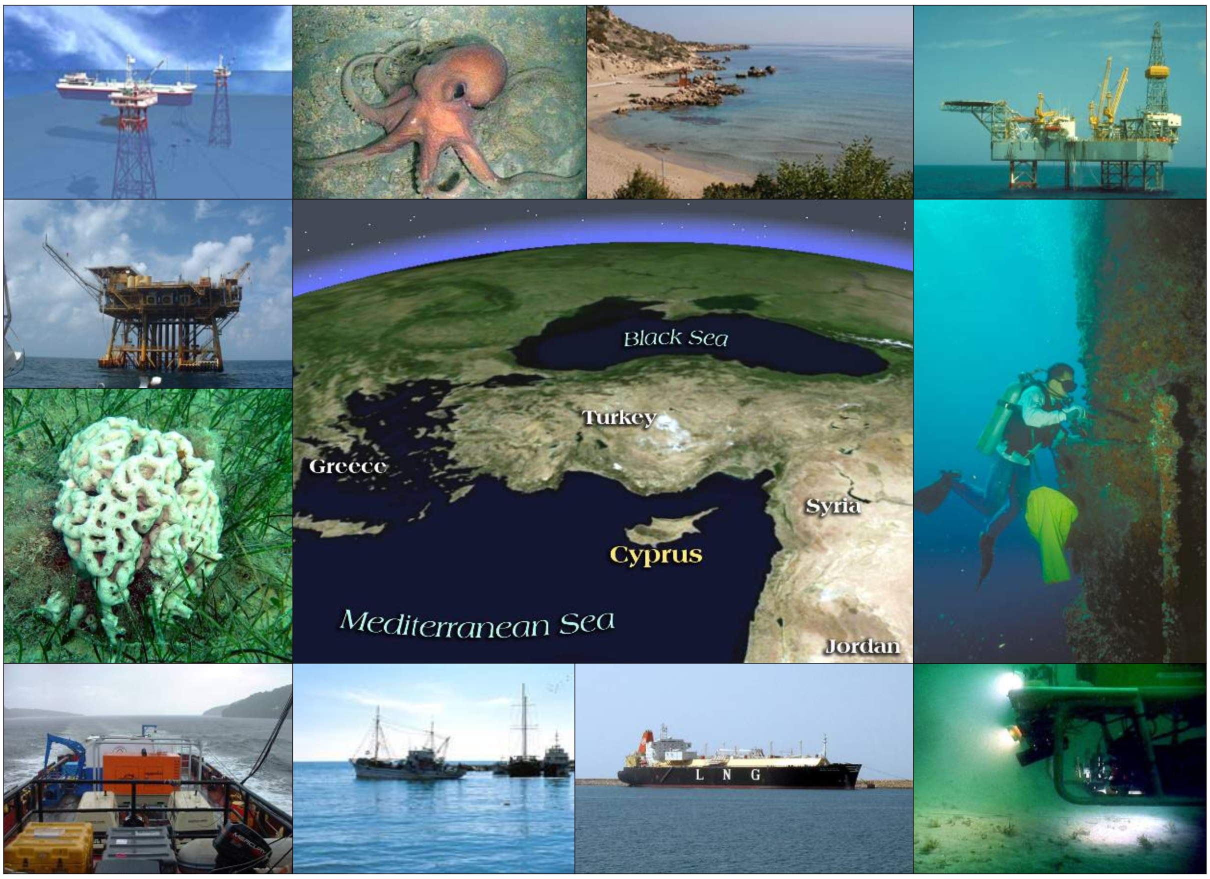
Contract Number (MCIT/ES/13/2007)

Environmental Report

(Chapters 1-3)

Strategic Environmental Assessment (SEA) Concerning Hydrocarbon Activities within the Exclusive Economic Zone of the Republic of Cyprus

15 November 2008



Prepared for:

Ministry of Commerce,
Industry and Tourism of the Republic of Cyprus

Prepared by the Consortium of:

Maritime Communication Services, Inc. | Aeoliki Ltd. | CSA International, Inc.

In Cooperation with:

University of Cyprus Oceanographic Centre

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Strategic Environmental Assessment (SEA) Concerning Hydrocarbon Activities within the Exclusive Economic Zone of the Republic of Cyprus

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List of Acronyms

AW	Atlantic Water
CMS	Convention on the Conservation of Migratory Species of Wild Animals
CPA	Cyprus Port Authority
CTO	Cypriot Tourism Organisation
CYCOFOS	Cyprus Coastal Ocean Forecasting and Observation System
DFMR	Department of Fisheries and Marine Research
DMS	dimethylsulfide
EEZ	Exclusive Economic Zone
EIA	environmental impact assessment
EMDW	Eastern Mediterranean Deep Water
FAO	Food and Agriculture Organization
FCCC	Framework Convention on Climate Change
GDP	Gross Domestic Product
GEBCO	General Bathymetric Chart of the Oceans
GFCM	General Fisheries Council for the Mediterranean
GMR	Greater Mediterranean Region
HERMES	Hotspot Ecosystems Research on the Margins of European Seas
IBA	Important Bird Areas
ICCAT	International Commission on the Conservation of Atlantic Tunas
IMCAM	Integrated Marine and Coastal Area Management
ITCZ	Inter-Tropical Convergence Zone
LIW	Levantine Intermediate Water
LSW	Levantine Surface Water
MBL	Marine Boundary Layer
MECAPIP	Mesometeorological Cycles of Air Pollution in the Iberian Peninsula
MEDUSE	Monitoring and Prediction of the Atmospheric Transport and Deposition of Desert Dust in the Mediterranean Region
MFS	Mediterranean Forecast System
MMJ	Mid-Mediterranean Jet
MPA	Marine Protected Area
NOAA	National Oceanic and Atmospheric Administration
NO_x	nitrogen oxide
ODP	Ocean Drilling Programme
PM	particulate matter
POEM	Physical Oceanography of the Eastern Mediterranean
REMPEC	Regional Marine Pollution Emergency Response Centre
RES	renewable energy sources
SAC	Special Area of Conservation
SCI	Site of Community Importance
SCMEE	Sub-committee on Marine Environment and Ecosystems
SEA	Strategic Environmental Assessment
SECAP	South European Cycles of Air Pollution
SST	sea surface temperature
T-S	temperature-salinity
T-TRAPEM	Transport and Transformation of Air Pollutants from Europe to the Mediterranean Region
TWT	two-way-time
UNCLOS	United Nations Law of the Sea Convention
VOC	volatile organic compound
XBT	expendable bathythermograph

Chapter 1
Non-Technical Summary

1.1 INTRODUCTION

This Environmental Report presents the findings of a Strategic Environmental Assessment (SEA) of the hydrocarbon licensing programme within the Exclusive Economic Zone (EEZ) of the Republic of Cyprus. The Ministry of Commerce, Industry and Tourism initiated the SEA to ensure environmental protection and sustainable development. The SEA was conducted in accordance with the Assessment of Impact on the Environment from Certain Plans and/or Programmes Law (No. 102(I)/2005), which is harmonised with Directive 2001/42/EC of the European Parliament and of the Council. It was prepared by a consortium consisting of Marine Communication Services, Inc. (MCI), Aeoliki Ltd., and CSA International, Inc. (CSA) in cooperation with the University of Cyprus Oceanographic Centre.

The licence area lies within the EEZ of the Republic of Cyprus and consists of 13 blocks, of which 11 were included in the 1st Licensing Round in 2007 (**Figure 1.1**). The total area is about 51 000 km^2. Individual blocks range in area from 1436 to 5728 km^2 and are 11 to 178 km from Cyprus. Water depths range from 248 to 2866 m.

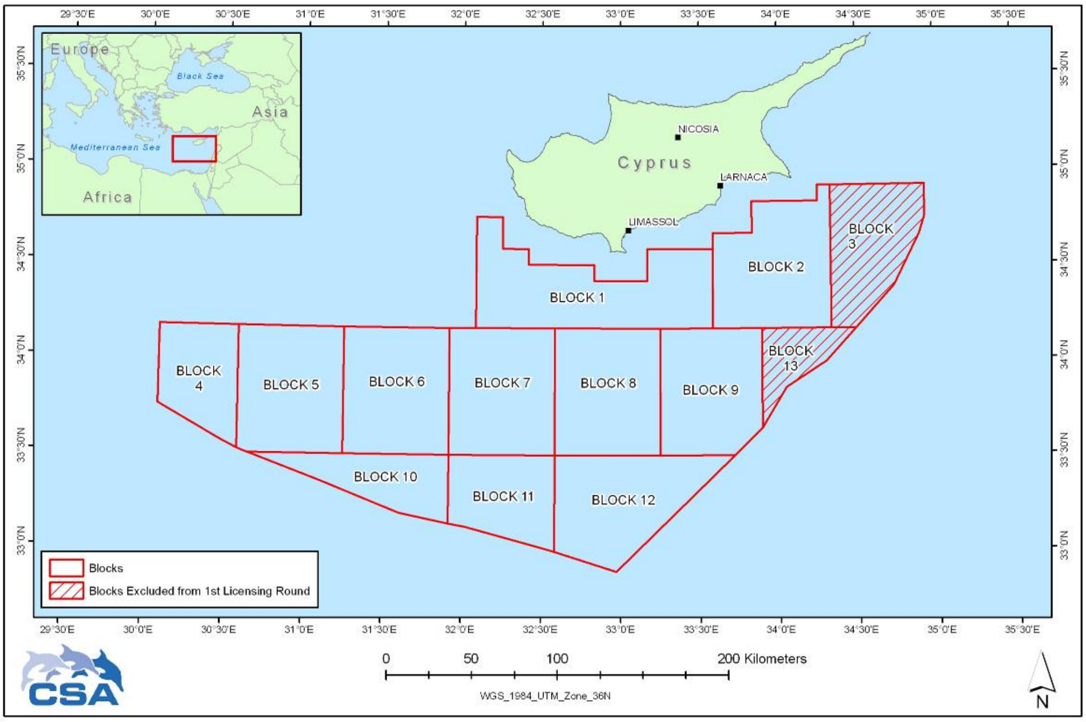


Figure 1.1. Location of the Cyprus Exclusive Economic Zone considered for hydrocarbon licensing.

According to Directive 2001/42/EC, the purpose of an SEA is to identify, describe, and evaluate the "likely significant environmental effects of implementing the plan or programme, and reasonable alternatives taking into account the objectives and the geographical scope of the plan or programme." Because this is a new area for hydrocarbon activities, there is no detailed scenario for development. Accordingly, the SEA focuses broadly on those activities most likely to result from the licensing programme, including prospecting, exploration, and exploitation. It is expected that detailed, specific Environmental Impact Assessments (EIAs) will be prepared for individual projects.

Specific objectives of the SEA are as follows:

- Describe the suite of hydrocarbon activities that may reasonably be expected to occur in the licensing area;
- Describe existing control measures governing hydrocarbon activities;
- Summarise existing environmental information and describe the baseline environment;
- Identify potential environmental effects of hydrocarbon activities and evaluate those likely to be significant;
- Recommend additional management and monitoring measures where necessary to ensure environmental protection and sustainable use of resources; and
- Identify data gaps and shortcomings in the existing information that could be remedied by further study.

The SEA process included a review of the legal and regulatory context for offshore hydrocarbon activities in the Republic of Cyprus licence area; a literature search for environmental baseline information; an evaluation of likely hydrocarbon activities based on the location, environmental characteristics, and nearby industry operations; an analysis of potential environmental effects; and development of recommendations for additional management and monitoring.

1.2 LICENSING PROGRAMME AND REGULATORY CONTEXT

The Republic of Cyprus has recently revised its legal framework in order to fully harmonise it with Directive 94/22/EC of the European Parliament and of the Council of 30 May 1994 on conditions for granting and using authorisations for the prospection, exploration, and production of hydrocarbons. Hydrocarbon activities in Cyprus are governed by the following legislation:

- The Hydrocarbons (Prospecting, Exploration, and Exploitation) Law, No. 4(I) of 2007 – subsequently referred to as the Hydrocarbons Law of 2007.
- The Hydrocarbons (Prospecting, Exploration, and Exploitation) Regulations of 2007 – subsequently referred to as the Hydrocarbons Regulations of 2007.

Under the Hydrocarbons Law of 2007, three types of hydrocarbon licences can be issued: Prospecting, Exploration, and Exploitation (**Table 1.1**).

Table 1.1. Types of licences for offshore hydrocarbon activities.

Type of Licence	How/When Issued	Characteristics
Prospecting	• As determined necessary by the Ministry of Commerce, Industry and Tourism	• Granted for up to 1 year • For evaluation of hydrocarbon potential by identifying geological structures • Includes gravity and magnetic surveys as well as seismic surveys; no drilling
Exploration	• Through Licensing Rounds open to qualified bidders	• Granted for 3 years; possibility for two renewals of 2 years each • Includes gravity and magnetic surveys, seismic surveys, and exploration drilling • On each renewal, 25% of the initial licence area is relinquished
Exploitation	• In the event of a discovery, an entity operating under an Exploration Licence has the right to be granted an Exploitation Licence for that discovery	• Granted for an initial period of up to 25 years after the approval of a development and production plan; possibility for one renewal of up to 10 years

Other relevant legislation includes the Contiguous Zone Law (63(I) of 2004) and the Exclusive Economic Zone Law (64(I) of 2004), which define the boundaries of the nation's contiguous zone and EEZ, respectively. In addition, Cyprus has signed bilateral agreements with Egypt (2003) and Lebanon (2007) delimiting the EEZ between these countries.

Cyprus is party to a number of international conventions and protocols, including MARPOL and the Barcelona Convention. Under the Barcelona Convention, there is an offshore protocol specifying control measures for hydrocarbon exploration and exploitation. This protocol was adopted on 14 October 1994 in Madrid; although Cyprus has signed and ratified the protocol, it has not yet entered into force because it has not been ratified by the requisite number of Parties.

1.3 GENERAL DESCRIPTION OF STUDY AREA

The Environmental Report includes a description of the current state of knowledge of the region covered by the hydrocarbon licensing programme. The affected environment is divided into the physical, biological, and socioeconomic environments of the Republic of Cyprus.

The physical environment consists of the meteorological and oceanographic conditions in the lease area, the characteristics of the sea floor (**Figure 1.2**), and the existing acoustic environment.

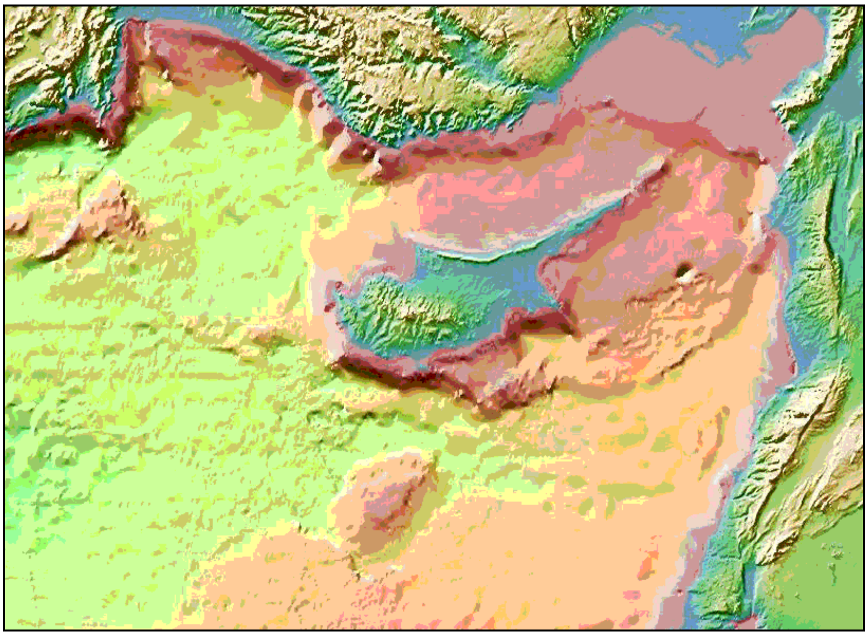


Figure 1.2. Morphobathymetry of the Eastern Mediterranean Sea including Cyprus and the Eratosthenes Seamount (Scripps Institution of Oceanography, 2008).

The biological environment within the licence area includes the following living elements:

- Marine plankton, including both phytoplankton (flora), which form the base of the food chain, and zooplankton (fauna), which link phytoplankton to fish production;

- Benthos, which refers to the animals (benthic fauna) and plants (benthic flora) that are found on, in or near the seabed;

- Nekton, which includes all the animals, but primarily fish species, found in the waters of the study area;

- Marine birds or sea birds, with particular attention to those species specifically noted in the Barcelona Convention Action Plan for Sea Birds;
- Marine mammals, sea turtles, and other protected or endangered species; and
- Areas of special concern such as Marine Protected Areas (MPAs), the Eratosthenes Seamount, and possible chemosynthetic communities.

Key marine environmental characteristics of the region include high salinity and temperature in surface waters as compared with the rest of the Mediterranean, a very low concentration of nutrients, and low productivity.

The socioeconomic environment discussions provide an overview of the main socioeconomic features relevant to the coastal area of Cyprus that may be affected by hydrocarbon activities. Economic resources reviewed are as follows:

- Commercial and recreational fisheries;
- Aquaculture;
- Shipping and marine operations including ports and oil terminals (**Figure 1.3**);
- Telecommunications, specifically submarine cable systems;
- Recreation and tourism; and
- Archaeological resources, antiquities, and cultural heritage.

Figure 1.3. Major Cyprus ports and oil terminals.

