider area. However, an in-depth analysis of the area according to the geomorphology and the biological status should be made before such instalments, to ensure the absence of organisms of special interest (e.g. endemic species, etc.) at the area.

Another environmental impact identified during this stage is the possibility of fish escaping in case of destruction of the fish cages or if holes are created on them. The new advances in technology like robotics and ROVs can monitor the status of the nets and the cages while being in use, therefore minimizing the impact.

Regarding the usage of the ropes and chains, there are not expected to be any environmental effects.

Stage 3

The process of attaching fish cages to the anchorage system is not expected to cause any destruction of flora and displacement of fauna, or any other environmental degradation.

Changes in Ambient Air Quality

Stage 1

The assembly of the mooring system and the construction of the fish cages is possible to affect the ambient air quality by:

- The presence of dust caused during construction works (can use saccofilters or other devices to minimise emissions)
- Exhaust gases from the use of the necessary machinery and equipment
- Chemicals used in the construction can be released into the atmosphere, such as paint and sealers.

Stage 2

The use of the vessels to transport the mooring system and the fish will add exhaust gases emission.

Stage 3

The process of attaching fish cages to the anchorage system is not expected to cause changes in ambient air quality.

Changes in Ambient Noise Levels

Stage 1

The assembly of the mooring system and the construction of the fish cages will increase the ambient noise levels from the use of the necessary machinery and equipment but can be moderated with the usage of low dB equipment.

Stage 2

Apart from the ambient noise level increase, it is expected that there will be a local increase in the underwater noise levels due to the operational procedures of the vessel and the whole procedure while placing the system.

Stage 3

Local increase of noise levels in the water is to be caused due to the vessel that carries the fish and the noise caused by the fish themselves.

Changes in Site Topography

The aquaculture facilities on land will not affect the topography of the site.

Occupational Accidents

In all stages, occupational accidents may occur if not all precautions are taken and if the personnel are not specialized and qualified.

Public Safety

Public safety might be affected in all stages if not all countermeasures are taken.

Socioeconomic Impacts

Stage 1 – 3

Socioeconomic impacts during the construction phase are mostly related to the following:

a. create new job opportunities, training and specialisation opportunities at various levels with a possibility to retrain employees from the ever-shrinking fisheries sector,
b. promote research, innovation, investment capacity and
c. promote the development of research facilities and state of the art infrastructure.

Stage 2

Failure of the equipment or mooring, accidents or changes in the sociopolitical status (e.g. changes in AZA licensing), will have an economic impact on the company.

Specifically, in this stage, the escape of fish from cages, due to inherent flaw of construction will have an economic impact on the company. On the other hand, the professional and amateur fishermen's exploitation of this event (including people fishing with reeds and spearguns) will benefit (also economically).

3.4 Operational Phase Impacts

3.4.1 Introduction

Aquaculture activities can potentially exert pressure on the environment. Potential environmental impacts include habitat loss and degradation, including changes to the biological communities, contamination, antibiotics pollution, nutrient and organic matter enrichment, species disturbance, displacement, and mortality.

In contrast, aquaculture can be subject to pressure and impacts from other activities in the aquatic ecosystem, such as pollution incidents, pathogens, contaminants etc.

The pressure and impacts of different aquaculture systems vary on multiple factors, including, type of cultured organism, farm location methods used, and the sensitivity or vulnerability of the environment to possible pressures.

According to Marine Strategy Framework Directive (2008/56 /EC), the main potential environmental impacts of aquaculture relevant come from:

- the introduction of non-indigenous species (NIS),
- nutrients,
- organic matter,
- contaminants including pesticides and litter,
- the disturbance to wildlife, and the
- possibility of the escape of farmed fish.

These may have implications for the MSFD descriptors.In the following section, potential identified impacts, including the potential interactions between aquaculture, the environment, and the MSFD descriptors based on Member States statements (Table 16), are described.

Table 16. Potential interactions between aquaculture, the environment, and MSFD descriptors based on Member States initial impact statements (2008/56 /EC).

Descriptor	Degree of interaction	Evidence & mitigation
1. Biodiversity	Small	If unmanaged, escapees, diseases, and parasites may have localised effects on biodiversity. These should be addressed by implementing the EIA, SEA and Habitats Directives. Siting is a critical factor in reducing the potential impacts on biodiversity.
2. Non-indigenous species	Moderate	Aquaculture provides a potential route for introducing NIS; the introduction of alien species in aquaculture is regulated by Regulation 708/2007, requiring a specific authorisation for any introduction of alien species.
3. Commercial fish & shellfish	Small	If unmanaged escapees (gene flow), diseases and parasites may have localised effects on wild commercial fish and shellfish.
4. Foodwebs	Small	If unmanaged escapees (gene flow), diseases and parasites may have localised effects on foodwebs. Siting is a critical factor in reducing the potential impacts on foodwebs.

5. Eutrophication	Small	Some impact at local scale, but generally unlikely to occur at sufficient scale at present to have significant impact since is at the open sea. In such cases, Member States may consider the application of nutrient-neutral schemes or other approaches that remove nutrients from the sea.
6. Sea-floor integrity	Small	Some impact at local scale due to siltation or scour, but unlikely to occur at sufficient scale at present to have significant impact. This can be mitigated by moving cages, fallowing areas, or relocating to more energetic sea areas (areas with greater circulation.
7. Hydrographical conditions	Small	Some impact at local scale due to formation of smallscale features including eddies, but unlikely to occur at sufficient scale at present to have a significant impact unless large scale facilities.
8. Contaminants	Small	Some impact at local scale due to contamination by hazardous substances and microbial pathogens, but unlikely to occur at sufficient scale at present to have significant impact. Mitigation comes from the regulatory limits set within food safety legislation. However, these regulatory limits, which are set to protect consumers' health, are not specifically designed to protect the environment. Therefore, additional action may be necessary to ensure

3.4.2 Impact on Site Hydrology

The infrastructure, including the containment, abstraction, discharge, harvesting, will not pose any impact to the hydro-morphological quality elements such as hydrology/typology- flow rates, wave exposure and habitat because the installation is an open sea installation and the environment is extremely harsh and can not be affected by such installations. The carrying capacity of each area will be determined in D12 and preliminary model runs are included in D11.