1.4 IMPACT ASSESSMENT

For this assessment, three phases of offshore hydrocarbon activities are recognised:

- **Prospecting** – activities to locate hydrocarbons and/or evaluate hydrocarbon potential by methods other than drilling. Prospecting includes seismic surveys, geological and geochemical sampling, electromagnetic surveys, and remote sensing.

- **Exploration** – the process of drilling one or more exploratory wells in a block to determine whether commercially exploitable hydrocarbons are present.

- **Exploitation (development and production)** – the process of exploiting commercial quantities of hydrocarbons. Key activities include drilling of development wells, installation of production facilities, installation of export facilities such as pipelines, routine operation of these systems, and eventual decommissioning.

Potential effects were evaluated by considering the "impact factors" (causes or sources) involved in each phase of hydrocarbon activities (**Table 1.2**).

Table 1.2. Impact factors for phases of offshore hydrocarbon activities.

Prospecting	Exploration	Exploitation
• Airgun noise • Vessel traffic and towed streamers • Effluent discharges • Air pollutant emissions • Sea floor disturbance	• Drilling rig installation and removal • Drilling rig presence • Drilling discharges • Other effluent discharges • Marine debris • Air pollutant emissions • Well testing • Support activities	• Facility installation • Presence of structures • Drilling discharges • Operational discharges • Marine debris • Air pollutant emissions • Support activities • Structure removal

Examples of important impact factors include airgun noise during seismic surveys (**Figure 1.4**), drilling fluids and cuttings discharges during exploration and exploitation (**Figure 1.5**), and placement of production facilities on the sea floor (**Figure 1.6**).

Table 1.3 summarises potential effects of offshore hydrocarbon activities in the licence area. The effects are grouped by phase (prospecting, exploration, and exploitation), followed by a separate listing for accidents. Within each phase, effects are organised by the impact factors identified for that phase. The table lists existing control measures and, for potentially significant effects, any additional mitigation measures recommended.

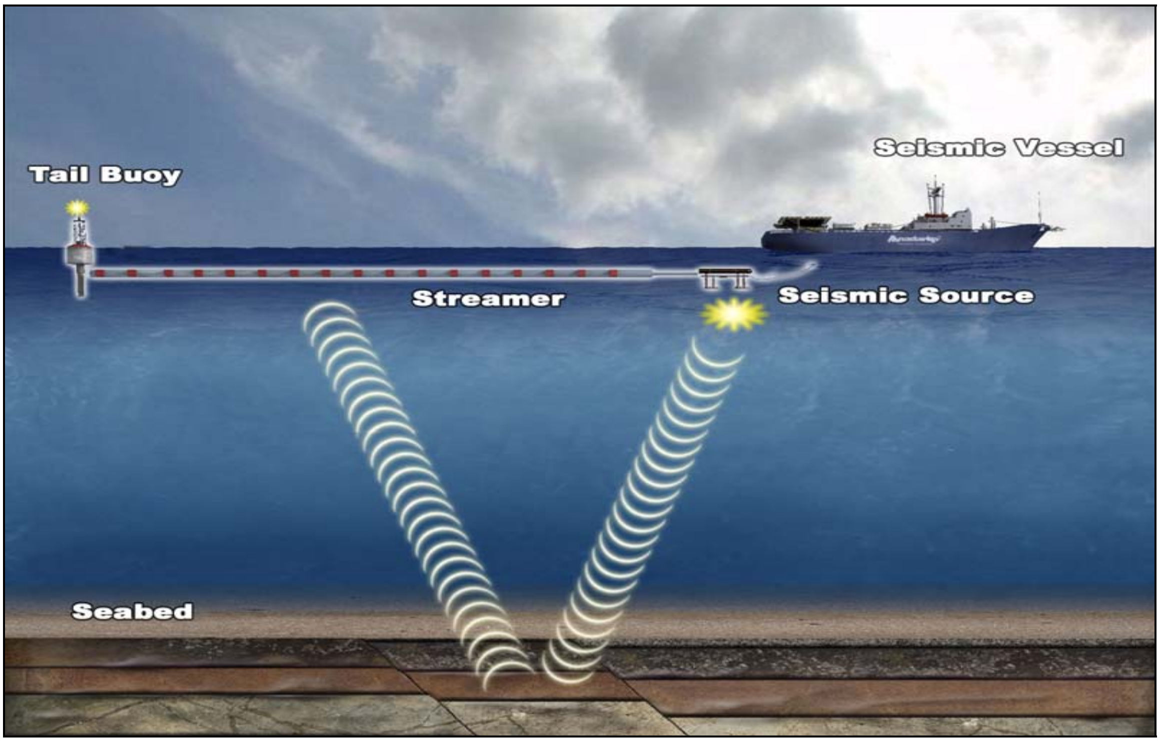


Figure 1.4. Illustration of a survey vessel towing a seismic source (airgun array) and streamers with underwater hydrophones. Equipment may extend 3 to 12 km behind the vessel.

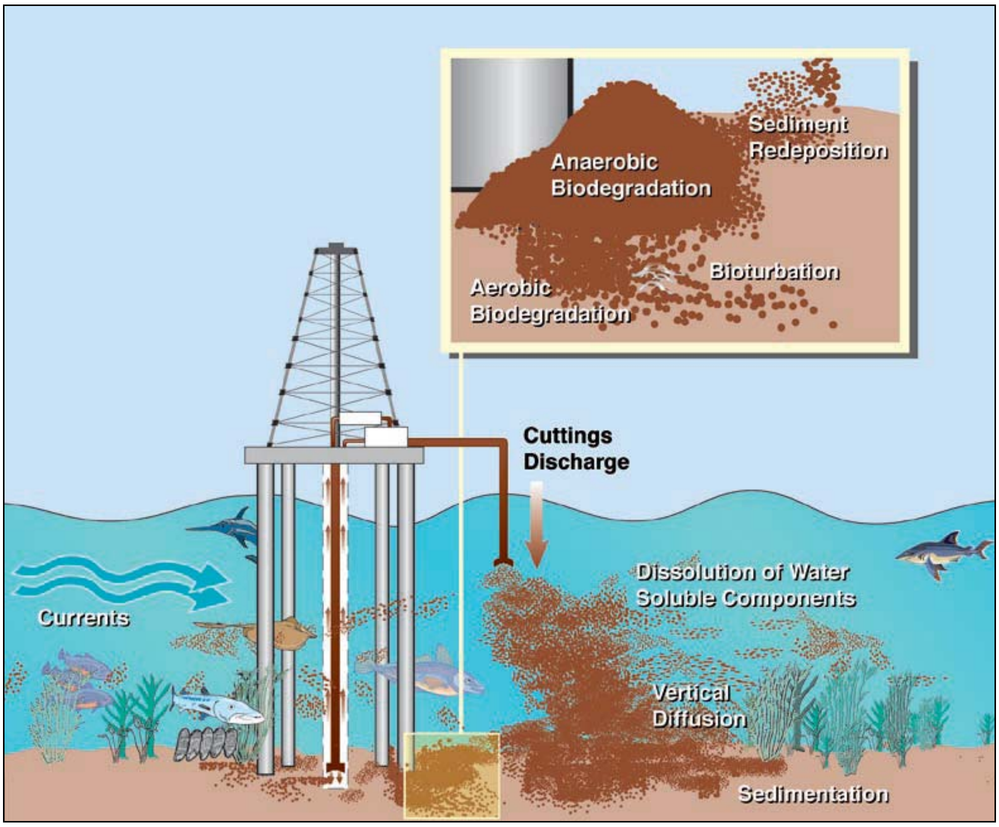


Figure 1.5. Fate of drilling discharges during exploration or exploitation (From: International Association of Oil & Gas Producers [OGP], 2003).

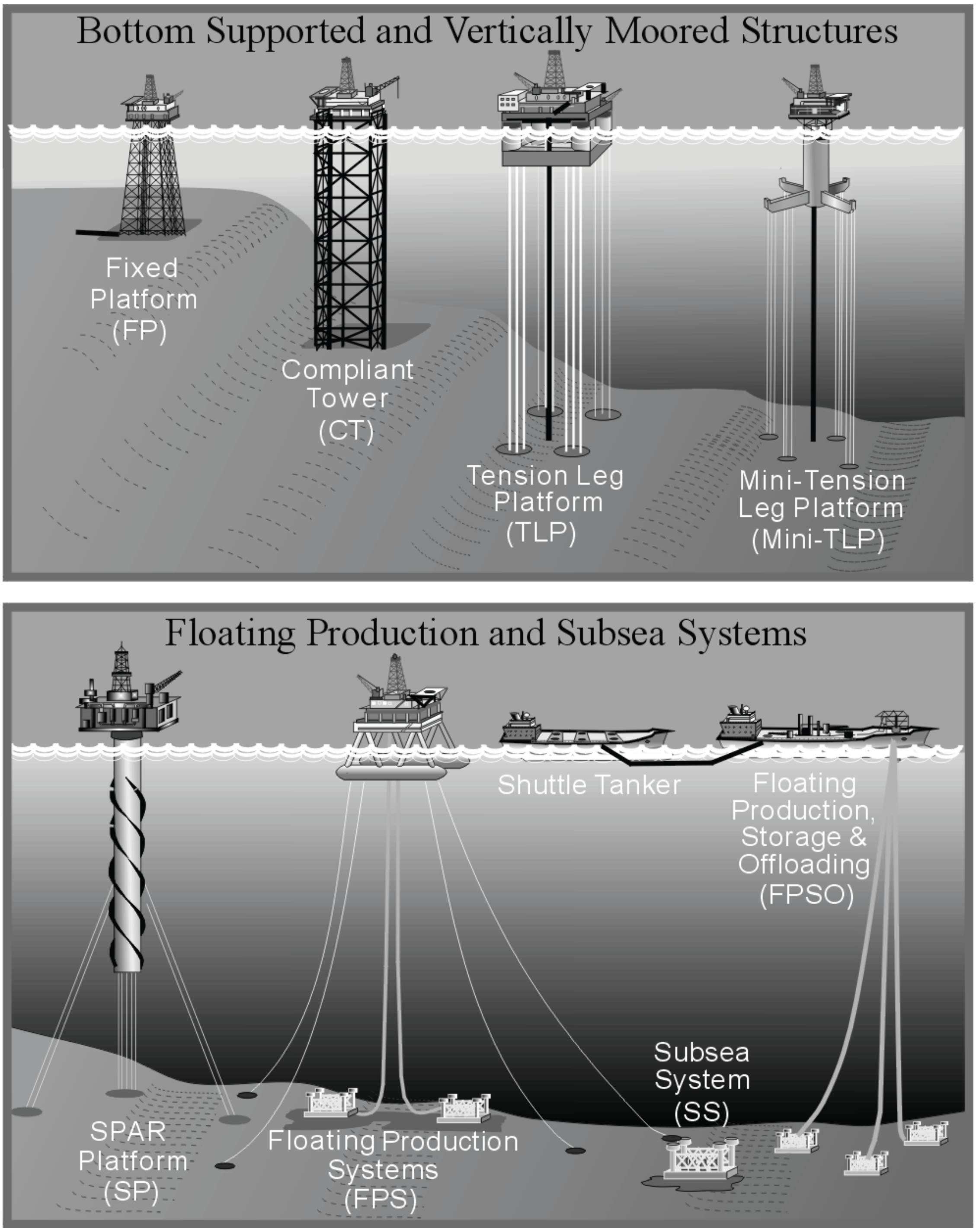


Figure 1.6. Types of deepwater development and production systems (From: Regg et al., 2000).

Table 1.3. Potential effects from offshore hydrocarbon activities in the licence area of the Republic of Cyprus.

Impact Factor	Potentially Significant Effects	Minor or Negligible Effects	Existing Control Measures Identified	Additional Mitigation Recommended
Prospecting				
Airgun noise	• Auditory trauma to marine mammals and sea turtles (including endangered, critically endangered, and vulnerable species)	• Disturbance of fishes, plankton, other organisms	• None	• Require licensees to implement a protocol to reduce the risk of auditory trauma to marine mammals and sea turtles. The protocol should include at a minimum, provisions for soft start, visual monitoring, and shutdown of the array
Vessel traffic and towed streamers	• Potential conflicts with fishing or shipping activities (e.g., temporary exclusion from certain areas, gear damage or entanglement)	• Small risk of vessels striking a marine mammal or sea turtle	• Hydrocarbon Regulations of 2007 require licensees to conduct operations in an environmentally acceptable and safe manner. It is assumed that licensees would notify Cyprus maritime authorities of survey location and schedule. Also, it is assumed that survey vessels would use appropriate signals in accordance with International Maritime Law	• Require licensees to consult with stakeholders prior to conducting streamer surveys to ensure that conflicts with fishing and shipping activities are minimised
Effluent discharges	• None	• Minor impacts on water quality similar to existing vessels in region	• MARPOL compliance	• None
Air pollutant emissions	• None	• Minor impacts on air quality similar to existing vessel and aircraft traffic in region	• MARPOL compliance	• None
Sea floor disturbance	• None	• Minor sea floor disturbance due to placement of cables or receiver boxes	• None	• None

Table 1.3. (continued)

Impact Factor	Potentially Significant Effects	Minor or Negligible Effects	Existing Control Measures Identified	Additional Mitigation Recommended
Exploration				
Drilling rig installation and removal	• Physical damage to deepwater corals (e.g., Eratosthenes Seamount), chemosynthetic communities, or historic shipwrecks due to placement of structures and/or anchors	• Physical damage to soft bottom benthos	• None	• Require licensees to evaluate project area for deepwater corals and chemosynthetic communities • Require licensees to maintain a separation distance of 100 m between any potential deepwater corals or chemosynthetic communities and any sea floor disturbances (including anchoring) within the activity footprint • Require licensees to conduct a remote sensing survey to evaluate project area for shipwrecks and submit an archaeological assessment report by a qualified marine archaeologist, including recommendations for avoidance or further study
Drilling rig presence (including noise and illumination)	• None	• Drilling rigs are likely to attract pelagic fish and plankton; noise may cause marine mammals or sea turtles to avoid the area	• None	• None
Drilling discharges	• Burial and anoxia effects on deepwater corals (e.g., Eratosthenes Seamount) or chemosynthetic communities if present within 500 m	• Burial and anoxia effects on soft bottom benthos	• None	• Require licensees to evaluate project area for potential presence of deepwater corals and chemosynthetic communities, and maintain a separation distance of at least 500 m from any drilling discharges
Other effluent discharges	• None	• Minor impacts on water quality near drilling rigs, similar to existing ship traffic in region	• MARPOL compliance	• None

Table 1.3. (continued)

Impact Factor	Potentially Significant Effects	Minor or Negligible Effects	Existing Control Measures Identified	Additional Mitigation Recommended
Marine debris	• Risk of death or injury to marine mammals, sea turtles, or birds due to ingestion of or entanglement with accidentally discarded debris	• Water quality impacts; cluttering of sea floor, shorelines	• MARPOL compliance • Hydrocarbon Regulations of 2007 require licensees to perform site restoration activities in accordance with good international petroleum industry practice	• None (existing measures assumed to be effective in avoiding significant effects)
Air pollutant emissions	• None	• Minor impacts on air quality, similar to other vessel and aircraft traffic in region	• MARPOL compliance	• None
Well testing	• Fallout of oil droplets due to incomplete combustion could produce a sheen on sea surface	• Minor impacts on air quality	• MARPOL compliance	• Require licensees to use a high-efficiency burner to minimise fallout of oil droplets and monitor for sheen on sea surface
Support activities	• Helicopters flying over Important Bird Areas (IBAs) could disturb coastal birds	• Small risk of vessel striking a marine mammal or sea turtle	• None	• Advise licensees to avoid flying over IBAs
Exploitation				
Facility installation	• Physical damage to deepwater corals (Eratosthenes Seamount), chemosynthetic communities, or historic shipwrecks due to placement of structures and/or anchors	• Physical damage to soft bottom benthos	• None	• Require licensees to evaluate project area for deepwater corals and chemosynthetic communities • Require licensees to maintain a separation distance of 100 m between any potential deepwater corals or chemosynthetic communities and any sea floor disturbances (including anchoring, sea floor template installation, and pipeline construction) • Require licensees to conduct a remote sensing survey to evaluate project area for shipwrecks and submit an archaeological assessment report by a qualified marine archaeologist, including recommendations for avoidance or further study

Table 1.3. (continued)

Impact Factor	Potentially Significant Effects	Minor or Negligible Effects	Existing Control Measures Identified	Additional Mitigation Recommended
Presence of structures	• None	• Platforms are likely to attract pelagic fish and plankton; underwater noise may affect behaviour of marine mammals or turtles	• None	• None
Drilling discharges	• Burial and anoxia effects on deepwater corals (Eratosthenes Seamount) or chemosynthetic communities if present within 500 m	• Burial and smothering of soft bottom benthos	• None	• Require licensees to evaluate project area for potential presence of deepwater corals and chemosynthetic communities, and maintain a separation distance of at least 500 m from any drilling discharges
Operational discharges	• None	• Minor impacts on water quality near offshore facilities, similar to existing ship traffic in region	• MARPOL compliance	• None
Marine debris	• Risk of death or injury to marine mammals, turtles, or birds due to ingestion of or entanglement with accidentally or improperly discarded debris	• Water quality impacts; cluttering of sea floor, shorelines	• MARPOL compliance • Hydrocarbon Regulations of 2007 require licensees to perform site restoration activities in accordance with good international petroleum industry practice	• None (existing measures assumed to be effective in avoiding significant effects)
Air pollutant emissions	• None	• Minor impacts on air quality, similar to other vessel and aircraft traffic in region	• MARPOL compliance	• None
Support activities	• Helicopters flying over IBAs could disturb coastal birds	• Small risk of vessel striking a marine mammal or sea turtle	• None	• Advise licensees to avoid flying over IBAs

Table 1.3. (continued)

Impact Factor	Potentially Significant Effects	Minor or Negligible Effects	Existing Control Measures Identified	Additional Mitigation Recommended
Structure removal	• Potential death or injury of a marine mammal or turtle (including endangered, critically endangered, or vulnerable species) if explosives are used	• Death or injury of fishes and other marine life near structures	• None	• Require protocol for protecting marine mammals and turtles during structure removal in accordance with international best practice
Accidents				
Oil spills including • Crude oil spill from a blowout • Diesel fuel spill • Drilling fluid base oil spill • Streamer cable fluid leak or spill	• Depending on size and nature of spill, effects could include violation of water quality standards; contamination of sediments; death or injury of marine mammals, turtles, and birds; contamination of coastal habitats including beaches; and interference with fishing, shipping, recreation, and tourism during response and cleanup operations	• Localised effects on air quality due to volatilisation of hydrocarbons • Effects on soft bottom benthos around wellsites in the event of a subsea blowout or a drilling fluid base oil spill sinking to the sea floor	• MARPOL requires Shipboard Oil Pollution Emergency Plan • Hydrocarbons Regulations of 2007 require licensees to (1) have an approved Contingency Plan for hydrocarbon leakage; (2) respond in the event of an accident, using reasonable and necessary measures in accordance with generally accepted practices applied in the international petroleum industry	• Oil spill trajectory modelling should be conducted to aid in understanding the fate of an oil spill at various locations in the licence area, the potentially affected environmental resources, and minimum response times
Hydrogen sulfide (H_2S) release	• Violation of air quality standards; potential death or injury of humans on offshore facilities and adjacent waters; potential death or injury of wildlife including birds	• None	• Under the Hydrocarbons Regulations of 2007, licensees are required to submit a well location report including geological and geophysical information and safety measures to be used in the drilling of the well	• Licensees should be required to submit information on expected H_2S levels for prospective drillsites as part of the approval process for drilling activities. • Where there is a significant risk of encountering H_2S during operations, licensees should be required to submit an H_2S contingency plan

MARPOL = International Convention for the Prevention of Pollution from Ships.

1.5 CONCLUSIONS AND RECOMMENDATIONS

1.5.1 Key Findings and Recommendations

The following conclusions and recommendations are based on the potentially significant effects identified during the SEA process. Each "issue" refers to an impact factor and the potentially affected resource(s).

Issue #1 Effects of Sea Floor Disturbances and Drilling Discharges on Deepwater Corals (Eratosthenes Seamount)

The Eratosthenes Seamount is located near the center of the licence area, primarily in Blocks 7 and 8, but also extending slightly into Blocks 11 and 12 (**Figure 1.7**). The seamount measures 120 km in length and is 80 km wide at its base. It rises approximately 2000 m from the surrounding abyssal plain, reaching a water depth of 690 m at the top of the feature. Although the geology of the seamount has been studied extensively, very little is known about its biology.

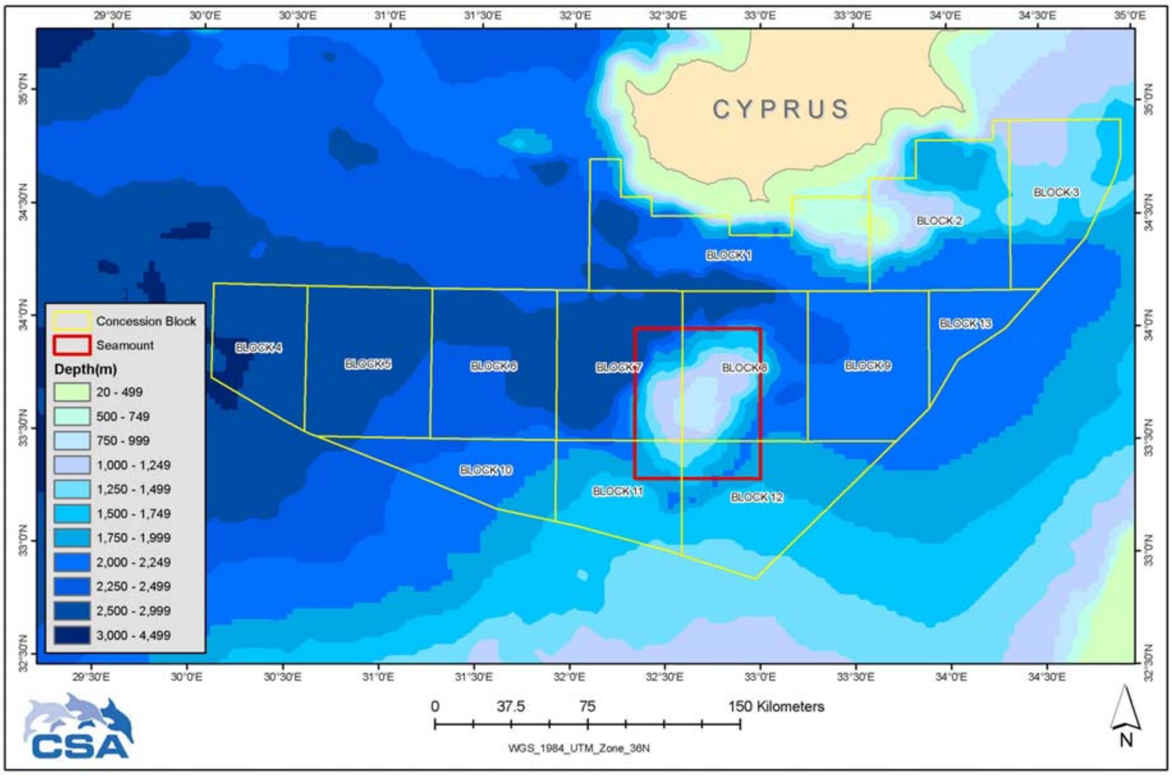


Figure 1.7. Location of the Eratosthenes Seamount as defined by a box extending from 33°20' to 34°N latitude and 32°20' to 33°E longitude.

The only biological study of the seamount has documented the presence of a diverse and rich fauna and the presence of rare deepwater corals as well as commercially important shrimp species. The faunal diversity and density indicate a uniquely rich environment, possibly an isolated refuge for populations of species that have disappeared from the adjacent continental slope. Additional environmental studies of the Eratosthenes Seamount are recommended.

The Eratosthenes Seamount does not have any formal protected status. However, in 2006, the General Fisheries Council for the Mediterranean (GFCM) recommended that demersal fishing with towed dredges and bottom trawl nets be banned in the seamount area. In addition, the Council of the European Union proposed a regulation protecting vulnerable habitats such as reefs, seamounts, deepwater corals, hydrothermal vents, and sponge beds from bottom fishing activities. It was adopted by the European Parliament in 2008.

During offshore hydrocarbon activities, deepwater corals would be susceptible to physical damage from anchoring, placement of production facilities on the sea floor, and installation of pipelines. Because they do not depend on sunlight, these corals are not likely to be significantly affected by light occlusion due to turbidity from drilling discharges. However, if present, they could be adversely affected or buried by drilling discharges (muds and cuttings) settling on them.

Most significant effects of hydrocarbon activities on deepwater corals on the Eratosthenes Seamount could be avoided by requiring licensees to conduct site-specific mitigation for individual projects. This is the basis for the following recommendation.

> **Recommendation** – Prior to conducting activities that involve drilling, anchoring, placement of drilling rigs or production facilities on the sea floor, or installation of pipelines, licensees should be required to use high-resolution seismic survey (i.e., geohazards) data, 3D seismic survey data, and any other pertinent information available to identify hard bottom areas that could support deepwater coral communities. If any such areas are identified, licensees should be required to conduct muds and cuttings discharge modelling to establish a separation distance that will protect these hard bottom areas and associated biological communities. In other parts of the world (i.e., the Gulf of Mexico), licensees are required to maintain the following separation distances: at least 500 m from each proposed drilling fluid and cuttings discharge location, and at least 100 m from the location of all other proposed sea floor disturbances (including those caused by anchors, anchor chains, wire ropes, sea floor template installation, and pipeline construction) (MMS, 2004). The Eratosthenes Seamount area is defined by a box extending from 33° to 34°N latitude and 32° to 33°E longitude.

Issue #2 Effects of Sea Floor Disturbances and Drilling Discharges on Chemosynthetic Communities

Chemosynthetic communities are rare, often high-density deepwater assemblages that exist independent of photosynthesis. They are based on symbiotic bacteria that oxidise simple compounds such as hydrogen sulfide and methane. At water depths beyond those supporting photosynthesis and where seepage of hydrocarbons, venting of hydrothermal fluids, or other geological processes occur, chemosynthesis can become the dominant ecosystem process.

The existence of chemosynthetic communities in the licence area has not been documented, but the potential clearly exists in the region. Maps from the HERMES (Hotspot Ecosystems Research on the Margins of European Seas) project show several such habitats in the Eastern Mediterranean. Additionally, recent acoustic surveys have documented the widespread distribution of mud volcanoes and related mud flows, fluid seeps, and brines along the Cyprus Arc, which runs between the Eratosthenes Seamount and the Cyprus mainland. These seafloor features are indicative of conditions that could support chemosynthetic communities.

During offshore hydrocarbon activities, chemosynthetic communities would be susceptible to physical damage from anchoring, placement of production facilities on the sea floor, and installation of pipelines. Because they do not depend on sunlight, chemosynthetic communities are not likely to be significantly affected by turbidity from drilling discharges. However, if present, they could be adversely affected or buried by discharged materials settling on them.

Chemosynthetic communities are considered environmentally sensitive resources and are recognized by the European Community as vulnerable habitats needing protection. The SEA did not identify any EU or Cyprus regulations or guidelines specifically protecting chemosynthetic communities during offshore hydrocarbon activities. In the absence of EU regulations, guidance is available from experience in another region where chemosynthetic communities have been discovered near intense offshore hydrocarbon activities – the Gulf of Mexico. Studies in that area have shown that high-density chemosynthetic sites are associated with recognizable geophysical features and can be effectively avoided.

Recommendation – Licensees proposing to conduct exploration or exploitation activities within the licence area that involve drilling, anchoring, placement of drilling rigs or production facilities on the sea floor, or installation of pipelines should be required to use high-resolution seismic survey (i.e., geohazards) data, 3D seismic data, and any other pertinent information available, to identify shallow geologic features that could support high-density chemosynthetic communities. If any such features are identified, licensees should be required to maintain the following separation distances: at least 500 m from each proposed drilling fluid and cuttings discharge location, and at least 100 m from the location of all other proposed sea floor disturbances (including those caused by anchors, anchor chains, wire ropes, sea floor template installation, and pipeline construction).

Issue #3 Effects of Sea Floor Disturbances on Shipwrecks and Submerged Archaeological Resources

The licence area is in a region where historical shipwrecks and other submerged archaeological resources are likely to be present. These features are susceptible to physical damage from sea floor-disturbing activities such as anchoring, placement of production facilities on the sea floor, and installation of pipelines.

The SEA did not identify any Cyprus regulations or guidelines specifically designed to protect undiscovered shipwrecks and other submerged archaeological resources during offshore hydrocarbon activities. Based on experience in the Gulf of Mexico, a region where shipwrecks have been discovered near offshore hydrocarbon activities, these resources can be protected by requiring remote sensing surveys and an archaeological assessment prior to conducting sea floor-disturbing activities. Typically, such archaeological surveys and assessments are conducted in conjunction with other surveys that an operator conducts prior to drilling or production (e.g., for shallow geohazards).

Recommendation – Prior to conducting exploration or exploitation activities that involve anchoring, placement of drilling rigs or production facilities on the sea floor, or installation of pipelines, licensees should be required to conduct a remote sensing survey of the sea floor to evaluate the potential for shipwrecks and other submerged archaeological resources. Licensees should be required to submit an archaeological assessment report by a qualified marine archaeologist to include any identified archaeological resources and recommendations for avoidance or further investigation. Based on the report, the Ministry could require avoidance or other protective measures.

Issue #4 Effects of Airgun Noise on Marine Mammals and Turtles

The Mediterranean Sea supports a diverse marine mammal fauna, including several species listed by the IUCN as endangered (e.g., fin whale) or vulnerable (e.g., sperm whale). Common species are likely to include the bottlenose dolphin, common dolphin, Risso's dolphin, and striped dolphin. The rare, critically endangered Mediterranean monk seal may be present in nearshore Cyprus waters but is unlikely to be found in offshore waters of the licence area due to the depth and distance from shore. Three sea turtles species occur in the area; the green and loggerhead turtles are endangered, and the leatherback turtle is critically endangered.

A common feature of most marine seismic surveys is the use of "airguns" (a compressed air sound source that is usually towed behind a vessel) to generate sound waves to penetrate the earth's crust. During these surveys, there is a risk of temporary or permanent auditory trauma to marine mammals and sea turtles within a range of a several hundred metres from a typical airgun array, particularly if they swim beneath the array. Baleen whales (e.g., fin whales) and some deep-diving species (e.g., sperm whales and beaked whales) may be at even greater risk than small dolphins. Relatively little is known of sea turtle hearing, but sounds produced by airguns overlap with the frequency range where turtle hearing is most sensitive. Marine mammals and sea turtles may avoid seismic survey areas at ranges of several kilometres from an airgun array.

The SEA did not identify any Cyprus regulations or guidelines specifically protecting marine mammals or sea turtles from auditory trauma during seismic surveys. Mitigation recommendations are proposed based on widely used protective measures that have been developed for the U.K. and the U.S. Gulf of Mexico.

Recommendation – During seismic surveys, licensees should be required to implement a protocol to reduce the risk of auditory trauma to marine mammals and sea turtles. The protocol should include, at a minimum, the following provisions:

- **Soft start** – Every time the use of the seismic array is initiated, "soft-start" procedures should be used to allow time for marine mammals and turtles to move away before the array reaches full power. The process should begin with the smallest source in an array and build up slowly over 20 to 40 minutes.
- **Visual monitoring** – Beginning at least 30 minutes before startup during daylight hours, visual observers should monitor a safety (exclusion) zone of 500-m radius around the source vessel. Startup of the array cannot begin until the safety zone is clear of marine mammals and turtles for at least 20 minutes.
- **Shutdown of the array** – Visual monitoring of the sea surface should continue while the seismic array is operating during daylight hours, and the array should be shut down if a whale, monk seal, or sea turtle enters the safety zone during visual monitoring. A whale is defined as a cetacean other than Family Delphinidae (i.e., including any baleen, sperm, or beaked whale).

Issue #5 Effects of Seismic Survey Vessels and Towed Streamers on Fishing and Shipping

During seismic surveys, a moving safety zone is maintained around the vessel and its towed streamers. The moving safety zone is necessary to prevent fishing vessels or other ships from damaging the survey equipment. A typical example could be 20 km long and 12 km wide and, if moving at 4.5 knots (8.3 km/hr), could take 2 to 3 hours to pass a particular point. Fishing activities in the licence area, including bottom trawling and long-lining, may be temporarily interrupted due to the extent of the moving safety zone around the survey vessel. The safety zones could result in temporary exclusion of fishing boats and other ships from certain areas. Some vessels would need to detour around the area. There is also the possibility of entanglement with long-line sets.

No existing control measures for this activity were identified. However, the Hydrocarbons Regulations of 2007 require licensees to ensure that operations are conducted in an environmentally acceptable and safe manner, consistent with the applicable environmental legislation and good international industry practice. Also, it is assumed that survey vessels would use appropriate signals in accordance with International Maritime Law (including communications via radio, lights, and flags) to warn other vessels of the exclusion zone.

> **Recommendation** – Licensees should be required to consult with stakeholders prior to conducting streamer surveys to ensure that conflicts with fishing and shipping activities are minimised.

Issue #6 Effects of Well Testing on Air and Water Quality

If a hydrocarbon formation is discovered during exploratory drilling, well testing may be conducted. A well test is a procedure to determine the productive capacity, pressure, permeability, and/or extent of a hydrocarbon reservoir. If hydrocarbons are brought to the surface during the well test, they are disposed of by burning. This combustion will result in emissions to the atmosphere. Air pollutant emissions from well testing will have a localised effect on air quality near the wellsite during the test period. Due to the distance offshore, no effects on coastal or onshore air quality are expected. However, fallout of oil droplets from well testing can produce a sheen on the sea surface, which would represent a significant effect.

> **Recommendation** – During well testing, licensees should be required to (1) use a high-efficiency burner to reduce the amount of hydrocarbon fallout and (2) monitor the sea surface to ensure that no visible sheen is produced.

Issue #7 Effects of Helicopter Traffic on Important Bird Areas

Vessel and helicopter traffic could periodically disturb individuals or groups of coastal birds. The effects would be similar to those of existing vessel and aircraft traffic. It is likely that individual birds would experience at most a short-term, behavioural disruption, and the effect is considered minor. However, significant effects could occur if helicopters traveled frequently over Special Protection Areas (SPAs) designated under the Birds Directive, or other Important Bird Areas (IBAs). There are currently seven designated SPAs and 25 identified IBAs on Cyprus.

> **Recommendation** – Licensees should be advised that helicopters engaged in support operations should avoid flying over SPAs and IBAs when traveling to or from the drilling rig. A map of SPAs and IBAs should be provided for this purpose.