3.4.3 Changes in the Status of Aquatic Flora and Fauna

3.4.3.1 Effects on biodiversity

Although some species are directly affected by aquaculture and species diversity beneath cages is generally decreased, it is not certain that the biodiversity is endangered by fish farming (Agius et al., 2006). Most scientifically documented effects are on macro faunal invertebrates at a zone beneath and close to the farm cages. These organisms are ecologically important, but it is very unlikely that they will become extinct or that their populations at larger spatial scales will be significantly affected.

The potential problems affecting biodiversity concerning aquaculture are the mortality of large fauna, the effects on sea-grass meadows and the changes in the trophic status of large water bodies. The MedVeg project has investigated the effects in Greek coastal waters, Cyprus, Sicily, and Spain. It has been shown that fish farming has a significant negative effect on Posidonia meadows, and therefore, it could pose an important risk if sites are not properly selected (Holmer et al., 2003). According to the recommendations of the MedVeg project (Effects of nutrient release from Mediterranean fish farms on benthic vegetation in the coastal ecosystem), fish farming should avoid shallow waters (<40m depth) and distances less than 800m from important Posidonia meadows. For the current project, since the aquaculture farms will be located at depths of more than 100m, sites with such inhabitants will be avoided; hence the impact will be low.

There is little evidence for change in trophic status from fish farming zones in Mediterranean coastal waters, where all the sites investigated have been found to maintain their oligotrophic characteristics. Although not explicitly addressed in any known local project, there is little evidence that large k-selection animals have suffered losses due to their interactions with fish farming.

3.4.3.2 Effects on plankton

Results from the AQUAENV project as mentioned above (Pitta et al., 1999) have shown that plankton assemblages near the fish farms are not significantly different to those at the control sites in terms of either quantity (abundance) or quality (diversity, species composition). Furthermore, recent experiments in the framework of the MedVeg project have shown a pronounced effect of microplankton grazing on phytoplankton cells which prevents the bloom of phytoplankton despite the constant supply of nutrients by the fish farms (Pitta et al., 2006).

3.4.3.3 Eutrophication

Under adverse conditions excessive nutrient enrichment may lead to eutrophication. The risk of eutrophication decreases if currents are strong enough to disperse waste products, feeding is regulated and pens are not overcrowded. Therefore, open sea aquaculture has an advantage to coastal fish farming. The offshore sites are more spacious for fish farms, pens are at a distance from the benthic floor, and constant water flows (Tidwell, 2012; Kankainen and Mikalsen 2014; Holm et al. 2017). The offshore environment can help avoid the accumulation of fish waste (e.g. uneaten feed or faeces), enhancing eutrophication.
In terms of good environmental status, the impact of aquaculture wastes on the underexamined ecosystem was using the model simulated outputs, by means of Eutrophication Index (E.I., Primpas et al., 2010) in Deliverables D10 and D11. It should be noted that the Levantine Sea is generally characterized as an oligotrophic area. The results showed that the impact from the fish farm wastes on the marine ecosystem functioning exhibit a small increase in net primary production, mostly in the vicinity of fish farms, while phytoplankton (Chl-a) shows a slightly lower increase. To be more precise model runs showed that the operation of Open Sea farms with 2,000, 3,000 and 5,000 tonnes per year will not affect the Eutrophication Index in Aphrodite's Hills and Governor's Beach areas as they are good to moderate However, the combination of 3,000 tonnes in Larnaca and 5,000 tonnes in Xylofagou revealed a transition in the EI from good to moderate in spring which stipulates that the carrying capacity of the marine habitat in these areas allows specific production volumes. In the case of

seaweed proliferation surrounding the cages, this can act as waste and nutrient filter, carbon sink, and oxygen enrichment, which can positively impact the ecosystem.

3.4.3.4 Effects on benthos

The effects of settling particulate material on benthic organisms investigated in the framework of the AQUAENV project showed significant changes in benthic communities beneath fish farms (Karakassis et al., 2000). Although none of the sites investigated was grossly polluted (i.e. azoic), there was a considerable decrease in benthic diversity since small body-sized opportunistic species mainly inhabited the seabed. However, in this case, again, the area affected was less than 25m from the edge of the cages.

In a paper reporting data from two sites in Greek coastal waters, Papoutsoglou et al. (1996) reported that visual inspection by divers failed to detect any effects on the seabed under the fish cages.

A recent investigation of changes at larger spatial scales in the framework of the AQCESS project showed little change in community structure or feeding types of the macrobenthic organisms. However, there was an increase in the biomass of megabenthos at a distance of 1-10 km, which could be associated with fish farming zones.

3.4.3.5 Effects on wild fish

The potential for genetic modification in wild fish can be considered because there are no predominantly wild breeds in the area.