Issue #8 Effects of Structure Removals on Marine Mammals and Sea Turtles

If offshore production facilities are established in the licence area, they would eventually be decommissioned at the end of their useful life. During decommissioning, offshore production facilities such as platforms would be removed. Typically, the platform legs are cut at the sea floor, sometimes using explosives. For offshore pipelines, the most common international practice is to clean the pipeline and abandon it in place.

If explosive charges are used for platform removal, then there is the potential for effects on marine mammals and sea turtles, including endangered, critically endangered, and vulnerable species. The risk of deaths and injuries of marine mammals and turtles can be effectively avoided through monitoring during removal operations.

Recommendation – Licensees should be required to follow international best practice for safe structure removal during decommissioning. Prior to structure removals, a decommissioning plan should be prepared that includes monitoring for the presence of marine mammals and sea turtles to avoid effects of underwater detonations.

Issue #9 Effects of Oil Spills on the Marine Environment

Oil spills are rare events, but the environmental and socioeconomic effects can be significant. The effect could vary substantially depending on the size of the spill, its chemical characteristics, the oceanographic and meteorological conditions at the time, and the effectiveness of spill response measures.

Spill prevention measures and contingency planning are key elements in reducing the risk of significant effects from oil spills. Under the Hydrocarbons Regulations of 2007, licensees must prepare and submit to the Minister for evaluation and approval a contingency plan for hydrocarbon leakage and fire. In the event of leakage or fire, the licensee immediately applies the relevant contingency plan. The licensee is required to take reasonable and necessary measures in accordance with generally accepted practices in the international petroleum industry.

Oil spill trajectory modelling is a useful aid in contingency planning. The Mediterranean oil spill trajectory model known as MEDSLIK has been used extensively in the region by response agencies from various nations as well as the Regional Marine Pollution Emergency Response Centre (REMPEC). A pilot study of the Cyprus EEZ has been conducted by the Cyprus Oceanography Centre using summer meteorological and oceanographic conditions. Results showed that for this particular period, the coast of Cyprus was not at risk (**Figure 1.8**). Additional modelling of trajectories over multiple seasons and spill sites (e.g., individual blocks) would aid in predicting the fate of an oil spill in the licence area, identifying potentially affected environmental resources, and determining minimum response times for contingency planning.

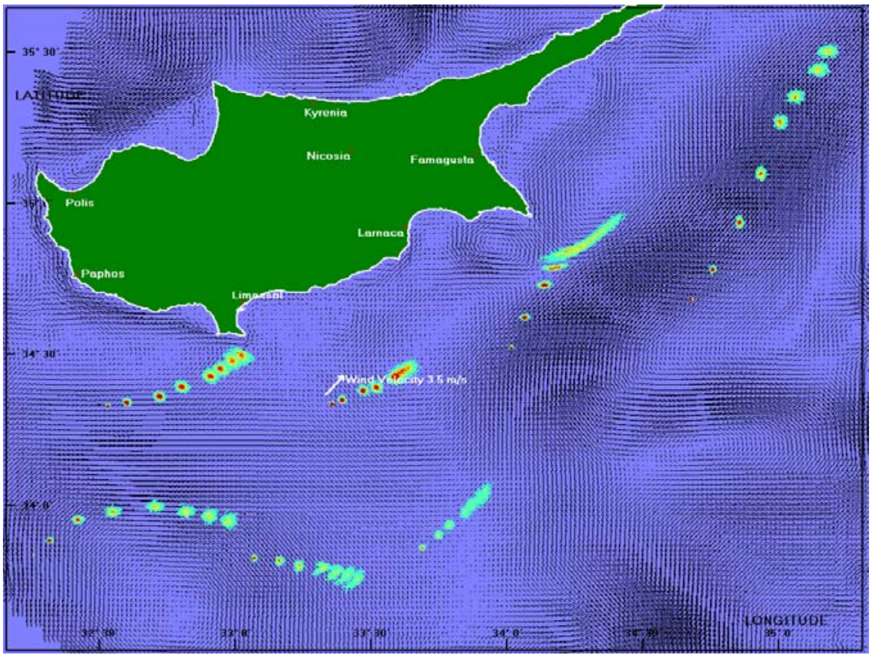


Figure 1.8. An example of the MEDSLIK oil spill predictions during a pilot study carried out by the Cyprus Oceanography Centre using summer meteorological and oceanographic data.

Recommendation – Conduct additional spill trajectory modelling using MEDSLIK to identify likely spill trajectories from multiple launch points in the licence area using seasonal meteorological and oceanographic data. Use the results to determine the likely fate of spills in the licence area, potentially affected environmental resources, and minimum times for a spill to reach shorelines of Cyprus and other countries in the region.

1.5.2 Recommendations for Additional Control, Management, and Monitoring

The Republic of Cyprus recently revised its legal framework to fully harmonise it with Directive 94/22/EC of the European Parliament on conditions for granting and using authorisations for the prospection, exploration, and production of hydrocarbons. The Hydrocarbons Law of 2007 and the Hydrocarbons Regulations of 2007 constitute the basic legal framework for offshore oil and gas activities in the licence area. However, Cyprus does not currently have regulations controlling drilling fluids and cuttings, produced water, or related discharges from offshore facilities.

No EU directives or guidance were identified concerning regulation of discharges from offshore hydrocarbon activities. However, two parallel sets of guidance have been used by other EU countries: the OSPAR Convention and the Barcelona Convention.

OSPAR Convention. For most of the hydrocarbon-producing states of western Europe (contracting parties are Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom), the "Convention for the Protection of the Marine Environment of the North-East Atlantic" (OSPAR Convention) is the basis for national laws governing the discharge of offshore effluents.

Activities under the OSPAR Convention are organised into six strategies: (1) protection and conservation of marine biodiversity and ecosystems; (2) eutrophication; (3) hazardous substances; (4) offshore oil and gas industry; (5) radioactive substances; and (6) monitoring and assessment. The offshore oil and gas industry strategy includes decisions and recommendations concerning offshore chemicals, produced water, organic-phase drilling fluids, management of offshore cuttings piles, disposal of disused offshore installations, environmental management systems, toxicity testing, monitoring and reporting, and related topics. Member states commit to implementing OSPAR decisions and recommendations in their national regulatory system.

Barcelona Convention. In 1976, 16 Mediterranean countries adopted the "Convention for the Protection of the Mediterranean Sea Against Pollution" (Barcelona Convention). The Barcelona Convention includes an offshore protocol specifically developed to control pollution during offshore hydrocarbon activities. This protocol was adopted in 1994 and has been signed and ratified by Cyprus; however, it has not yet entered into force because it has not been ratified by the requisite number of countries. The offshore protocol addresses control of harmful or noxious substances and materials; oil and oily mixtures; drilling fluids and cuttings; sewage; garbage; reception facilities, instructions, and sanctions; safety measures; contingency planning; monitoring; removal of installations; specially protected areas; and transboundary pollution.

The Barcelona Convention offshore protocol is the basis for produced water discharge standards in several Mediterranean EU countries and would be a logical starting point for Cyprus to develop discharge requirements for offshore hydrocarbon activities. In addition, the Barcelona Convention offshore protocol provides a comprehensive set of guidelines for various aspects of offshore activities in a single document, in contrast to the numerous decisions, recommendations, and amendments of the OSPAR Convention. Two disadvantages of the Barcelona Convention offshore protocol are that it has not legally entered into force and its provisions are somewhat out of date.

> **Recommendation** – Discharge requirements should be established for drilling fluid and cuttings, produced water, and other effluents from offshore hydrocarbon activities in the licence area. In developing the requirements, the Barcelona Convention offshore protocol and the OSPAR Convention offshore oil and gas industry strategy should be considered as sources of guidance. In addition, it is recommended that detailed requirements of the Barcelona Convention offshore protocol and its annexes should be reviewed to ensure that all hydrocarbon activities in the licence area are consistent with the requirements of the protocol.

1.5.3 Data Gaps

This Environmental Report includes a review of existing environmental and socioeconomic data for the region. While data gaps are noted for several individual topics, only those relevant to the offshore licensing programme are listed here. Foremost is the lack of knowledge concerning the ecology of the Eratosthenes Seamount, including the extent and biological characteristics of its deepwater coral communities. In order to fill this gap, a reconnaissance study of the seamount would need to be conducted, including a combination of side-scan sonar surveys to map the extent of emergent hard bottom, visual observations (e.g., using a benthic camera) to document the presence of deepwater corals and other epifauna in relation to sea floor characteristics, and collection of benthic samples (e.g., dredges, trawls, box cores) to aid in identifying the fauna. Filling these data gaps will be useful in establishing a better baseline of the pre-existing environmental conditions, but this is not considered a prerequisite to continuing with the licensing activities.

In summary, the relevant data gaps identified in the Environmental Report, with recommendations for further study, are as follows:

- Assessment of Eratosthenes Seamount ecology including deepwater corals;
- Measurements of hydrocarbon and trace metal concentrations in sea floor sediments from the licence area to provide a useful baseline for detecting future changes due to offshore hydrocarbon activities;
- Extension or increase of resolution of the existing ocean flow models in order to improve the accuracy and reliability of oil spill fate and trajectory modeling; and
- Collection of additional subsurface current, temperature, and salinity data in the licence area at sufficiently high temporal and/or spatial resolution to constrain ocean flow forecasting models and circulation hypotheses.

Chapter 2
Introduction

2.1 BACKGROUND

In 2007, the Republic of Cyprus held its 1st Licensing Round for the grant of Hydrocarbon Exploration Licences and subsequent Hydrocarbon Exploitation Licences within its Exclusive Economic Zone (EEZ). The licence area lies within the EEZ of the Republic of Cyprus and consists of 13 blocks (**Figure 2.1**), of which 11 were included in the 1st Licensing Round.

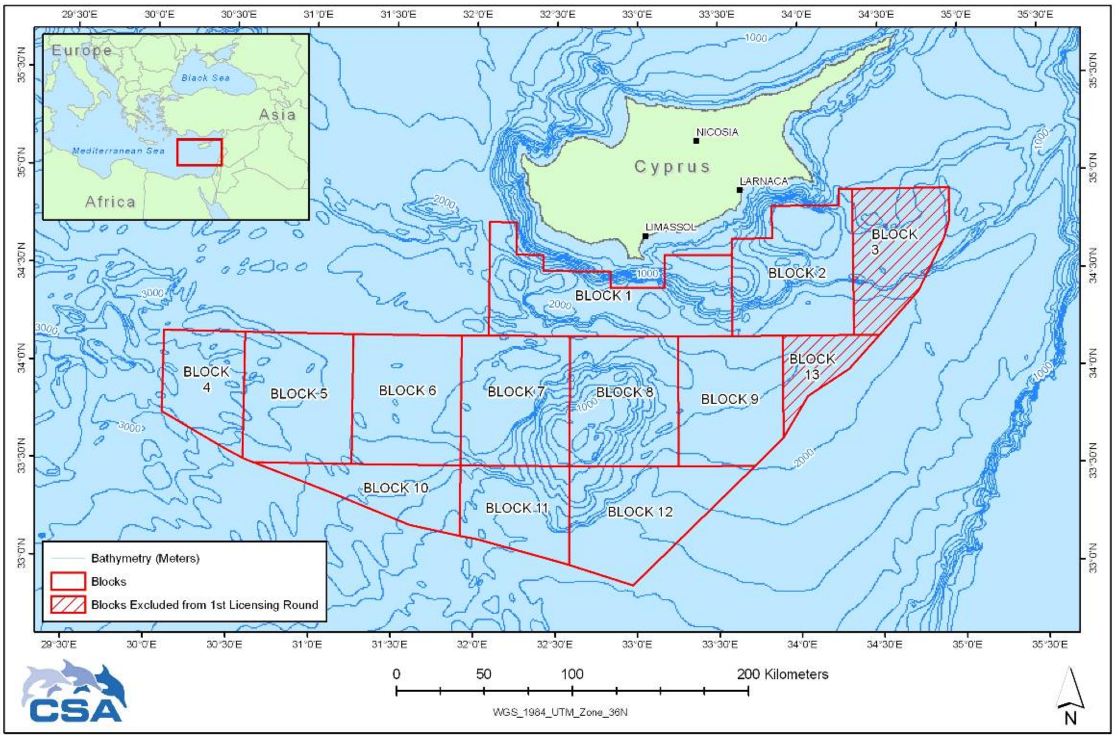


Figure 2.1. Location of the Cyprus Exclusive Economic Zone considered for hydrocarbon licensing.

The competent authority for offshore hydrocarbon licensing is the Council of Ministers, represented by the Ministry of Commerce, Industry and Tourism. Accordingly, the Ministry initiated this Strategic Environmental Assessment (SEA) of the hydrocarbon licensing programme. An SEA is required to ensure environmental protection and sustainable development in decisions regarding government plans and programmes. This SEA has been prepared by a consortium consisting of Marine Communication Services, Inc. (MCI), Aeoliki Ltd., and CSA International, Inc. (CSA) in cooperation with the University of Cyprus Oceanographic Centre. A list of contributing authors, professional affiliates, and their fields of expertise is presented in **Appendix A**. The SEA was conducted according to the provisions of the Assessment of Impact on the Environment from Certain Plans and/or Programmes Law (No. 102(I)/2005), which is harmonised with Directive 2001/42/EC of the European Parliament and of the Council. This Environmental Report presents the findings of the SEA.

2.2 STRATEGIC ENVIRONMENTAL ASSESSMENT PURPOSE AND SCOPE

According to Directive 2001/42/EC, the purpose of an SEA is to identify, describe, and evaluate the "likely significant environmental effects of implementing the plan or programme, and reasonable alternatives taking into account the objectives and the geographical scope of the plan or programme."

The purpose of this SEA is to evaluate the likely significant environmental effects of implementing the hydrocarbon licensing programme in the Cyprus EEZ. Because this is a new area for hydrocarbon activities, there is no detailed scenario for development. Accordingly, the SEA focuses broadly on those activities most likely to result from the licensing programme, including prospecting, exploration, and exploitation. It is expected that detailed, specific Environmental Impact Assessments (EIAs) will be prepared for individual projects.

Specific objectives of the SEA are as follows:

- Describe the suite of hydrocarbon activities that may reasonably be expected to occur in the licensing area;
- Describe existing control measures governing hydrocarbon activities;
- Summarise existing environmental information and describe the baseline environment of the licensing area;
- Identify potential environmental effects of hydrocarbon activities and evaluate those likely to be significant;
- Recommend additional management and monitoring measures where necessary to ensure environmental protection and sustainable use of resources; and
- Identify data gaps and shortcomings in the existing information that could be remedied by further study.

Table 2.1 summarises the required contents of an Environmental Report for an SEA as specified in Annex I of Directive 2001/42/EC and where the required information is presented in this Environmental Report.

2.3 STRATEGIC ENVIRONMENTAL ASSESSMENT PROCESS AND METHODOLOGY

The SEA process included the following steps:

- Developing a detailed revised outline for the Environmental Report based on a review of relevant European Community directives and guidance, similar SEAs for offshore hydrocarbon activities, and consultation with the Ministry;
- Preparing a review of the legal and regulatory context for offshore hydrocarbon activities in the Cyprus EEZ;
- Conducting a literature search for environmental baseline information;
- Preparing a description of likely hydrocarbon activities based on the location, environmental characteristics, and nearby industry activities;

- Identifying impact agents (e.g., effluents, emissions, and accidents);
- Identifying potential environmental effects and evaluating those identified as potentially significant; and
- Developing recommendations for additional management and monitoring measures.

The SEA is subject to public consultation in accordance with the EIA Law (No. 102(I)/2005) and Directive 2001/42/EC. The Ministry is planning to organize a public conference/workshop to be held during October 2008 in Nicosia to present the findings and recommendations of the study. The public and relevant authorities will be invited to hear the outcome of the study and express their opinions, which will be incorporated into the Final Environmental Report.

Table 2.1. Required contents of an Environmental Report for a Strategic Environmental Assessment according to Annex I of Directive 2001/42/EC.

Required Contents	Location in Environmental Report
(a) an outline of the contents, main objectives of the plan or programme and relationship with other relevant plans and programmes;	Chapter 3.1
(b) the relevant aspects of the current state of the environment and the likely evolution thereof without implementation of the plan or programme;	Chapter 4
(c) the environmental characteristics of areas likely to be significantly affected;	Chapter 4
(d) any existing environmental problems which are relevant to the plan or programme including, in particular, those relating to any areas of a particular environmental importance, such as areas designated pursuant to Directives 79/409/EEC and 92/43/EEC;	Chapter 4
(e) the environmental protection objectives, established at international, Community or Member State level, which are relevant to the plan or programme and the way those objectives and any environmental considerations have been taken into account during its preparation;	Chapter 3
(f) the likely significant effects on the environment, including issues such as biodiversity, population, human health, fauna, flora, soil, water, air, climatic factors, material assets, cultural heritage including architectural and archaeological heritage, landscape, and the interrelationship between the above factors;[1]	Chapter 5
(g) the measures envisaged to prevent, reduce and as fully as possible offset any significant adverse effects on the environment of implementing the plan or programme;	Chapter 3.4 Chapter 6.2
(h) an outline of the reasons for selecting the alternatives dealt with, and a description of how the assessment was undertaken including any difficulties (such as technical deficiencies or lack of know-how) encountered in compiling the required information;	Chapter 3.1.3 Chapter 2 Chapter 6.3
(i) a description of the measures envisaged concerning monitoring in accordance with Article 10;	Chapter 3.4 Chapter 6.2
(j) a non-technical summary of the information provided under the above headings.	Chapter 1

[1] These effects should include secondary; cumulative; synergistic; short-, medium-, and long-term permanent and temporary; and positive and negative effects.

2.4 REPORT ORGANIZATION

The main chapters of this Environmental Report are as follows:

1. Non-Technical Summary;

2. Introduction (this chapter) – describes the purpose, scope, and methods of the SEA and organization of the Environmental Report;

3. Description of Licensing Programme and Hydrocarbon Activities – summarises the programme, the regulatory context including existing control measures, and the types of hydrocarbon activities anticipated;

4. Compilation of Environmental Information – summarises environmental characteristics of the area and any existing environmental problems that are relevant to the programme;

5. Impact Assessment – evaluates the potentially significant environmental impacts of implementing the licensing programme, including prospecting, exploration, and exploitation activities; and

6. Conclusions and Recommendations – summarises key impact findings, recommends additional management and monitoring measures, and identifies regulatory considerations.

Chapter 3
Description of Licensing Programme and Hydrocarbon Activities

3.1 LICENSING PROGRAMME

3.1.1 Background and Objectives

The Energy Service of the Ministry of Commerce, Industry and Tourism has the overall responsibility for energy in Cyprus. Specifically, these responsibilities include the following:

- Monitoring and coordinating the supply and availability of sufficient energy capacity for domestic needs;
- Monitoring and participating in the formation of the European Policy for energy issues;
- Suggesting ways for implementation of the European Acquis, assisting in the preparation of Laws, Regulations, and Rules, and implementing programmes for their promotion;
- Preparing and implementing programmes for energy conservation, promotion of renewable energy sources (RES) and developing technologies for utilising RES; and
- Assisting the Republic in the formation of the national energy policy for Cyprus in coordination with all other bodies involved.

The energy policy of Cyprus is fully harmonised with the energy policy of the EU. The main axis of the energy policy involves safeguarding a healthy competition in the market, maintaining security of the energy supply, and fulfilling the country's energy demands, all with the least possible burden on the national economy and environment. Key aspects of implementing the energy policy include:

- Liberalisation of the electricity market by abolishing the monopoly of the Electricity Authority of Cyprus on the generation and supply of electricity. Developments are also being followed to import natural gas;
- Liberalisation of the oil sector by abolishing the pricing control system and cross-subsidization between different oil products and the adjustment of prices on the basis of market events and the excise duty in force;
- The establishment and operation of a strategic oil stock terminal;
- The implementation of development programmes related to the use of energy conservation, technologies, utilization of ingenious RES, and the protection of the environment from industrial pollution; and
- The promotion of oil products and other environmentally friendly sources of energy such as natural gas.

The offshore licensing programme is a key aspect of the national energy policy. The objective of the programme is to promote the development of hydrocarbon resources within the EEZ, which are national resources owned by the Republic of Cyprus. Through the licensing programme, the hydrocarbon potential of the EEZ can be evaluated, and if commercially exploitable resources are discovered, they can be promptly and efficiently developed.

3.1.2 Block Locations and Licensing Schedule

The study area, which lies within the Cyprus EEZ, is approximately 51 000 km^2 and consists of 13 blocks (**Figure 3.1**). The 1st Licensing Round, which was held in 2007, included 11 of the blocks in the EEZ (**Table 3.1**).

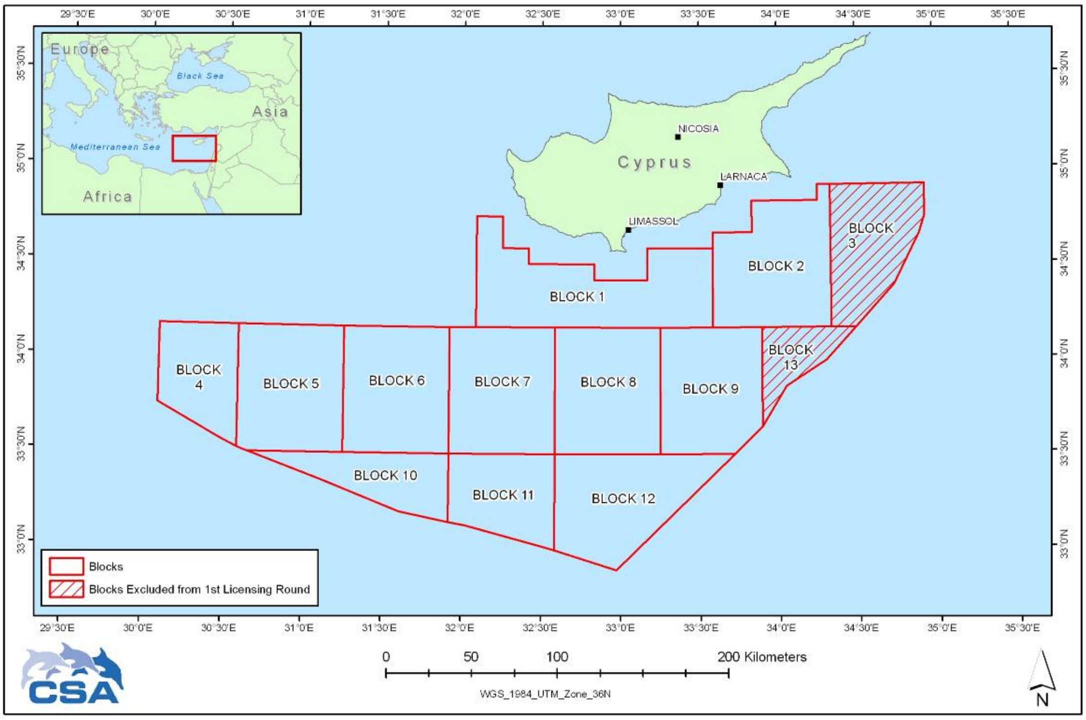


Figure 3.1. Location of Exploration Blocks in the Cyprus Exclusive Economic Zone.

Table 3.1. Selected characteristics of the licence blocks.

Block	Average depth (m)	Maximum depth position (°N Latitude, °E Longitude)	Minimum depth position (°N Longitude, °E Latitude)	Bathymetry Range (m)	Surface Area (km^2)	Minimum Distance to Cyprus (km)
1	1798.4	32.742, 34.238	33.583, 34.430	397 – 2574	5728.3	11.39
2	1575.4	34.067, 34.169	33.631, 34.428	248 – 2051	4731.6	11.70
3	1481.1	34.333, 34.265	34.442, 34.752	782 – 2020	3490.2	21.73
4	2678.3	30.128, 33.866	30.201, 34.152	2449 – 2866	2729.0	178.45
5	2470.6	30.583, 33.858	31.177, 33.554	2201 – 2750	4547.8	124.98
6	2389.1	31.766, 33.968	31.820, 33.522	2002 – 2619	4554.8	79.38
7	2195.8	32.530, 34.107	32.583, 33.670	846 – 2613	4554.8	53.94
8	1764.0	32.583, 34.074	32.686, 33.649	730 – 2588	4554.8	43.96
9	2108.6	33.250, 33.970	33.252, 33.548	1887 – 2351	4271.9	48.12
10	2044.9	30.708, 33.498	31.828, 33.178	1652 – 2475	2555.1	143.86
11	1621.7	32.245, 33.443	32.547, 33.492	1194 – 2186	2953.8	122.75
12	1633.9	32.991, 33.468	32.672, 33.500	1185 – 2026	4605.3	117.88
13	2068.1	33.895, 33.939	34.291, 33.990	2010 – 2124	1436.0	76.51

3.1.3 Alternatives Considered

According to Directive 2001/42/EC, the SEA should address "reasonable alternatives taking into account the objectives and the geographical scope of the plan or programme."

According to EC guidance, the environmental report should be prepared containing relevant information, identifying, describing and evaluating the likely significant environmental effects of implementing the plan or programme, and reasonable alternatives, taking into account the objectives and the geographical scope of the plan or programme. The Ministry considered reasonable alternatives in the process of designating the boundaries of the licence blocks, purposefully creating a buffer zone of 15 – 20 km nearshore as a conservation measure. The existence of important habitats and ecosystems within the licence area was also taken into consideration. It was determined that these areas would be protected by requiring site-specific mitigation measures rather than altering the configuration of the licence blocks as described elsewhere in this report.

3.2 LEGAL AND REGULATORY CONTEXT

3.2.1 Hydrocarbon Licensing

The Republic of Cyprus has recently revised its legal framework in order to fully harmonise it with Directive 94/22/EC of the European Parliament and of the Council of 30 May 1994 on conditions for granting and using authorisations for the prospection, exploration, and production of hydrocarbons.

Hydrocarbons activities in the Republic of Cyprus are governed by the following legislation:

- The Hydrocarbons (Prospecting, Exploration, and Exploitation) Law, No. 4(I) of 2007 – subsequently referred to as the Hydrocarbons Law of 2007.

- The Hydrocarbons (Prospecting, Exploration, and Exploitation) Regulations of 2007 – subsequently referred to as the Hydrocarbons Regulations of 2007.

Other relevant legislation includes the Contiguous Zone Law (63(I) of 2004) and the Exclusive Economic Zone Law (64(I) of 2004), which define the boundaries of the nation's contiguous zone and EEZ, respectively. In addition, Cyprus has signed bilateral agreements with Egypt (2003) and Lebanon (2007) delimiting the EEZ between these countries.

The competent authority for granting hydrocarbon licences is the Council of Ministers, represented by the Ministry of Commerce, Industry and Tourism. Three types of hydrocarbon licences can be issued: Prospecting, Exploration, and Exploitation (**Table 3.2**).

Table 3.2. Types of licences for offshore hydrocarbon activities.

Type of Licence	How/When Issued	Characteristics
Prospecting	• As determined necessary by the Ministry of Commerce, Industry and Tourism	• Granted for up to 1 year • For evaluation of hydrocarbon potential by identifying geological structures • Includes gravity and magnetic surveys as well as seismic surveys; no drilling
Exploration	• Through Licensing Rounds open to qualified bidders	• Granted for 3 years; possibility for two renewals of 2 years each • Includes gravity and magnetic surveys, seismic surveys, and exploration drilling • On each renewal, 25% of the initial licence area is relinquished
Exploitation	• In the event of a discovery, an entity operating under an Exploration Licence has the right to be granted an Exploitation Licence for that discovery	• Granted for an initial period of up to 25 years after the approval of a development and production plan; possibility for one renewal of up to 10 years

Applicants selected during a Licensing Round for an Exploration Licence are required to enter into a Production Sharing Contract with the Republic of Cyprus. The Contract addresses the exploration period as well as the exploitation period in the event of a commercial hydrocarbon discovery.

3.2.2 Strategic Environmental Assessment

According to the provisions of the Assessment of Impact on the Environment from Certain Plans and/or Programmes Law (No. 102(I)/2005), which is harmonised with Directive 2001/42/EC of the European Parliament and of the Council, an SEA is required for the consideration of environmental protection and sustainable development in decisions regarding the Republic's plans and programmes. The required contents of an SEA have been summarised in **Section 2.2**.

3.2.3 Environmental Impact Assessments

According to the Hydrocarbons Law of 2007, an entity that submits an application for an Exploitation Licence is obliged to submit an EIA for compliance with the provisions of the Assessment of Impact on the Environment from Certain Works Law (No. 140(I) of 2005).

3.3 OVERVIEW OF HYDROCARBON ACTIVITIES

For this assessment, three main phases of offshore hydrocarbon activities are recognised, based on the licences issued by the Ministry: prospecting, exploration, and exploitation. Brief summaries of these activities are presented in **Sections 3.3.1**, **3.3.2**, and **3.3.3**. Activities are described in more detail in **Chapter 5**, Impact Assessment.

3.3.1 Prospecting

Under the Hydrocarbons Law of 2007, "prospecting for hydrocarbons" means the attempt to locate hydrocarbons and/or to evaluate the hydrocarbon potential by any appropriate method other than drilling. Prospecting typically involves a suite of geophysical and geological activities, including seismic surveys, geological and geochemical sampling, electromagnetic surveys, and remote sensing surveys. Prospecting activities are often considered to be part of the exploration phase (e.g., in the offshore protocol of the Barcelona Convention), but they are discussed separately in this SEA because the activities and impacts are so different from those of exploratory drilling.

From an impact perspective, seismic surveys are the main concern because they are a source of high-energy underwater noise. Seismic surveys involve the use of sound waves to develop an image of subsurface strata and structures where hydrocarbons could accumulate and be retained.

A 2D seismic survey has already been conducted in the licence area by PGS Geophysical in 2006. The survey covered an area of approximately 51 000 km^2. A 3D seismic survey has been conducted in Block 3. Additional seismic surveys focusing on individual blocks or areas of interest may be conducted during the exploration and exploitation phases.

3.3.2 Exploration

During the Exploration phase, one or more exploratory wells would be drilled in a block to determine whether commercially exploitable hydrocarbons are present. An operator may also conduct additional seismic surveys and/or other prospecting surveys to help select drilling locations and identify geohazards. To date, no exploratory drilling has occurred in the licence area.

Typically, a self-contained, mobile drilling rig would be brought into the area to drill a well. Based on water depths in the licensing area (400 to 3000 m), the most likely type of drilling rigs would be dynamically positioned drillships or semisubmersibles, which do not anchor on the sea floor. Each well would be drilled to a predetermined depth and either temporarily suspended or abandoned in accordance with industry standards. During drilling, the rig may discharge drilling fluids and cuttings and other effluents in accordance with regulations and best international practices (see **Section 3.4**).

If a hydrocarbon formation is discovered during exploratory drilling, a well test may be conducted. A well test is a procedure to determine the productive capacity, pressure, permeability, and/or extent of a hydrocarbon reservoir, and it may involve burning a small quantity of oil or gas. If a well is deemed productive, it may be suspended by installing cement or mechanical plugs to isolate the hydrocarbon intervals and fitting a well suspension cap to allow reentry of the well at a later date (for completion and production).

If no commercially exploitable reservoir is found during exploratory drilling, a well would be permanently plugged with cement or mechanical plugs and abandoned. A site clearance survey would be conducted to ensure that any debris from drilling activities is removed from the sea floor around each drillsite.

3.3.3 Exploitation (Development and Production)

The exploitation phase is the process of developing and producing commercial quantities of hydrocarbons. Key activities include drilling of development wells, installation of production facilities, installation of export facilities such as pipelines, and routine operation of these systems. To date, no development and production activities have occurred in the licence area.

A variety of development and production systems could be used within the licensing area. The type of facilities selected by an operator is based on several factors, including water depth, reservoir type, and proximity to existing oil and gas infrastructure and support operations. Examples could include conventional fixed platforms, compliant towers, floating production systems, or subsea systems controlled remotely from onshore facilities. The location and extent of onshore facilities, if any, has not been determined at this stage.

3.4 CONTROL, MANAGEMENT, AND MONITORING

3.4.1 MARPOL Convention

Cyprus is party to a number of international conventions and protocols. One of the most important is the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78). MARPOL is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. It is a combination of two treaties adopted in 1973 and 1978, respectively, and has been updated by amendments through the years. MARPOL currently comprises six Annexes, all of which have been ratified by Cyprus:

- Annex I – Regulations for the Prevention of Pollution by Oil;
- Annex II – Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk;
- Annex III – Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form;
- Annex IV – Prevention of Pollution by Sewage from Ships;
- Annex V – Prevention of Pollution by Garbage from Ships; and
- Annex VI – Prevention of Air Pollution from Ships.

Table 3.3 summarises the main MARPOL provisions that are relevant for oil and gas exploration and exploitation.

Table 3.3. Key MARPOL provisions relevant to oil and gas activities.

Environmental Aspect	Relevant Provisions of MARPOL 73/78	Annex
Drainage water	Ship must be proceeding en route, not within a "special area" and oil must not exceed 15 ppm (without dilution). Vessel must be equipped with an oil filtering system, automatic cutoff, and an oil retention system.	I
Accidental oil discharge	Shipboard oil pollution emergency plan (SOPEP) required.	I
Bulked chemicals	Prohibits the discharge of noxious liquid substances, pollution hazard substances, and associated tank washings. Vessels required to undergo periodic inspections to ensure compliance. All vessels must carry a Procedures and Arrangements Manual and Cargo Record Book.	II, III
Sewage discharge	Discharge of sewage is permitted only if the ship has approved sewage treatment facilities, the test result of the facilities are documented, and the effluent will not produce visible floating solids nor cause discoloration of the surrounding water.	IV
Garbage	Disposal of garbage from ships and fixed or floating platforms is prohibited. Ships must have a garbage management plan and shall be provided with a Garbage Record Book.	V
Food waste	Discharge of food waste ground to pass through a 25-mm mesh is permitted for facilities more than 12 nmi from land.	V
Air pollutant emissions	Sets limits on sulphur oxide and nitrogen oxide emissions from ship exhausts and prohibits deliberate emissions of ozone-depleting substances including halons and chlorofluorocarbons. Sets limits on emissions of nitrogen oxides from diesel engines. Prohibits the incineration of certain products on board such as contaminated packaging materials and polychlorinated biphenyls.	VI

The Mediterranean Sea is designated under MARPOL Annexes I and V as a “special area” that is provided with a higher level of protection. For example, all oil-carrying ships are required to be capable of retaining oily wastes on board for discharge to shore reception facilities. This involves the fitting of appropriate equipment, including an oil-discharge monitoring and control system, oily-water separating equipment and a filtering system, slop tanks, sludge tanks, piping, and pumping arrangements.