3.4.4 Impacts on Sediment

3.4.4.1 Changes in sediment and benthic societies in sediment

Excess food and excrement of fish (indigestible food) are transported by sea currents and eventually settle to the bottom resulting in a change in the physicochemical composition of the sediment by increasing the concentration of phosphorus, the organic matter in the sediment (Edgar et al., 2010). The physicochemical changes of the sediment change the composition and structure of benthic biocommunities resulting in the reduction of biodiversity and the predominance of opportunistic species that can withstand anoxic conditions (e.g. polychaetes) (Tomassetti et al., 2009; Neophytou et al., 2010). Furthermore, dissolved and particulate nutrients from the uneaten fish food and excretory products can cause smothering of the seabed and de-oxygenation of the water column, affecting the physico-chemical quality elements. These can also contribute to local eutrophication, with impacts on biological quality elements; When organic enhancement of an ecosystem ensues, oxygen consumption by heterotrophic organisms rises. This generates anaerobic conditions that reduce compounds such as NH4, H2S, and CH_4. H_2S is toxic to fish; anoxia prevents microbial activity resulting in low ATP (Islam 2004). This can pose a risk to wild fish populations and cages. A recent investigation of sedimentary geochemical variables at larger spatial scales in areas surrounding fish farming zones (AQCESS project) showed no significant changes (not even subtle ones) at distances of 1-10 km. It should similarly be noted that even in the worst case (shallow, silty sites), the signs of degradation of the sediment beneath the farms are subject to significant seasonal changes, becoming less severe during winter when the food supply decreases and sediment resuspension and oxygenation increase (Karakassis at al., 1998). There was no sign of anaerobic sediments beneath the cages, and at the same time, there were no discrepancies on water quality parameters.

It should be noted that oxygen consumption by heterotrophic organisms increases when organic enrichment of an ecosystem occurs. This creates anaerobic conditions that produce reduced compounds such as NH_4, H_2S, and CH_4. H_2S is toxic to fish; anoxia inhibits microbial activity resulting in low ATP (Islam 2004). This can harm wild fish populations and those in the cages. Mantzavrakos et al., 2007, showed increased nutrient concentrations of nutrients (ammonium-nitrogen and phosphate) near the cage sites. However, little accumulation of organic sediments from waste food or faeces was recorded because wild species were fed on the waste (Mantzavrakos et al. 2007). An evaluation of potential impacts assessed the concentrations of nutrients in sediment and the water, the effects on the benthic community, and the rate of biofouling growth. The result found no change in inorganic nitrogen and phosphorus, organic matter, organic nitrogen and total carbon, and macroinvertebrates.

3.4.5 Impact on Water Quality

3.4.5.1 Nutrients

Various risks are correlated with open sea aquaculture, mainly land conversion and environmental degradation from contamination. Hazards that could apply to open ocean practices comprise alteration in water composition (nutrient content, organic matter content, chemical enrichment, turbidity, anoxia), fluctuations in nutrient and oxygen levels which can lead to the creation of toxic compounds, ecosystem degradation, the introduction of pathogens, change of genetic diversity in wild stocks, and the hatchery broods may diminution in fitness after several generations (Bert 2007).

According to the international aquaculture literature, nutrients are released from wastes such as food surpluses and fish excrement increasing the organic matter and resulting in organic pollution. Ammonia and dissolved phosphorus are aquaculture wastes produced during the operation of fish farms. Scientific research has shown increased ammonia in fish cages attributed to fish excretions (Sara, 2007; Neophytou and Klaoudatos, 2008). Ammonia ions (NH4+) in the nitrification cycle are converted by bacteria to nitrites (NO_2-) and then to nitrates (NO_3). Dissolved phosphorus comes mainly from excess food and indigestible food (fish secretions). The Eastern Mediterranean is characterized as oligotrophic with phosphorus as the limiting factor; the increase of components in the water column results in primary production (Pitta et al., 2005; Holmer et al., 2008).

The degree of impact and the amount of waste produced depends on:

a. the biomass of the fish in the cages,

b. the methods and frequency of feeding the fish

c. the quality and quantity of food, and

d. the experience and training of staff in the process of feeding fish.

The waste dispersion depends on the amount of food, the currents in the area, the number and arrangement of the fish cages, the geographical location and the depth at which they are located (Karakassis et al., 2000).

For the purposes of OS-Aqua,the HCMR's AIM model was applied following mass balance calculations in the four selected areas and considering satellite mean monthly sea-surface temperature data for the period (2015-2018). Three nested sub-models were used to estimate the impact of aquaculture wastes on the Cypriot marine ecosystem, in terms of good environmental status, using the model simulated outputs, by means of a Eutrophication Index (with PO_4, NO_3, NO_2, NH_4 in mmol/m^3 and Chl-a in mg/m^3) and the environmental scaling of <0.04 for very good, 0.04 - 0.38 as good, 0.38 - 0.85 for moderate, 0.85 - 1.51 for poor and > 1.51 for bad. The results showed that the effect from the fish farms is mainly visible during spring and autumn periods, characterized by relatively higher aquaculture wastes and relatively stronger stratification than the winter period. Environmental conditions during these periods appear good to moderate, even in the vicinity of the fish farms, suggesting that aquaculture wastes are effectively dispersed by ocean currents. The impact of open sea aquaculture at Xylofagou and Larnaca sites appears slightly stronger as compared to both Aphrodite's hills and Governor's beach areas. This may be attributed to the relatively weaker currents and the anti-cyclonic pattern in the enclosed Larnaкa bay. Details of this study can be found in Deliverable 10.

The effects of fish farm wastes on marine geochemistry have been investigated in the framework of the AQUAENV project (funded by the Greek General Secretariat for R&D). It has been shown that the accumulation of uneaten food and faecal pellets result in conspicuous changes to the physical and chemical properties of the marine sediments beneath the cages (Karakassis et al., 1998, 2000, 2002, Belias et al., 2003). Furthermore, a significant percentage of food residues are consumed by wild fish populations gathered around the fish cages (Holmer et al., 2007). It has been shown that dissolved wastes (primarily ammonium and phosphate) have little impact on nutrient loading at the farming sites (Pitta et al., 1999).

The induction of phytoplankton blooms in Eastern Mediterranean could be considered negligible since, the increased concentration of nutrients mainly favours the increase of picophytoplankton and microorganisms consumed by the microzooplankton at a rapid rate (Pitta et al., 2005; Zohary et al., 2005; Holmer et al., 2008; Síokou-Frangou et al., 2010; Kletou and Hall Spencer, 2012). Nevertheless, toxic bloom forming alga are present in the area and could have detrimental effects on fish-stock and human health (Hassoun et al. 2021, Rubino et al. 2017).

In general, turbulence, temperature, salinity, nutrient levels and other hydrographic properties should be monitored to assess the possible impact and frequency of harmful algal blooms (Abdenadher et al. 2012).

Based on the deliverable 10, The HCMR's AIM model was applied following mass balance calculations in the four selected areas and considering satellite mean monthly sea-surface temperatures data for the period (2015-2018). Three nested sub-models were used to estimate the impact of aquaculture wastes on the Cypriot marine ecosystem, in terms of good environmental status, using the model simulated outputs, by means of a Eutrophication Index (with PO_4, NO_3, NO_2, NH_4 in mmol/m^3 and Chl-a in mg/m^3) and the environmental scaling of <0.04 for very good, 0.04 - 0.38 as good, 0.38 - 0.85 for moderate, 0.85 - 1.51 for poor and > 1.51 for bad. The results showed that the effect from the fish farms is mainly visible during spring and autumn periods, characterized by relatively higher aquaculture wastes and relatively stronger stratification than the winter period. Environmental conditions during these periods appear good to moderate, even in the vicinity of the fish farms, suggesting that aquaculture wastes are effectively dispersed by ocean currents. The impact of open sea aquaculture at Xylofagou and Larnaca sites appears slightly stronger as compared to both Aphrodite's hills and Governor's beach areas. This may be probably attributed to the relatively weaker currents and the anti-cyclonic pattern in the more enclosed Larnaca bay.

Biofouling is a significant problem faced by most aquaculture projects. Biofouling can decrease the efficacy of materials and equipment, cause damage in the netting, reduce water exchange causing oxygen deprivation and accumulated wastes, lead to escapes of organisms, and compete with resources with cultured organisms, limit light availability and harbour pathogens for fish. However, it can be beneficial because it can be used as a water filter and extract pollutants and pathogens, precipitating suspended particles, providing food for fish, or increasing dissolved oxygen concentrations. Biofouling is dictated mostly by water's chemical and physical characteristics, such as temperature and current velocity. The rate varies on the mesh size of nets, water temperature, water velocity, and productivity of the site (Hincapie-Cardenas 2007).

3.4.5.2 Impact of anthropogenic waste disposal

In the marine area around all the aquaculture units, increased quantities of garbage can be observed (e.g. cans, food wrappers).

Furthermore, aquaculture and fishing nets, cage weights, and boat anchors have been observed from time to time, contributing to seabed pollution. According to the literature review of Kletou & Hall-Spencer (2012), in the case of waste made of plastic, they decompose into tiny plastic pieces, which absorb organic pollutants such as PCBs and PAHs DDTs, PBDEs, alkylphen and bisphenol A. Often, these particles are consumed by marine organisms thought to be food, with the result that the organisms absorb the organic pollutants while the plastic residues remain unbroken inside the organisms or even block their gastrointestinal tract causing even death. The scenario of anthropogenic waste affecting the aquaculture farms is somehow obscure since the location of the farms is not in the near vicinity.

Another impact is due to the vessels. During the construction project and in the operation stage of the fish unit, the movement of the vessels can be associated with the possible loss of fuel or oil from the vessel.

3.4.6 Ambient Noise Levels

3.4.6.1 Underwater anthropogenic noise

According to the "Maritime Strategy Law of 2010", underwater anthropogenic noise is a source of pollution. Scientific research into the study of underwater noise has begun relatively recently, and research to identify and record the environmental impact of underwater noise pollution is limited.

Data on the effects of underwater noise pollution on fish are minimal and concern very few fish species and different noise sources, making it impossible to correlate them and draw an overall conclusion for this area. In these few studies, each fish reacts differently to each noise source or noise frequency. The association of fish and noise refers to the level of noise pressure relative to the noise resistance of the fish, causing temporary or permanent hearing loss (Popper & Hastings, 2009).

Although there is no data so far on the underwater sounds as well as their effects on marine organisms in the AZAs, possible anthropogenic sources of underwater noise in these areas are a) the movement of boats and ships, b) the conduct of military drills from the navy, and c) refueling at terminals.

However, given the existing coastal shipping network (e.g. fishermen, aquaculture vessels, commercial and private vessels), the environmental impact is expected to be negligible.

In the Larnaka AZA area and less in Aphrodite Hills AZA, an extra noise source is the aeroplanes flying from and to the International Airports of Larnaka and Pafos respectively. In addition, as Larnaka AZA is near the Sea Shooting Range an extra source of noise is the noise produced by the military drills.

3.4.7 Fish Diseases & Deaths

Diseases in aquaculture species have been recorded in fish farms abroad, leading to high mortality of fish. Indicatively, in 1995, large losses were recorded in fish units produced seabream and seabass (Tsipoura-Lavraki) in Greece, which were due to the occurrence of viral encephalopathy (Le Breton et al., 1997). Infection outbreaks in marine organisms have been increasing and the increase in the practice in open ocean aquaculture (Harvell et al. 2004). Bacteria that are associated with disease in the species seabream and seabass , as well as parasites that these fish ingest, include, among others: *Listonella anguillara, Photobacterium damselae, Tenacibaculum maritimus, Pseudomonas sp., Streptococcus iniae, Mycobacterium marinum και Sparicotyle chrysophrii* (Toranzo, et al. 2005; Antonelli et al., 2010; Rigos & Katharios, 2010).

In addition, according to research by Fernandez-Jover et al. (2010), no transmission of parasites from these two aquaculture species to wild fish has been observed, which accumulate near the fish cages. In several cases, antibiotics are given to the fish to treat the disease.

In Cyprus, there have been no serious diseases in the farmed species seabream and seabass, , only isolated cases in which no medication was used, except for the removal and incineration of the infected fish in an authorized incinerator. The absence of serious diseases could be attributed to:

a. the environmental conditions of the marine environment (oligotrophic waters),
b. the location of the fish cages in the open sea and not in closed bays
c. the maintenance of small concentrations of fish and
d. the immediate recognition of the possible unforeseen death of the farmed fish and their removal from the maintenance team and the staff specializing in feeding the fish.