Discharge requirements for the Mediterranean Sea as a “special area” under Annex V will take effect on 1 May 2009. After that date, disposal of the following materials into the Mediterranean Sea will be strictly prohibited: all plastics, including but not limited to synthetic ropes, synthetic fishing nets, plastic garbage bags and all other garbage including paper products, rags, glass, metal, bottles, crockery, dunnage, lining, and packing materials.

3.4.2 Barcelona Convention

In 1976, 16 Mediterranean countries and the European Community adopted the Convention for the Protection of the Mediterranean Sea Against Pollution (Barcelona Convention). In 1995, the Contracting Parties adopted an amended version of the Barcelona Convention, renamed the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean. Cyprus is a contracting party to the Barcelona Convention, along with the European Community and 20 other countries.

The Barcelona Convention generally commits its contracting parties to take appropriate measures to prevent, abate, combat, and eliminate pollution of the Mediterranean Sea and to protect and enhance the marine environment so as to contribute toward its sustainable development. It further commits the parties to:

(a) applying the precautionary principle – i.e., where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation;

(b) applying the “polluter pays” principle – i.e., the costs of pollution prevention, control, and reduction measures are to be borne by the polluter, with due regard to the public interest; and

(c) undertaking EIAs for proposed activities that are likely to cause a significant adverse impact on the marine environment and are subject to an authorisation by competent national authorities.

The Barcelona Convention has given rise to seven protocols addressing specific aspects of Mediterranean environmental conservation:

- Dumping protocol;
- Prevention and emergency protocol;
- Land-based sources and activities protocol;
- Specially Protected Areas and biodiversity protocol;
- Offshore protocol (exploration and exploitation);
- Hazardous wastes protocol; and
- Integrated Coastal Zone Management protocol.

The most relevant of these for the licensing programme is the offshore protocol (**Appendix B**). **Table 3.4** summarises key provisions of this protocol. This protocol was adopted on 14 October 1994 in Madrid; although Cyprus has signed and ratified the protocol, it has not yet entered into force because it has not been ratified by the requisite number of Parties. In addition, the provisions of the offshore protocol have no effect in the licensing area until they are enacted as laws or regulations in Cyprus.

Table 3.4. Key provisions of the "offshore protocol" of the Barcelona Convention.[1]

Source	Guideline
General	• Operators shall be required to use the best available environmentally effective and economically appropriate techniques and to observe internationally accepted standards regarding wastes, as well as the use, storage, and discharge of harmful or noxious substances and materials, with a view to minimising the risk of pollution.
Authorisation	• All exploration and exploitation activities shall be subject to prior written authorisation from a designated competent authority. Such authority must be satisfied that the installation has been constructed according to international standards and practice and the operator has the technical competence and financial capacity to carry out the activities. • The authorisation may impose conditions regarding measures, techniques, or methods designed to reduce to the minimum risks of and damage due to pollution resulting from the activities. • Authorisation shall be refused if there are indications that the proposed activities are likely to cause significant adverse effects on the environment that could not be avoided by compliance with the conditions laid down in the authorisation.
Chemicals, including harmful or noxious substances and materials	• Operators of any offshore installation are required to have a Chemical Use Plan that shows: (i) the chemicals that the operator intends to use in the operations; (ii) the purpose or purposes for which the operator intends to use the chemicals; (iii) the maximum concentrations of chemicals the operator intends to use within any other substances, and maximum amounts intended to be used in any specified period; and (iv) the area within which the chemical may escape into the marine environment. • The use and storage of chemicals shall be approved by the competent authority on the basis of the Chemical Use Plan. The competent authority may regulate, limit, or prohibit the use of chemicals. • Each substance and material used for activities must be accompanied by a compound description provided by the entity producing such substance or material. • Disposal of harmful or noxious substances and materials listed in Annex I of the Protocol is prohibited. Disposal of substances and materials listed in Annex II requires a special permit. Disposal of all other harmful or noxious substances and materials that might cause pollution requires a prior general permit.
Oil and oily mixtures	• Parties to the Protocol shall develop and adopt common standards for disposal of oil and oily mixtures. Standards shall not be less restrictive than the following: - For machinery space drainage, maximum oil content of 15 mg/L. - For production water, oil content not to exceed 40 mg/L monthly average, 100 mg/L maximum at any time. • Spills of high oil content in processing drainage and platform drainage shall be contained, diverted, and then treated as part of the product, but the remainder shall be treated to an acceptable level before discharge, in accordance with good oilfield practice. • Oily waste and sludges from separation processes shall be transported to shore. • All necessary precautions shall be taken to minimise losses of oil into the sea from oil collected or flared from well testing. • All necessary precautions shall be taken to ensure that any gas resulting from oil activities should be flared or used in an appropriate manner.

Table 3.4. (continued).

Source	Guideline
Drilling fluids and cuttings	• Parties to the Protocol shall formulate and adopt common standards for the use and disposal of drilling fluids and cuttings in accordance with provisions of Annex V of the Protocol. • Water-based drilling fluids and drill cuttings are subject to the following requirements: (a) the use and disposal of such drilling fluids shall be subject to the Chemical Use Plan and the provisions of this Protocol regarding harmful and noxious substances and (b) drill cuttings shall either be disposed of on land or into the sea in an appropriate site or area as specified by the competent authority. • Oil-based drilling fluids and drill cuttings are subject to the following requirements: (a) such fluids shall only be used if they are of a sufficiently low toxicity and only after the operator has been issued a permit by the competent authority when it has verified such low toxicity; (b) disposal into the sea of such drilling fluids is prohibited; (c) disposal of drill cuttings into the sea is permitted only on the condition that efficient solids control equipment is installed and properly operated, the discharge point is well below the surface of the water, and the oil content is less than 100 g/kg of dry cuttings; (d) disposal of such drill cuttings in Specially Protected Areas is prohibited; and (e) in case of production and development drilling, a programme of seabed sampling and analysis relating to the zone of contamination must be undertaken. • The use of diesel-based drilling fluids is prohibited. Diesel oil may exceptionally be added to drilling fluids in such circumstances as the Parties may specify.
Sewage	• Discharge of sewage from installations permanently manned by 10 or more persons is prohibited except in cases where: (a) the installation is discharging sewage after treatment as approved by the competent authority at a distance of at least 4 nmi from the nearest land or fixed fisheries installation; (b) the sewage is not treated, but discharge is carried out in accordance with international rules and standards; or (c) the sewage has passed through a sewage treatment plant certified by the competent authority. • Stricter provisions may be imposed where deemed necessary – e.g., because of the ocean current regime or proximity to a Specially Protected Area or if the discharge is mixed with harmful or noxious substances. • In all cases, the discharge must not produce visible floating solids or colouration, discolouration, or opacity of the surrounding water.
Garbage	• Disposal of all plastics is prohibited, including but not limited to synthetic ropes, synthetic fishing nets, and plastic garbage bags as well as all other nonbiodegradable garbage, including paper products, rags, glass, metal, bottles, crockery, dunnage, lining, and packing materials. • Disposal of food wastes shall take place as far away as possible from land, in accordance with international rules and standards. • If garbage is mixed with other discharges having different disposal or discharge requirements, the more stringent requirements shall apply.
Waste disposal	• Operators shall satisfactorily dispose of all wastes and harmful or noxious substances and materials in designated onshore reception facilities, except as otherwise authorised by the Protocol.
Safety measures	• The competent authority must ensure that safety measures are taken with regard to the design, construction, placement, equipment, marking, operation, and maintenance of installations. • The competent authority must ensure that, at all times, the operator has on the installations adequate equipment and devices, maintained in good working order, for protecting human life, preventing and combating accidental pollution, and facilitating prompt response to an emergency, in accordance with the best available environmentally effective and economically appropriate techniques and provisions of the operator's Contingency Plan. • The competent authority shall require a certificate of safety and fitness for the purpose issued by a recognised body to be submitted with respect to production platforms, mobile offshore drilling units, offshore storage facilities, offshore loading systems and pipelines, and such other installations as may be specified. • Safety measures are further detailed in Annex VI of the Protocol.

Table 3.4. (continued).

Source	Guideline
Contingency planning	• Operators of installations are required to have a Contingency Plan to combat accidental pollution, coordinated with the nation's Contingency Plan established in accordance with the Protocol concerning Cooperation in Combating Pollution of the Mediterranean Sea by Oil and Other Harmful Substances in Cases of Emergency and approved in conformity with the procedures established by the competent authorities. • Each contracting party shall establish coordination for the development and implementation of Contingency Plans. Such plans shall be established in accordance with guidelines adopted by the competent international organization. • Specific requirements for Contingency Plans are provided in Annex VII of the Protocol.
Monitoring	• Operators shall be required to measure, or to have measured by a qualified expert, the effects of activities on the environment and to periodically report on them or upon request by the competent authority. • The competent authority shall establish, where appropriate, a national system to regularly monitor installations and the impact of activities on the environment so as to ensure that the conditions attached to the grant of the authorisation are being fulfilled.
Removal of installations	• Operators shall be required by the competent authority to remove any installation that is abandoned or unused in order to ensure safety of navigation. Such removal shall also have due regard to other legitimate uses of the sea, in particular fishing, the protection of the marine environment, and the rights and duties of other nations. The operator shall take all necessary measures to prevent spillage or leakage from the site of the activities. • The competent authority shall require the operator to remove old or unused pipelines or to clean them inside and either abandon or bury them so that they do not cause pollution, endanger navigation, hinder fishing, threaten the marine environment, nor interfere with other legitimate uses of the sea or with the rights and duties of other nations. The competent authority shall ensure that appropriate publicity is given to the depth, position, and dimensions of any buried pipeline and that such information is indicated on nautical charts.
Specially Protected Areas	• For the protection of areas defined in the Protocol concerning Mediterranean Specially Protected Areas and any other area established by a party and in furtherance of the goals stated therein, the parties shall take special measures in conformity with international law, either individually or through multilateral or bilateral cooperation, to prevent, abate, combat, and control pollution arising from activities in these areas. • In addition to the measures referred to in the Protocol concerning Mediterranean Specially Protected Areas for the granting of authorisation, such measures may include: (a) Special restrictions or conditions when granting authorisations for such areas: (i) The preparation and evaluation of Environmental Impact Assessments (EIAs); (ii) The elaboration of special provisions in such areas concerning monitoring, removal of installations, and prohibition of any discharge. (b) Intensified exchange of information among operators, competent authorities, Parties, and the Organization regarding matters that may affect such areas.
Transboundary effects	• Each nation shall take all measures necessary to ensure that activities under its jurisdiction are so conducted as not to cause pollution beyond the limits of its jurisdiction.
Environmental Impact Assessments	• Applications for authorisation of activities must include a survey concerning the effects of the proposed activities on the environment. • The competent authority may, in light of the nature, scope, duration, and technical methods employed in the activities and of the characteristics of the area, require that an EIA be prepared. • Minimum contents of an EIA are specified in Annex IV of the Protocol.

[1] "Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil." This protocol was adopted on 14 October 1994 by the contracting Parties; although Cyprus has signed and ratified the protocol, it has not yet entered into force because it has not been ratified by the requisite number of Parties.

3.4.3 Other International Conventions and Protocols

Cyprus is party to a number of other international conventions and protocols, as summarised in **Table 3.5**.

Table 3.5. Other relevant international conventions and agreements to which Cyprus is a party.

Protocol	Explanation
RAMSAR Convention on Wetlands (1971)	Provides the framework for national action and international cooperation for conservation and wise use of wetlands. Parties agree to: (1) work towards the wise use of wetlands through national land-use planning, appropriate policies and legislation, management actions, and public education; (2) designate suitable wetlands for the List of Wetlands of International Importance and ensure their effective management; and (3) cooperate internationally concerning transboundary wetland systems and development projects affecting wetlands.
Convention on the Conservation of Migratory Species of Wild Animals (CMS) (1979)	The CMS aims to conserve terrestrial, marine, and avian migratory species throughout their range. CMS Parties strive to protect migratory species threatened with extinction, conserve or restore places where they live, mitigate obstacles to migration, and control other factors that might endanger them. CMS also promotes concerted action among the states.
United Nations Law of the Sea Convention (UNCLOS) (1982)	Provides a universal legal framework for the management of marine natural resources, including efforts to prevent, reduce, and control marine pollution.
Vienna Convention for the Protection of the Ozone Layer (1985)	Commits governments to take measures to protect human health and the environment against adverse effects resulting from depletion of the ozone layer. Cooperative research and information exchange are encouraged to understand and assess effects of ozone layer modification on human health and the environment.
Montreal Protocol on Substances that Deplete the Ozone Layer (1987)	Supplements the Vienna Convention and is designed to regulate the production and consumption of ozone-depleting substances. Phase-out schedules are specified for controlled substances to allow for progressive tightening over time as scientific evidence for ozone depletion trend is strengthened and substitutes are developed.
Framework Convention on Climate Change (FCCC) (1992)	Aims to stabilise greenhouse gas concentrations in the atmosphere at levels that would prevent dangerous human interference with the climate system and that are consistent with sustainable development. Governments should take precautionary measures to anticipate and prevent or minimise climate change and its adverse effects.
Agenda 21 of the United Nations Conference on Environment and Development (1992)	Agenda 21, also known as the Rio Declaration, is a comprehensive plan of action to be taken globally, nationally, and locally by governments and organizations to reduce human impacts on the environment. Chapter 17 of Agenda 21 addresses protection of the oceans, and Section 17:30 calls for states to assess the need for additional measures to control degradation of the marine environment from sea-based activities, including activities associated with oil and gas platforms.
Convention on Biological Diversity (1992)	In support of conserving biological diversity, governments commit to integrating conservation and sustainable use of biological resources into national decisionmaking, establishing a system of protected areas, and requiring environmental impact assessment of proposed projects that may adversely affect biological diversity.
Kyoto Protocol to the FCCC (1997)	The Kyoto Protocol has the same objectives, principles, and institutions as the FCCC, but significantly reinforces the Convention by committing the parties to individual, legally binding objectives for the reduction or limiting of their greenhouse gas emissions.
Stockholm Convention (2001)	The Stockholm Convention is a global treaty to protect human health and the environment from persistent organic pollutants by prohibiting, phasing out as soon as possible, or restricting the production, placing on the market, and use of these substances.

3.4.4 National Regulations

The Hydrocarbons Regulations of 2007 include several provisions relating to protection of the environment, as summarised in **Table 3.6**.

Table 3.6. Environmental provisions of the Hydrocarbons Regulations of 2007.

Regulation Number	Explanation
Applications 6(6)(d)	Applications that are submitted for an exploration licence are required to include a short notice regarding the exploration activities and possible impact they have to the environment and measures that the exploration work programme intends to take for dealing with them.
Work practices 13(1)	A licensee shall carry out hydrocarbon operations in a proper, safe, and workmanlike manner and in accordance with good oilfield practices. A licensee shall, at all times, comply with the present Regulations and any other legislation, guidelines, and instructions relating to work practices, employers' obligations, safety, and health at work and the rights of employees.
Work practices 13(2)	A licensee shall: (a) ensure that all materials, supplies, machinery, plant, equipment, and installations used by the licensee and subcontractors comply with generally accepted standards in the international petroleum industry and are of proper construction and kept in good working order; (b) use natural resources of the licensed area as productively as practicable; (c) prevent damage to producing formations and ensure that hydrocarbons discovered, mud, or any other fluids or substances do not escape or be wasted; (d) prevent damage to hydrocarbon and water-bearing strata that are adjacent to a producing formation or formations and prevent water from entering any strata bearing hydrocarbons, except where water injection methods are used for secondary recovery operations or are intended otherwise in accordance with generally accepted international petroleum industry practice; (e) properly store hydrocarbons in receptacles constructed for that purpose, and not store crude oil in an earthen reservoir, except temporarily in an emergency; and (f) implement provisions of the Solid and Dangerous Waste Law with respect to hydrocarbon wastes.
Protection of the environment 15(1)	A licensee shall ensure that hydrocarbon operations are conducted in an environmentally acceptable and safe manner, consistent with the applicable environmental legislation and good international industry practice, and are monitored to ensure the same.
Protection of the environment 15(2)	A licensee shall take all necessary measures to: (a) minimise any avoidable environmental damage or destruction to the water, the soil, or the atmosphere in relation to hydrocarbon operations; (b) the provisions of the International Convention for Civil Liability concerning Damage from Oil Pollution are met.
Protection of the environment 15(3)	If the licensee's failure to comply with the provisions of Sub-regulations (1) and (2) above and any relevant legislation results in environmental pollution in water, the soil, or the atmosphere, the licensee takes all necessary and reasonable measures to remedy or eliminate the pollution and the effects thereof.
Protection of the environment 15(4)	If the Minister reasonably determines that any works or installations erected by the licensee or any operations conducted by the licensee endanger or may endanger persons or third-party property or cause pollution or harm wildlife, marine organisms, or the environment to a degree that the Minister deems unacceptable, the Minister may require the licensee to take remedial measures and repair any damage to the environment.
Contingency plan 15(6)(a)	Prior to the commencement of any drilling operations, the licensee prepares and submits to the Minister for evaluation and approval a contingency plan for hydrocarbon leakage and fire. In the event of leakage or fire, the licensee immediately applies the relevant contingency plan.
Contingency plan 15(6)(b)	In a case of any emergency or accident, other that those referred to in Sub-Regulation (6)(a) that affect the environment, the licensee takes reasonable and necessary measures in accordance with generally accepted practices applied in the international petroleum industry.
Contingency plan 15(7)	In the event that the licensee fails to take steps, measures, or action as required in the Sub-Regulations (1) to (6), within the time period specified by the Minister, the Minister may direct to be taken any action which may be necessary, and the licensee shall be liable for the costs and expenses of such actions.

Table 3.6. (continued).

Regulation Number	Explanation
Drilling practices 17(1)	A licensee shall ensure that the well design and conduct of drilling operations, including without limitation its casing, cementing, well spacing, and plugging operations, are in accordance with generally accepted practices in the international petroleum industry.
Abandonment 16(1)	Unless otherwise directed by the Minister, on expiry or termination of a licence or relinquishment of part of the licensed area, the licensee shall: (a) remove all equipment and installations, structures, plants, appliances, and pipelines from the relinquished area or former licensed area in a manner agreed with the Minister pursuant to an abandonment plan provided by the Contract; and (b) perform all necessary site restoration activities in accordance with good international petroleum industry practice, and shall take all other action necessary to prevent hazards to human life or to the property of others or the environment.
Well abandonment 18(1)	Before abandoning any well, a licensee shall give, in the case of a producing well, not less than thirty (30) days' written notice and, in the case of any other well, not less than two (2) days' written notice to the Minister of its intention to abandon. Such notice shall be accompanied by a satisfactory programme for the abandonment and plugging of the well identified in the notice.
Well abandonment 18(3)	A licensee shall (a) undertake to securely plug such well to prevent pollution and possible damage to the reservoir and shall, except as the Minister may otherwise direct or the Contract may otherwise provide, remove all equipment, materials, and facilities relating thereto; (b) ensure that cemented strings or other forms of casing shall not be withdrawn without the prior written approval of the Minister; and (c) permit an authorised officer to inspect such operations.
Construction and maintenance of installations, pipelines, and related facilities 19(1)	A licensee shall maintain in good condition and repair all structures, equipment, and other installations in the licensed area or used in connection with the hydrocarbon operations.
Construction and maintenance of installations, pipelines, and related facilities 19(2)	In conducting offshore operations, a licensee shall, in accordance with international petroleum industry practice and applicable legislation and regulations, ensure that works and installations erected shall: (a) be constructed, placed, marked, buoyed, equipped and maintained so that there are safe and convenient channels for shipping; (b) be fitted with navigational aids and illuminated between sunset and sunrise; (c) be kept in good repair and working order; and (d) not hinder navigation or fishing or cause pollution of the sea or rivers.

3.5 OTHER RELEVANT EU DIRECTIVES

Two European Community Directives have been cited previously as central to the licensing programme and this Environmental Report. Directive 94/22/EC specifies conditions for granting and using authorisations for the prospection, exploration, and production of hydrocarbons. Directive 2001/42/EC concerns environmental assessment of plans and programmes and is the basis for this Environmental Report. Other European Community Directives that are broadly relevant to activities in the marine environment include the Habitats Directive, Birds Directive, and Marine Strategy Directive, as discussed below.

3.5.1 Habitats Directive and Birds Directive (Natura 2000)

The Habitats Directive (92/43/EEC) was adopted in 1992 as a means of protecting the most seriously endangered species and habitats to be found in Europe. The Habitats Directive complements the Birds Directive (79/409/EEC) of 1979, and the designated areas under both of these directives form a network of protected sites known as Natura 2000. All EU member states are required to take steps to ensure that natural habitats and species in the network receive "favourable conservation status," with the aim of guaranteeing their long-term survival. The Member States themselves contribute to the network, which is made up of Special Protection

Areas (SPAs) for birds and Special Areas of Conservation (SACs) designated for other species and for habitats. Natura 2000 sites can be designated on both land and water. Marine Natura 2000 areas are protected by conservation measures to ensure they are not overfished or affected by pollutants from sewage or shipping traffic.

3.5.2 Marine Strategy Directive

The Marine Strategy Directive (2008/56/EC) was adopted in 2008 to more effectively protect the marine environment across Europe. It aims to achieve good environmental status of the EU's marine waters by 2021 and to protect the resource base upon which marine-related economic and social activities depend. The Marine Strategy constitutes the vital environmental component of the EU's future maritime policy, designed to achieve the full economic potential of oceans and seas in harmony with the marine environment.

The Marine Strategy Directive establishes European Marine Regions on the basis of geographical and environmental criteria. Each Member State – cooperating with other Member States and non-EU countries within a marine region – is required to develop strategies for their marine waters. The marine strategies must contain a detailed assessment of the state of the environment, a definition of "good environmental status" at regional level, and the establishment of clear environmental targets and monitoring programmes.

Each Member State must draw up a programme of cost-effective measures. Prior to any new measure, an impact assessment that contains a detailed cost-benefit analysis of the proposed measures is required. Where Member States cannot reach the environmental targets, specific measures tailored to the particular context of the area and situation will be drawn up.

Chapter 4
Compilation of Environmental Information

Chapter 4 is organised into the physical, biological, and socioeconomic environments of the Republic of Cyprus. The current state of knowledge of the region covered by the hydrocarbon licensing blocks of the EEZ of the Republic of Cyprus is described in order to properly frame the potential impacts of hydrocarbon activities.

4.1 PHYSICAL ENVIRONMENT

The physical environment of the region covered by the hydrocarbon licensing blocks of the EEZ of the Republic of Cyprus is discussed in the following subsections. Meteorological and oceanographic conditions are described, in addition to the characteristics of the sea floor, regarding both its morphology and make-up. Finally, the acoustic environment is discussed.

4.1.1 Meteorology and Air Quality

4.1.1.1 Weather and Climate

The Mediterranean Sea is closed from all sides and surrounded by high peninsulas and mountain barriers. The gaps between these major mountainous regions divert the atmospheric flow and form various scales of atmospheric circulations. These topographic formations, together with the landscape variability, result in the formation of regional climatic conditions that vary significantly from place to place. This is especially true for the eastern part of the Mediterranean where the Greek and Asia Minor peninsulas are separated by Aegean Sea. Both the southern and northern areas of the Asia Minor peninsula are characterised by steep mountains. The island of Cyprus is located at the lee side of the Asia Minor peninsula where the flow always exhibits a cyclonic type of circulation. The area of Cyprus is known for cyclogenetic activity that is the subject of forced anti-clockwise circulation initially along the Aegean and then around the Asia Minor peninsula over a relatively warm sea.

The climatic conditions of the East Mediterranean Region can be roughly divided into cold and warm periods. The cold period of the year (December – March) is characterised by the low index circulation that is associated with intense cyclogenetic activity. During the cold period, cyclogenesis is a common characteristic in some locations. The anticyclonic type of circulation during this period is associated with cold core anticyclones laying over the Central Europe or Balkan Region.

The warm period (June – September) is characterised by high index circulation where the North Atlantic lows pass over Europe and only edges of the fronts reach the northeast part of the Mediterranean (Kallos et al., 1993; Kassomenos et al., 1995). During the warm period, the entire Mediterranean Region is occupied by anticyclonic activity and large scale subsidence. This period of the year is highly controlled by the balance between the North Atlantic anticyclone (that extends towards Mediterranean) and the monsoon activity over the Indian Ocean and the Middle East. A pressure gradient between the western and eastern part of the Mediterranean ranges from 10 to 40 hPa, with 20 hPa being the more typical gradient (Millan et al., 1997; Kallos et al., 2007).

During the transient seasons of spring and autumn, the synoptic circulation varies between cold- and warm-types. Each of the transient seasons extends for approximately 2 months, April and May for spring and October and November for autumn.

Typical tracks of the low systems that reach Cyprus are:

- From the west along the Central Mediterranean and south of Crete. These lows are generated in the Western Mediterranean (mainly in the Gulf of Genoa or Gulf of Lions and at the lee side of Atlas Mountains) from the northwest following a path over the Greek Peninsula and north of Crete. Such lows are relatively weak but are rejuvenated in the South Ionian and/or Aegean Sea. These systems are the results of cold outbreaks from central and eastern Europe initially moving towards the Balkan and Black Sea Regions and then along the Ionian and Aegean Seas. They are synoptic systems that provide significant amounts of precipitation in Cyprus.

- From the south-southwest to southwest. These are lows generated in the area of the Atlas Mountain or the Gulf of Syrtis that move eastward along the North African coast. These lows are one of the major suppliers of rain in the Middle East as well as in Cyprus. These systems appear very often during the spring season.

During the cold period, outbreaks of cold air occur over the Asia Minor Peninsula. This cold air provides significant amounts of snow over the mountainous regions of Turkey, but not in Cyprus since the air reaching the area is dry. Such outbreaks of cold air, however, sometimes lead to cyclogenesis in the area of Cyprus (Kallos and Metaxas, 1980).

In addition to this synoptic pattern, the regional component of the flow is also considerable due to thermal circulations developed in the area. More specifically, the land of North Africa is almost bald and closer to the equator, so it receives high levels of solar radiation during daytime hours, which heat the land to high temperatures. The land of southern Europe is mostly covered by vegetation and is at 10º to 15º higher latitudes and therefore is not heated to the extent it is in the North African area. Mediterranean water temperatures are significantly lower than land temperatures and remain constant day and night. Thermal circulations form, and during the day-hours, sea-breeze cells develop with variable strength. Sea breezes during the day-hours are strong over the North African coast and penetrate deep inland. Sea breezes over the European coasts are not as strong and in many places do not develop at all due to steep topography. The combination of synoptic circulation with a strong component from north-to-south and thermal circulations like the sea breezes have the effect of the weakening European-coast sea breezes and strengthening other breezes along the North African coasts. This differential heating between the land of North Africa and southern Europe with the Mediterranean waters has a resulting strong net flow from north-to-south and is associated with large-scale subsidence over the Mediterranean waters. This mechanism is much stronger during the warm period of the year and leads to the formation of the trade winds along the Aegean called “etesians” or “meltemi.” The etesians are regional-scale thermal circulations that exhibit considerable daily variability. More specifically, the synoptic scale pressure gradient in the area is enhanced during the day-hours because of the development of a thermal low over Turkey. The etesians are strong winds that blow along the Aegean Sea and veer towards the southeast over the Eastern Mediterranean and Cyprus (Kallos et al., 1993).

Synoptic classification for the Northeast Mediterranean is useful in examining the frequency of appearance of the various synoptic patterns, the resulting in-flow, and weather conditions. This information is also useful in understanding basic characteristics of scales, paths, and transformation of air pollutants, especially those transported from southern and southeast Europe to the Northeast and Eastern Mediterranean.

A synoptic classification scheme for the Northeast Mediterranean has been developed at the framework of the T-TRAPEM project (Kallos et al., 1996; Varinou, 2000). This scheme has been modified accordingly to fit the specific synoptic conditions in the area of Cyprus. It is based on the analysis of the synoptic maps and surface observations over a 10-year period (1986 to 1996). The resulting classification scheme consists of 12 synoptic categories (**Table 4.1**).

Table 4.1. Synoptic classification scheme for the Northeast Mediterranean.

Synoptic Classes	Main Characteristics	Relative Frequency (%)	Resulting Winds in Cyprus
1	A strong pressure gradient develops over the Aegean Sea and the area of Bosporus behind a low pressure system or a cold front that has passed over Greece and north or south of Crete	10	WSW – NNW
2	A high pressure system over central or eastern Europe and the Balkan Peninsula	8	NW – NE
3	Extension of the Siberian anticyclone towards the west or southwest Europe	3	NW – ENE
4	A deep low covers the Central Mediterranean area and Cyprus is ahead or within its warm sector	3	SW – S
5	Etesians	11	W – NW
6	A cold front or trough passing over the Northeast Mediterranean	12	Turn of the winds from SW to NW
7	Westerly flow prevails over the Central and Northeast Mediterranean due to the passage of a deep depression or a sequence of depressions over central Europe	4	W – NW
8	Northeast Mediterranean is behind a cold front or in the cold sector of a low with weak pressure gradient in the Balkan area	6	WNW
9	A weak anticyclonic system covers the Mediterranean Sea and south Europe during the cold period of the year	8	WNW – local upslope/downslope and drainage flows
10	A weak anticyclonic system covers the Mediterranean Sea and south Europe during the warm period of the year	13	Local thermal circulations – sea/land breezes
11	Cyprus is within the warm sector of a weak low	9	WSW
12	A ridge of high pressure covers the Central Mediterranean mainly during the transient seasons and favours warm spells over the Eastern Mediterranean area	13	SW – local thermal circulations – transport of desert dust

The rainy period mainly occurs during the cold and transient seasons. The rain supply systems are lows that move to the Cyprus area from the west (northwest-to-southwest). They are well organised or decaying systems that move eastward and rejuvenate as they are supplied by cold air massed from the north through the Ionian or Aegean Seas. These lows are well known in literature as “Cyprus Lows,” and named by Fandy (1946) and referred to in Reiter (1975). Such systems are associated with synoptic categories 1, 3, 4, 6, and 8 as listed in **Table 4.1**.

Cyprus has relatively high levels of humidity because of the long paths of flow over the sea even during the cold period of the year when the sea surface temperature (SST) is 12ºC to 16ºC. During September and October, the SST is still high (24ºC to 26ºC), while the winds are relatively low. This leads to high humidity levels, especially in the coastal areas.

The dominant wind direction is from the southwest-to-northwest sector due to the general circulation and local thermal circulations. In general, during the winter the winds are from the southwest-to-north and occasionally from the north-to-east. During spring, winds are from the west-to-north while during the summer and autumn they are from the west-to-northwest. The windiest parts of the island are in the western and southwestern areas.

Due to orographic formations and the orientation of the island with respect to the topographic formations of southern Turkey, remarkable local circulations will dominate certain locations. Sea/land breezes develop over the coastal areas due to temperature contrasts between the land and water. In general, these sea breezes are stronger during the warm period of the year when they start early in the morning and last until evening. The maximum wind speed occurs during late afternoon. The onset and cease times of sea breezes depend on the orientation of the coastline, orientation of the cell with respect to the synoptic scale flow, position and characteristics of nearby orographic barriers, landscape, and other factors. Sea breeze strength varies from 3 to 6 m/s, and even as high as 9 m/s if combined with upslope flows and not opposed by synoptic winds. Sea breeze rotation is either clockwise or anticlockwise depending on the orientation of the coastline. In general, in areas where the land is to the west of the sea, rotation is clockwise, and where the land is to the east of the sea, rotation is anticlockwise. Sea breezes can penetrate inland by a few tens of kilometres, but this is subject to the existence of topographic barriers, especially near the coastline. Sea breezes are supported by anabatic winds that are due to the slopes and orientation (azimuth) of the topographic formations and the time of day.

Land breezes appear after late evening until the first morning hours. The onset and cessation of land breeze cells are subject to the season and slopes of the topographic formations as well as the azimuth of their slopes. These cells are relatively low-speed circulations (2 to 4 m/s) that are difficult to separate from katabatic and drainage flows. The main windward areas of Cyprus are the Toodos Mountains and its slopes that are mostly oriented toward the west/south and north.

In general, all coastal areas of Cyprus are windy, due either to exposure in the synoptic or local forcing. The sector from northwest-to-west and southwest is considered the windiest due to exposure to the prevailing wind flow that is generally from the northwest. Other areas are characterised by moderate winds, except the northern and southern regions where peak winds are associated with extreme weather systems.

Western Coastal Areas

During the cold period of the year, prevailing winds are from the western sector (from north-to-south) due to synoptic-scale forcing and are moderate to strong. During the warm period, the synoptic pattern results again in winds from the western sector. This wind circulation is enhanced by sea breeze and upslope circulations during the day, while at night land breezes, katabatic winds, and drainage flows oppose the synoptic-forcing winds. During transient seasons, the situation transitions between the cold and warm season characteristics.

Southern Coastal Areas

During the cold period of the year, the prevailing winds are from the west-to-southwest and sometimes appear from the east. During the warm period and transient seasons, the resulting flow is the combination of western synoptic-scale forcing with the southern thermal-circulation forcing. In general, winds are light to moderate with directions ranging from south to northwest according to the daily cycle.

Eastern Coastal Areas

During the cold period of the year, winds are from various directions with light to moderate strength. Local circulations are weak during the cold period, strengthening during the warm period and becoming similar to synoptic forcing. During the warm period, prevailing winds are mainly from the southwest, which results in strengthening the winds in areas where the sea breezes have the same direction as the synoptic flow and reducing them where the breezes blow in the opposite direction.

Northern Coastal Area

During the cold period where thermal circulations are weak, the resulting flow is from the west and, under certain synoptic conditions, from the east. Orographic blocking assists in this wind direction. During the warm period when thermal circulations are strong, the resulting flow is mainly from northwest-to-northeast.

Inland Areas

From the inland areas, the west-, north-, and south-facing slopes of Troodos Mountain are characterised as windy, while the eastern slopes are characterised as leeward areas. The Kyrenia Range is, in general, characterised as a light wind region with exception during strong synoptic forcing with winds from the north to east. The other inland locations are characterised by high wind variability during the seasons and the course of the day. Gusty winds are observed in the plain areas under certain synoptic forcing, mainly associated with extreme weather events.

4.1.1.2 Air Quality

General Characteristics

Air pollution in Cyprus has become a major problem in several areas during the last century. This is especially true for the Mediterranean Region for many synergistic reasons. Initially, the main problem was the so-called industrial-type air pollution, which is mainly associated with industrial activities and central heating. During the last few decades this type of air pollution has tended to be replaced by photochemical pollution, which is associated mainly with traffic. During recent years, other types of air pollution sources such as shipping and airport activities (take-off, approach, landing, taxiing, testing of engines, airport vehicles, etc.) have also come into consideration.