However, the authorities are immediately informed in extreme suspicion of any possible disease (Veterinary Services and Department of Fisheries and Marine Research).

The effects that could be caused will be mainly economic for the company itself and environmental through the possible contamination of water and causing diseases in wild populations if the disease is transmitted through water or if the dead fish are not collected from the fish in time.

3.4.8 Public Health and Safety

Impacts are recognized in the field of Public Health of the employees as a result of:

a. the safety of workers in plant processing facilities,
b. the compliance with ISO and hygiene in the process of processing products intended for human consumption,
c. the increase the availability of healthy differentiated products.
d. innovative energy-saving and waste treatment applications that have little impact on the environment

The compliance of health and safety standards, the rules of good practice, and ISO can lead to a harmonious coexistence of aquaculture with other users of the marine area (e.g. fishermen, tourism, etc.).

Public Health can also be benefited by providing high nutritional value products with improved quality and at affordable prices and by all the actions taken by the companies, the Veterinary and the Public Health Services.

3.4.9 Socio-economic Impacts

Contrary to what might be anticipated, the major influences of aquaculture toward the improvement of social well-being and equity are to be observed not in food security and income for poor producers, though these may be important for households involved in aquatic farming. Instead, they are to be found in ancillary service provision, and where aquaculture is deep, low-value species, commercially oriented and produces small in the enhanced provision of high-quality animal protein at low cost to consumers. Aquaculture generates employment for the poor, low-cost fish for domestic consumption on local markets and economic activity from selling high-value species in national and international markets. Advantages generated through the supply, processing and distribution chain can be substantial and significantly greater than those directly associated with farming.

Due to the concentration of productive activities in AZAs (sea and land), economies of scale in the production process are achieved, aiming at the operation of economically viable production schemes. It is also worth mentioning that the proposal for the establishment of AZAs aim to make the best use of available space and reduce the costs incurred by businesses to be deployed.

The proposed AZAs in Cyprus, will result in the strengthening and support of entrepreneurship, the increase of income, the securing of both the existing jobs in the existing facilities as well as new jobs and additional ones in the ancillary sectors related to their operation (e.g. supply of fuel, maintenance of equipment, etc.), ensuring the quality of products produced, through on-site standardization and promotion of local production, which increases its added value, as well as the competitiveness of the economy.

In the proposed AZAs, the safety of workers, facilities and livestock, the improvement of production conditions and protection of the aquatic environment will be achieved.

Table 17 below presents the existing and projected jobs in Open Sea, fish hatcheries and packaging units.

The calculation of permanent jobs in OS Aqua is based on the assumption that for a conventional HDPE cage unit with a capacity of 500 tons / year the minimum staff required is a total of 13.85 people (0.0277 people per tonne produced) while in larger units of 1,000 tons / year the minimum staff required amounts to a total of 24 people (0.024 people per ton produced).

Regarding the calculation of permanent jobs on land, for hatcheries the staff required is 5 people per million of fry with a capacity of up to 10 million fish. For a packaging plant, the staff required is about 5 people for every 1,000 tonnes packed.

As presented in the following table, a significant increase in the number of employees in the proposed AZAs is expected.

If in the four new AZAs, 5,000 tonnes per year will be produced, the hatcheries will need to produce 69 million fingerings for an additional capacity of 4 x 5,000 tonnes (i.e. 20,000 tonnes in total new production). If in this capacity, we will add the existing licenses of capacity of 9,000 tonnes, then the expected new employment is depicted in the following Table.

Table 17. Existing and Expected Jobs

		Existing positions (2019)	OS AQUA positions
On-growing units	**8,181 tonnes**	**196 FTE**	**696 FTE**
Packaging stations		**14 FTE**	**48 FTE**
Hatcheries	**19.02 million**	**95 FTE**	**445 FTE**

Administration - Support		**35 FTE**	**100 FTE**
Total		**340 FTE**	**1,289 FTE**

It is expected that 1,289 FTEs will be created if 4 AZAs of 5,000 tonnes each will be created (379.12% increase).

There is no doubt at present that Cyprus needs to continue with its prudent but steady expansion of marine aquaculture. First of all, given the present state of the fishing industry in Cyprus, the merging of local expertise and entrepreneurship with that of foreign know-how and technology is expected to increase the contribution of this sector to the Cypriot economy.

The motives for the expansion of the aquaculture sector with new developments as the ones proposed can be summarised as follows (Agius et al., 2006):

i. the favourable climate and seawater temperatures which ensure good growth rates for a wide variety of marine species

ii. the availability of good sites of a good working depth and at a reasonable distance from the coastline which should ensure manageable logistics and minimal environmental impact

iii. the presence of adequate water flushing into deeper waters in the vicinity which, together with attributes described in the previous point, should ensure the sustainability of the expanded volumes of farming

iv. it will enable Cyprus to retain its position among the lead countries in the Mediterranean basin in the field of offshore fish farming technology; Cyprus was a pioneer of such technology in the eighties

v. the presence of the necessary human resource skills, research facilities, investment capacity and appropriate infrastructure

vi. EU membership; in principle, the EU supports responsible and sustainable aquaculture development among its member states

vii. the opportunity to expand the domestic market

viii. Following the previous point, there is an opportunity to promote "a national product" as is happening in some other European countries such as Italy. This will have a positive impact on the trade deficit as well as on the quality of life as consumption of fresh fish will be replacing that of frozen product

ix. it will create new job opportunities at various levels with a possibility to retrain employees from the ever-shrinking fisheries sector if this is deemed necessary

x. it will enable Cyprus to exploit the current boom in tuna farming, and potential future opportunities in new species as the relevant technologies improve

xi. it will allow existing farms to improve their economies of scale and overall logistics of the operation

xii. it will encourage the production of processed aquaculture products; this will not only add value to the product but also promote the consumption of locally raised and processed products in a world where pre-packaged foods are gaining popularity with supermarket chains and the consumer

xiii. the proximity of the country to the Near and Middle East where the aquaculture industry is at its very beginnings, could offer greater opportunities both from the marketing and technology transfer perspectives.

As expected, some potential drawbacks have to be considered. The local authorities can resolve some of these in conjunction with the industry, given the means and the conviction to move ahead. Others are inherent to the country's particular situation and simply have to be accepted and built into the relevant equations, be the socio-economic, political or environmental.

The main considerations in this respect are summarised below (Agius et al., 2006).

i. relative isolation of the island and the consequent additional transport and communication costs
ii. being an island state with relatively limited sites, the potential for expansion on an international scale can be curtailed, making it difficult to compete on the export markets with much larger competitor countries
iii. sensitive environmental issues
iv. numerous competing users mainly tourism. Aquaculture growth can create conflicts between competing users and uses of land and water resources.

3.4.9.1 Gender relations

Aquaculture development may affect divisions of labour and access to resources between men and women. Culture plays a central role in determining appropriate gender roles in producing, processing, distributing, and marketing fish or other products. Women may gain additional responsibilities in production systems oriented toward household consumption or sales within the immediate community, while men may play a more central role in activities associated with producing goods destined for more distant commercial markets.

Since household expenditures in many rural cultures are the domain of women, increased availability of money may be used for household needs, improving the family's welfare.

3.4.9.2 Infrastructural development

Aquaculture development may also require physical and economic infrastructure, including roads and markets for inputs and products. Such roads may have important indirect consequences for local communities; opening up market channels of other goods from the community to wider markets; allowing the penetration of new commercial goods into previously isolated rural areas; improved access to labour markets, health care facilities; and educational opportunities for residents.

3.4.9.3 Food and Feed supply

Aquaculture contributes to the nutritional needs of a wide cross-section of human populations. While in some areas fish is the only affordable source of animal protein available to the poor in others, such as Europe, it is generally a high value product. Small-scale aquaculture generates food for the producer's household and immediate community, thus contributing to social resilience. Aquaculture is an increasingly important source of high-quality animal protein for direct human consumption. When aquaculture production is geared towards national urban and international markets, local people earn sufficient incomes to purchase foods produced elsewhere.

Feed sustainability largely depends on managing the small pelagic fisheries that provide the fish meal (Benetti et al., 2006). Such fisheries may not essentially be stable and may become overexploited due to the cultivation of unnaturally high populations of a top predator. Fish waste is generally a function of metabolic processes, feed coefficient, feed composition, feed wastage, and fish species and volume (Islam 2004). Therefore, these factors need to be considered when developing feed composition. It is recommended to use high-quality feeds with high digestibility and assimilation coefficients (Alston et al. 2005). High-quality feeds are designed for low nitrogen excretion rates, beneficial to the environment. Fish meal costs are increasing over time due to declining fish stocks. Therefore, much research is going into developing feeds with less expensive protein sources and higher feeding efficiency. Feedstock without fish protein may remain in the environment for more time. However, this remains further investigated (Bert 2007).

3.4.9.4 Balances in wealth, income, and power

An ecological approach to aquaculture must consider the distribution of direct and indirect costs and benefits within society as aquaculture development can adversely impact community resilience by leading to increased social and economic disparities. This is especially so if it leads to inequality in wealth and income, mainly if such economic inequality is used to establish political power and make rigid class distinctions. Both local elites and urban entrepreneurs, built fortunes based on exports, leaving the bulk of the coastal population worse off relatively and absolutely. People who become marginalized will resort to increasingly desperate means of survival, including destructive farming or fishing activities that undermine biophysical resiliency. Where monopolistic or oligopolistic markets exist or corrupt political systems set policies and issue permits, producers can be vulnerable to forces beyond their control.

3.4.9.5 Fish escapes

The escape of fish from the fish cages may be due to: a) destruction of the nets due to natural factors (e.g. creation of small openings in the nets through which the fish could escape), b) accidents during the fishing process, and c) destruction of nets and cages by malicious intent or accident. Due to the durability of the net material and with a daily inspection and repair of the fish cages by a maintenance team, the possibility of fish escaping due to the destruction of nets by natural causes is negligible. The possibility of fish escaping as a result of accidents in catching fish is also considered negligible if the personnel is trained in the process of catching fish. Finally, regarding the escape of juveniles due to malicious actions, this kind of event may cause unbearable financial consequences. For example, in 2012, an aquaculture company of Cyprus was sabotaged by strangers who cut the fish cages of the company, as a result of which 70 tons of sea bream escaped into the marine environment and the financial consequences, in this case, were particularly unbearable for the company. The escaped sea bream was caught by professional and amateur fishermen (including people fishing with reeds and spearguns), who benefited positively (and economically).

The risk of escapes can be avoided by the installation of innovative technology and durable infrastructure. Attacks by predators can be avoided by routine clean-ups of dead fish.. In addition, the risk can be accounted for through the financial plan. Therefore, this risk is negligible as long as proper procedures are followed.

3.4.9.6 Tourism

Potential effects on tourism could occur in case of:

a. significant aesthetic pollution. However, the proposed AZAs are located in more distance and deeper waters than all other aquaculture units
b. bathing water pollution from poor water due to aquaculture waste including dead fish which may be washed up on the beaches due to improper collection and incineration of dead fish.

Given the existing legislations and directives and the implementation of good aquaculture practices and environmental monitoring, it is expected that there will be a harmonious coexistence of tourism and aquaculture.

It is noted that in Cyprus, no disturbances have been observed on bathing or tourist areas, even on beaches located near fish farms such as the Governor's Blue Flag Beach (opposite Governor’s Beach AZA).

3.4.9.7 Fisheries

Based on the existing legislation and the "Aquaculture (General) Regulations, 2002 (P.I. 533/2002)", fishing is prohibited 100m around the perimeter of the aquaculture farms. In the areas of the units, there is a concentration of large numbers of wild populations due to the excess food around the cages. This contributes to the increase of catches (Giannoulaki et al., 2005). Many amateur fishermen, especially on weekends, gather around the fish cages to catch commercial species. Therefore, it is expected that fisheries and open sea aquaculture could harmoniously coexist.

Social and environmental impact description of optimal sites for aquaculture development

The tables **Error! Reference source not found.**Table 19below present the environmental and socioeconomic impact, for the construction (**Error! Reference source not found.**) and operation (Table 19) stages.

Table 18. Impact Identification during the Construction Phase (low (-) medium (=) and high negative impact (≡); low (+) medium (++) and high positive (+++) impact. No impact is signified by (o) from OS to the Environment and the Socioeconomy and vice versa

Parameter	Construction Phase	Xylofagou AZA	Larnaka AZA	Governor's Beach AZA	Aphrodite Hills AZA
	Environmental Impacts	**Weight Assignment**			
Destruction of Flora and Displacement of Fauna	Stage 1:				
	No impact	o	o	o	o
	Stage 2:				
	Changes in the structure of the benthic macro fauna.	-	-	-	-
	Fish Escapes	-	-	-	-
	Stage 3: No impact	o	o	o	o
Ambient Air Quality	Stage 1:				
	Presence of dust caused during construction works,	-	-	-	-
	Exhaust gases from the use of the necessary machinery and equipment	-	-	-	-
	Stage 2:				
	Exhaust gases emissions from the vessels used from transportation	-	-	-	-
	Stage 3:				
	No impact	o	o	o	o
Ambient Noise Levels	Stage 1:				
	increase the ambient noise levels from the use of the necessary machinery and equipment	-	-	-	-
	Stages 2 & 3:				
	Local increase in the underwater noise levels as a result of operational procedures of the vessel	-	-	-	-

Site Topography	Stage 1: The in-land facilities construction will change the topography	-	-	-	-
Occupational Accidents	In all stages, occupational accidents may occur if not all precautions are taken and if the personnel are not specialized and qualified.	-	-	-	-
Public Safety	Public safety might be affected in all stages if not all counter-measures are taken.	-	-	-	-
	Socioeconomic Impacts	**Weight Assignment**			
	Stages 1-3: New job opportunities at various levels	+++	+++	+++	+++
	Retrain employees from the ever shrinking fisheries sector	+++	+++	+++	+++
	Development of human resource skills, research facilities, investment capacity and appropriate infrastructure	+++	+++	+++	+++
	Stage 2: Fish escapes will have negative economic impact on the companies but a positive impact on professional and amateur fishermen	= ++	= ++	= ++	= ++

Table 19. Impact Identification during the Operational Phase (low (-) medium (=) and high negative impact (≡); low (+) medium (++) and high positive (+++) impact. No impact is signified by (o) from OS to the Environment and the Socioeconmy and vice versa

Parameter	Operational Phase	Xylofagou AZA	Larnaka AZA	Governor's Beach AZA	Aphrodite Hills AZA
	Environmental Impacts	**Weight Assignment**			
Site Hydrology	The infrastructure can impact hydro-morphological elements such as hydrology/typology- flow rates, wave exposure and habitat. No impact	o	o	o	o
Status of Aquatic Flora and Fauna	<u>Impact on Biodiversity:</u> Changes in the structure of the benthic macro fauna.	-	-	-	-
	Mortality of large fauna,	-	-	-	-
	Effects on sea-grass meadows	-	-	-	-
	Changes in the trophic status of large water bodies.	-	-	-	-
	Transmission of diseases to wild populations	-	-	-	-
	<u>Eutrophication</u> (based on D10) Seaweed proliferation	=	=	-	-
		++	++	++	++
	<u>Impact on benthic animals</u> Decrease in benthic diversity, since small body-sized opportunistic species mainly inhabit the seabed	-	-	-	-
	Increase in the biomass of megabenthos	-	-	-	-
Sediment	Changes in sediment and benthic societies in sediment	-	-	-	-
	De-oxygenation of the water column and smothering of the seabed	-	-	-	-

Water quality Waste Generation	Ammonia and dissolved phosphorus as aquaculture wastes (see D10 and D11)	=	=	-	-
	Induction of phytoplankton blooms (See D10 and D11)	=	=	-	-
	Deterioration in the water quality near the fish farm (reduced oxygen levels, water transparencies, increased total bacterial counts)	-	-	-	-
	Local pollution from (garbage, nets, loss of fuel/oil from vessels etc.)	-	-	-	-
	Wild fish populations consume significant percentage of food residues,the wild fish consumes uneaten pellets and they will not leach nutrients to the environment.	++	++	++	++
	Increased anthropogenic waste disposal (eg cans, food wrappers, plastic, fishing nets)	-	-	-	-
Ambient Noise Levels	Increase of noise and vibration from the existing levels in a marine environment due to the movement of vessels which will impact the OS and not vice versa	-	-	-	-
	Increase noise levels to existing levels in terrestrial environment due to vehicle traffic	-	-	-	-
	Increase noise levels due to air traffic	=	=	-	-
	Increase noise levels due to the military drills	-	=	-	-
Fish Diseases & Deaths	Bacteria that are associated with diseases	-	-	-	-
	Parasites that are ingested by fish	-	-	-	-
	Socioeconomic Impacts	**Weight Assignment**			
Economic	The favourable climate and seawater temperatures ensure good growth rates for a wide variety of marine species	++	++	++	++
	The availability of good sites of a good working depth and at a reasonable distance from the coastline should ensure manageable logistics and minimal environmental impact	++	++	++	++
	The presence of adequate water flushing into deeper waters in the vicinity, together with attributes described in the previous point,	++	++	++	++

	should ensure the sustainability of the expanded volumes of farming				
	It will enable Cyprus to retain its position among the lead countries in the Mediterranean basin in the field of offshore fish farming technology	++	++	++	++
	The presence of the necessary human resource skills, research facilities, investment capacity and appropriate infrastructure	++	++	++	++
	EU membership; in principle, the EU supports responsible and sustainable aquaculture development among its member states	++	++	++	++
	Opportunity to expand the domestic market	++	++	++	++
	Opportunity to promote “a national product” This will have a positive impact on the trade deficit as well as on the quality of life as consumption of fresh fish will be replacing that of frozen product	++	++	++	++
	New job opportunities at various levels with a possibility to retrain employees from the ever shrinking fisheries sector if this is deemed necessary	++	++	++	++
	Enable Cyprus to exploit the current boom in tuna farming, and potential future opportunities in new species as the relevant technologies improve	++	++	++	++
	Existing farms will improve their economy of scale and overall logistics of the operation	++	++	++	++
	it will encourage the production of processed aquaculture products; this will not only add value to the product but also promote the consumption of locally raised and processed product	++	++	++	++
	the proximity of the country to the Near and Middle East could offer greater opportunities both from the marketing and technology transfer perspectives	++	++	++	++
	Increased competition	=	=	=	=
	Relative isolation of the island and the consequent additional transport and communication costs	=	=	=	=
	Being an island state with relatively limited sites, the potential for expansion on an international scale can be curtailed making it difficult to compete on the export markets with much larger competitor countries	=	=	=	=

Occupational, Public Health and Safety	<u>Public Health:</u> Compliance with ISO and hygiene in the process of processing products intended for human consumption,	-	-	-	-
	Increase the availability of healthy differentiated products.	++	++	++	++
	High nutritional value products with improved quality at affordable prices	+	+	+	+
	<u>Safety</u> Safety of workers in plant processing facilities,	-	-	-	-
	The compliance of health and safety standards, the rules of good practice and ISO can lead to a harmonious coexistence of aquaculture with other users of the marine area	++	++	++	++
Gender relations	Divisions of labour and access to resources between men and women	+	+	+	+
Infrastructural development & Transportation	Requirement for physical and economic infrastructure including roads and markets for both inputs and products –higher CAPEX	++	++	++	++
	Increased boat traffic in the area.	=	=	=	=
	Port infrastructure.	++	++	++	++
Food and Feed supply	Aquaculture contributes towards the nutritional needs of a wide cross section of human populations	++	++	++	++
	When aquaculture production is geared towards national urban and international markets, local people earn incomes sufficient to purchase foods produced elsewhere.	+	+	+	+
	Feed costs increase over time	=	=	=	=
Wealth, income, and power	Effects on community resilience by leading to increased social and economic disparities	=	=	=	=
Fish escapes & Fishery	Negative Economic impact on aquaculture companies	-	-	-	-
	Increase in catches by fishermen	++	++	++	++
Tourism	Aesthetic pollution.	-	-	-	-
	Water quality impact for swimming activities.	-	-	-	-
Fishery	Fishing is prohibited 100m around the perimeter of the aquaculture farms	++	++	++	++

4 Conclusions and Recommendations

This section concludes on the outcomes of the identified socioeconomic and environmental impacts of the selected sites for the OS aquaculture development and outlines a number of recommendations.

Impacts vary with species, farming methods and management techniques, precise location and local environmental conditions and wildlife. They can be prevented, minimised or mitigated by the adoption of appropriate environmental safeguards, including regulatory, control and monitoring procedures. Regulatory good practices and suggestions are included in the EU Communication of 2016, "On the application of the Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD) in relation to aquaculture" (COM,2016).In terms of the identified environmental impacts, only aquaculture wastes can potentially affect the environment as was showcased by simulations (see D10 and D11). The impact of the existing fish farm wastes is mainly visible during spring and autumn periods, characterized by relatively higher aquaculture wastes. Environmental conditions during these periods appear good to moderate, even in the vicinity of the fish farms, suggesting that aquaculture wastes are relatively low and effectively dispersed by ocean currents. Changes in the food web structure are mainly characterized by an increase of dinoflagellates in the surroundings of fish farms that are generally considered an indicator for eutrophication. This increase was higher in the western bay (Akrotiri) of the area, which was only visible with the combination of 3,000 tonnes in Larnaca and 5,000 tonnes in Xylofagou indicating that the carrying capacity of the marine habitat in these areas allows only smaller production volumes. The rest of the identified environmental impacts were found to have a minimal effect.

According to the socioeconomic impacts, medium/ moderate effects were identified due to the increased competition, the relative isolation of the island and the consequent additional transport and communication costs, the fact that Cyprus is an island state with relatively limited sites and the potential for expansion on an international scale can be curtailed making it difficult to compete on the export markets with much larger competitor countries and finally on the fact that fish meal is becoming more expensive over time due to declining fish stocks.

The remaining of the identified impacts, whether they were environmental or socioeconomic, pose low negative impact or, in many cases, exhibit a positive effect. It is noted that this deliverable performs solely a description of the current state of the environment and the socioeconomic characteristics of the selected zones that are expected to be affected by the implementation of the aquaculture development.

As a final remark, further research is required to determine the effects of the OS aquaculture operations. Scientific evidence should continue to play a significant role in this industry, advising best practices and developing viable solutions to environmental problems. It is thus recommended to install a pilot module at the selected areas in Cyprus followed by seasonal site surveys and monitoring. As the sector develops further, it must consider how to constantly improve its environmental sustainability; this is fundamental for the long-term economic sustainability of aquaculture and our food security. In the long term, the ultimate aim is to commercialize a pilot design that is truly useful, scientifically robust and fit-for-purpose. This ambition is based on the excellent relationships we have acquired with stakeholders during this project and a thorough understanding of stakeholder's emerging challenges.

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