The primary pollutants entering in the photochemical cycles are nitrogen oxides (NO_x), mainly nitric oxide (NO) and nitric dioxide (NO_2), and volatile organic compounds (VOCs). Another important group of air pollutants are the oxidants (e.g., ozone [O_3] or peroxyacetal [PAN]), which are by-products of the aforementioned primary compounds. The various air pollutants react with other chemical species in the atmosphere, forming a large variety of other species. Some of these chemical processes are induced by insolation. Different chemical cycles (e.g., nitrogen or carbon cycles) may compete, and the products might be completely different. During the last two decades, aerosols in the atmosphere came more under scrutiny because of implications that range from disturbances in the radiation budget and cloud formation (and therefore climate) to health. Aerosols and, in general, particulate matter (PM) are of different origin, and their compositions and properties vary significantly. One category of aerosols is associated with photochemical processes, especially gas-to-particle conversion. Another category is associated with natural sources. PM from natural sources arises from soil dust, sea salt spraying, pollen from the trees, etc.

The transformation processes of air pollutants in the atmosphere, and in particular, photochemical processes, are highly nonlinear because of the sensitivity exhibited by the primary cycles of reactions (mainly nitrogen and organic compounds). Because of different rates of production/destruction of oxidants from the primary cycles of reactions, the distribution of various air pollutants entered into the photochemical cycles exhibits significant spatial and temporal variations. Such variations could also be due to the spatial and temporal distribution of the emissions. In addition, other important factors controlling these variations are meteorological conditions and landscape characteristics (orography, vegetation cover, and soil properties), mainly their spatial variations. These are the most important factors controlling the air quality in urban or rural areas; their roles are briefly described below.

Spatial-temporal Distribution of Air Pollutant Sources

The spatial and temporal distributions of various sources of air pollutants directly influence the observed concentrations and therefore the transformation processes. Spatial and/or temporal variations in emission patterns might significantly affect air quality in an area (and in the neighbouring region). This problem is more pronounced in urban areas where the introduction of new technologies in the automobile industry (e.g., the use of catalytic converters) as well as changes in traffic regulations or modifications in city planning might cause significant modifications in emission patterns and therefore might affect the air quality, both locally and regionally. The construction of an emission inventory is a very complicated problem where several uncertainties might be introduced. Spatial/temporal distributions of emissions can deviate significantly from average conditions that are considered during the compilation of emission inventories. Emission inventories are frequently used in photochemical modeling, but because of the many uncertainties in emission estimates, modelling results can deviate significantly.

Rates of Production/Destruction

The rates of production/destruction of oxidants from primary cycles of reactions are controlled by various parameters such as the ratios between primary pollutant concentrations and meteorological conditions. All branches in the main chemical mechanisms have not been fully understood, and some rate constants are approximations rather than exact estimates. Because of existing uncertainties in emission inventories, ratios between some primary pollutants, especially NO_x/VOCs, might vary significantly. Such a variation might lead the photochemical calculations towards another direction entirely. This is especially true in cases where polluted air masses of different ages are mixed or high amounts of PM are present. Such cases are common in the Mediterranean region where urban or industrial plumes travel long distances within the marine boundary layer or within the lower troposphere where they are mixed with local sources.

Meteorological Conditions

Meteorological conditions of various scales are considered very important because they control the transport, transformation, and removal processes. Without a detailed description of the meteorological fields, the photochemical processes cannot be accurately described. Most urban air quality studies consider a region of about 100 km around the city under study. The main reason for that is the consideration of thermal circulations in the vicinity around the city limits. This has been shown to not always be correct (e.g., Kallos et al., 1993, 1994; Rao et al., 1995) because the so-called mesoscale circulations, which exhibit diurnal variations, cover areas larger than the urban areas. Even the so-called regional-scale phenomena exhibit significant diurnal variations due to differential heating. Local weather conditions (at urban scale) and the associated circulation results from synoptic, regional, and meso- and microscale interactions. Inaccurate consideration of any of these scales in air pollution modelling can affect the local circulations and therefore local conditions. These are cases that will be seen in prognostic model simulations (e.g., Kallos et al., 1994). Local meteorological conditions of an urban area are affected significantly by the topographic characteristics existing in the vicinity. The shape and orientation of the coastline and/or the topographic ridges (e.g., hills, mountains) in a region around the urban area of interest are some key parameters for the formation of local circulations. Large-scale topographic ridges can create channeling of the synoptic- and regional-scale flow, which might significantly modify local atmospheric conditions in an area. Such local flow characteristics play very important roles in urban and regional air quality.

Landscape Characteristics

Landscape characteristics, mainly their spatial variations, are very important as well and play a significant role in the formation of local atmospheric conditions and in the removal processes. The effects of the landscape characteristics and especially their horizontal variations on the boundary layer growth were the subject of several studies in the past (e.g., Segal et al., 1988, 1989, and references therein; Avissar and Pielke, 1989; Pielke et al., 1991; Pielke and Uliasz, 1993). The association of the landscape variability with the dispersion characteristics has been an important subject of study during the last years (Pielke and Uliasz, 1993). Kallos (1995) discussed the relation between land-use changes, city planning, and air quality. It was demonstrated that land-use changes can cause climatic changes at local or regional scale according to the scale of intervention. In an urban environment, such landscape variations can control local atmospheric conditions and therefore air quality.

Transformation Processes

The transformation processes, especially the photochemical ones, exhibit latitudinal and longitudinal variations. Latitudinal variations are associated with the amount of solar radiation reaching the lowest atmospheric layers and the ground, and longitudinal variations are associated mainly with regional landscape characteristics. Such variations were found to be very important in Europe and especially in the Mediterranean region. As it was found from various research programmes (e.g., MECAPIP, SECAP, Transport and Transformation of Air Pollutants from Europe to the Mediterranean/T-TRAPEM), the urban plumes keep their characteristics for hundreds of kilometres away from their sources (Millan et al., 1992; Kallos et al., 1995). According to the findings of these research projects, photochemical pollution is not only an urban-scale problem but also a regional one. A brief description of the results obtained so far in the Eastern Mediterranean Region is given below.

Long-range Transport in the Mediterranean Region

The climatic conditions in the Greater Mediterranean Region (GMR) are known to have significant regional scale characteristics capable of long-range transport. The climatic patterns and physiographic characteristics of the GMR force air quality in the area to exhibit remarkable spatiotemporal variability.

The major pollutant sources of anthropogenic origin in the Mediterranean region are located in Europe. The existence of mega-cities (e.g., Istanbul, Cairo, and Athens), industrial activities, and energy production/consumption in the area have resulted in elevated emissions of several pollutants such as NO_x, sulphur (S), carbon monoxide (CO), nonmethane hydrocarbons (NH_3), ammonia, etc. It is evident that sources of anthropogenic pollutants are located mainly in central and southern Europe, with minor contribution from North Africa. Besides anthropogenic PMs, is the marine environment also contributes PM with production of salt spray and dimethylsulfide (DMS) (Kouvarakis and Mihalopoulos, 2002). According to marine biologists, atmospheric input of nutrients to the marine environment is just as important as inputs from rivers (Herut et al., 1999).

Concentrations of various pollutants (primary and/or secondary) are found to be significant in remote locations and may occur in multiple-layer structure up to a few kilometres above the surface. For the GMR, the term of tropospheric ozone transport and its precursors should be of great interest, as well as the role of O_3 in the production of several other pollutants, such as mercury (Hg). A great number of recent studies have focused on the important role of aerosols in air quality of a specific area due to the potential impact on human health and ecosystems. Aerosol concentration and deposition patterns are important, along with O_3 and its precursors, especially with respect to predicting air quality degradation episodes. Desert dust is another crucial component that contributes to air quality degradation of the GMR.

A considerable amount of work was devoted to analyzing and studying the paths and scales of transport and deposition of O_3 and aerosols in the GMR, resulting from both natural and anthropogenic influence. Levels of atmospheric gases and aerosol are monitored in ambient air quality networks because of their potential impact on human health, visibility, and climate. As suggested in previous studies (Kallos et al., 1995; Kallos, 1999; Millan et al., 1997), the synoptic/regional circulation during summer favours the long-range transport of air pollutants released from southern and eastern Europe and the Central Mediterranean towards the Eastern Mediterranean, North Africa, and Middle East. Projects like MECAPIP, SECAP, and T-TRAPEM provided the first information about the re-circulation mechanisms, layering, paths, and transformation processes, mainly the photo-oxidants (Kallos et al., 1997; Millan et al., 1997). The mechanism of Saharan dust transport towards the Mediterranean and Europe was the subject of other projects (e.g., MEDUSE). This cooperating effort continued at the framework of the BEMA, MAMCS (Pirrone at al., 2003), SUB-AERO (Lazaridis et al., 2006), and ADIOS projects.

Several studies in the past have identified the paths and scales of transport of gases such as O_3 and NO_x in the atmosphere. A large amount of anthropogenically-generated gases and aerosols (e.g., sulphur dioxide and sulphates) contribute to increased concentrations of pollutants in the atmosphere and to the reduction of visibility. This is mainly attributed to fine particles that are capable of long-range transport influencing the air quality in remote locations. In addition, natural aerosols, whose main source of origin is the Sahara desert, contribute significantly to increased particle concentration in the atmosphere. The Sahara is the largest desert in the world, and Europe is frequently exposed to large amounts of dust generated in intense dust storms. Therefore, dust particles affect the air quality of a specific region mainly as episodic phenomena. Several studies in Europe and other parts of the world suggest that fine desert particles (around 2.5 μm in size) are a considerable portion of the entire dust production and can travel thousands of kilometers, affecting remote locations (Prospero et al., 2001; Uno et al., 2001; Kallos et al., 2007).

The findings of research conducted during the last 20 years on the long-range transport of air pollutants over the Mediterranean, especially the eastern part, is summarised in the recently published work of Kallos et al. (2007). Emphasis is given to the convoluted effects of both anthropogenic and naturally-produced air pollution and to air quality degradation at various scales. Long-range transport over the eastern part of the Mediterranean is summarised in **Figure 4.1**.

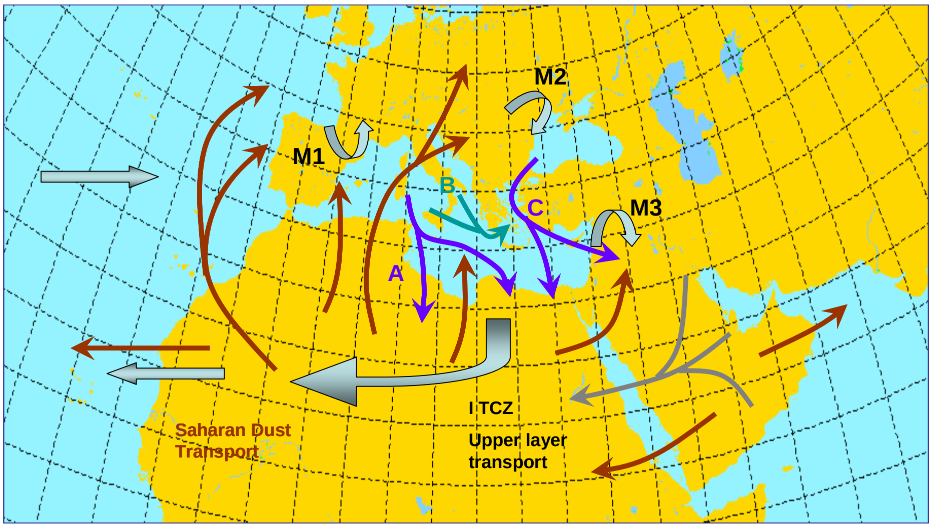


Figure 4.1. Characteristic paths and scales of transport of air masses in the Euro-Mediterranean Region. The blue, green, and grey arrows indicate transport paths of anthropogenic pollutants in the Euro-Mediterranean Region (ozone sulfates, etc.). The grey arrows are associated mostly with the upper layer transport, the blue and green ones with movement of pollutants in the lower troposphere layers. The red-brown arrows indicate transport of desert dust from the North Africa region (From: Kallos et al., 2007).

More specifically, **Figure 4.1** also illustrates the following:

- Transport of air masses from Europe towards the Mediterranean Sea, Middle East, and North Africa occurs during all seasons, with summer being the most efficient (transport paths A, B, and C).

- Air quality in various locations in the Mediterranean Region, especially near the coast, is mainly defined by thermal circulations (diurnal cycle) (paths M1, M2, and M3), but the long-range component is also considered to be significant.

- Venting of urban or industrial plumes located near the coastal zone occurs through two different paths:

    1. Towards the free troposphere with the aid of the upslope flows during day-hours.

    2. Towards the marine boundary layer, where they are trapped and travel long distances until they reach land.

- The transport over Mediterranean waters mainly occurs within the Marine Boundary Layer (MBL). Polluted air masses from the MBL are injected in the free troposphere, and in several locations the existence of islands acting as chimneys contributes in a significant way to the described behaviour.

- Some locations of the Mediterranean Region act as “temporal reservoirs” where air pollutants are “concentrated” and “aged enough” before they are re-advected again (e.g., Black Sea and Western Mediterranean) (path C).

- In the Western Mediterranean, vertical transport is considerable and leads to multiple layering (path M1), while in the Eastern Mediterranean the horizontal component of transport dominates.

- In general, the time scale of transport of air masses from Europe to the Middle East is approximately 2 to 3 days (transport paths A, B, and C). Transport from the western part of the Mediterranean to southeast Europe is in the range of 1 to 2 days. Transport from the western part of the Mediterranean to the Middle East and northeast Africa is, in general, longer (3 to 4 days) (transport path A).

- Air quality in urban areas of southeast Europe, North Africa, and the Middle East is significantly affected by the long-range transport patterns described because the time scales are still within the life span of most of air pollutants.

- During summer, the Inter-Tropical Convergence Zone (ITCZ) is located in northern Africa, south of the Mediterranean coast (25^{o} N to 30^{o} N), over southern Libya and Egypt where strong convergence lines occur.

- Air masses from Europe should reach the mid-tropospheric layers of the Equatorial Zone within a time period of a few days (4 to 6). This results in a massive upward transport of various aged pollutants.

- Mixing aged pollutants with dust particles existing in the area can produce new types of particle formations.

Long-range Transport and Influence of Air Quality in Cyprus

Cyprus is affected by the long-range transport of air pollutants of both anthropogenic and natural origin. Air pollutants of anthropogenic origin that reach Cyprus originate mainly upstream of the main flow patterns. These pollutants are emitted from sources located in eastern Europe, the Black Sea, and the Balkan area as well as the Western Mediterranean, Greece, and Turkey. Under certain circumstances, long-range transport occurs from the coastline of Egypt, Israel, Lebanon, and Syria due to the blocking of the flow along the Middle East coastlines and deflection towards the north, especially during the night hours (Wanger et al., 2001). The long-range transport of anthropogenic pollutants towards Cyprus is more efficient during the warm period of the year because of trade winds and the absence of precipitation. As it was found in Luria et al. (1996), the amounts of sulphates reaching Israel during summer are very high compared to other selected locations, with the highest amounts observed during the warm period of the year. Dispersion patterns of polluted air masses released from various sources in Europe are shown in **Figure 4.2**. These patterns are typical for gas as well as for PM of anthropogenic origin.

Photochemical pollution in the Mediterranean results in the formation of high O_3 concentrations as well as aerosols. Typical patterns of O_3 concentrations are shown in **Figure 4.3**. Ozone produced during the previous days is transported and remains almost untouched during the night hours over the sea. This kind of transport is more important in the mountainous regions of the island of Cyprus because transported O_3 is even higher at higher atmospheric levels. Similar patterns are observed for aerosol formation (sulphates), which is an indication of long-range transport (see **Figure 4.4**).

Desert dust is transported towards Cyprus mainly during the transient seasons of spring and autumn and arises from the Sahara (Michaelides et al., 1999). It occurs secondarily from sources in Syria and Turkey when a low system is located over the Middle East. Dust transport is a rather episodic phenomenon. The transport of dust towards Cyprus exhibits similarities with dust transport towards Athens and Greece. Analysis of dust transport towards Greece indicates that dust transport occurs approximately two-thirds of the days, contributing significantly to air quality degradation. Dust is usually transported from the Sahara towards Cyprus under anticyclonic conditions or ahead of a trough. Under such circumstances, air masses within the lowest few kilometres of the troposphere are warm and dry and therefore favourable for stable conditions and formation of stagnation. In such cases, local air pollution sources do not disperse; sunshine and moisture within the marine boundary layer assist in aerosol formation. This aerosol formation and the simultaneous dust transport increase PM concentration in the atmosphere and reduce visibility.

In Cyprus, the most important industrial installations are power plants. Airports and sea ports also are considerable sources of pollutants. The major urban conglomerate is Nicosia, on the mainland. While coastal cities and recreation areas contribute to air quality degradation by adding emissions from traffic, heating, and cooking, these emissions are not at critical amounts that can cause significant violations of air quality. Since the long-range component of air pollutant transport is considerable, local emissions can additively increase local concentrations, especially in coastal areas due to recirculation processes.

Urban and industrial plumes can travel long distances and retain their characteristics for some days, affecting air quality in remote locations, urban or not. For the case of Cyprus, the contribution from such remote sources is quite significant. This is more obvious for sources near the coast and for cases with weather conditions favouring the transport of emitted pollutants towards/over the sea. The transport from southern Europe towards Eastern Mediterranean waters occurs during all seasons but mainly during summer. During summer, transport is increased as a result of stable conditions prevailing in the region (mainly due to large-scale subsidence), the absence of removal processes, the appearance of trade winds, and the insolation. In general, the transport occurs from north-to-south, and air quality in Cyprus and the Middle East in general is significantly affected.

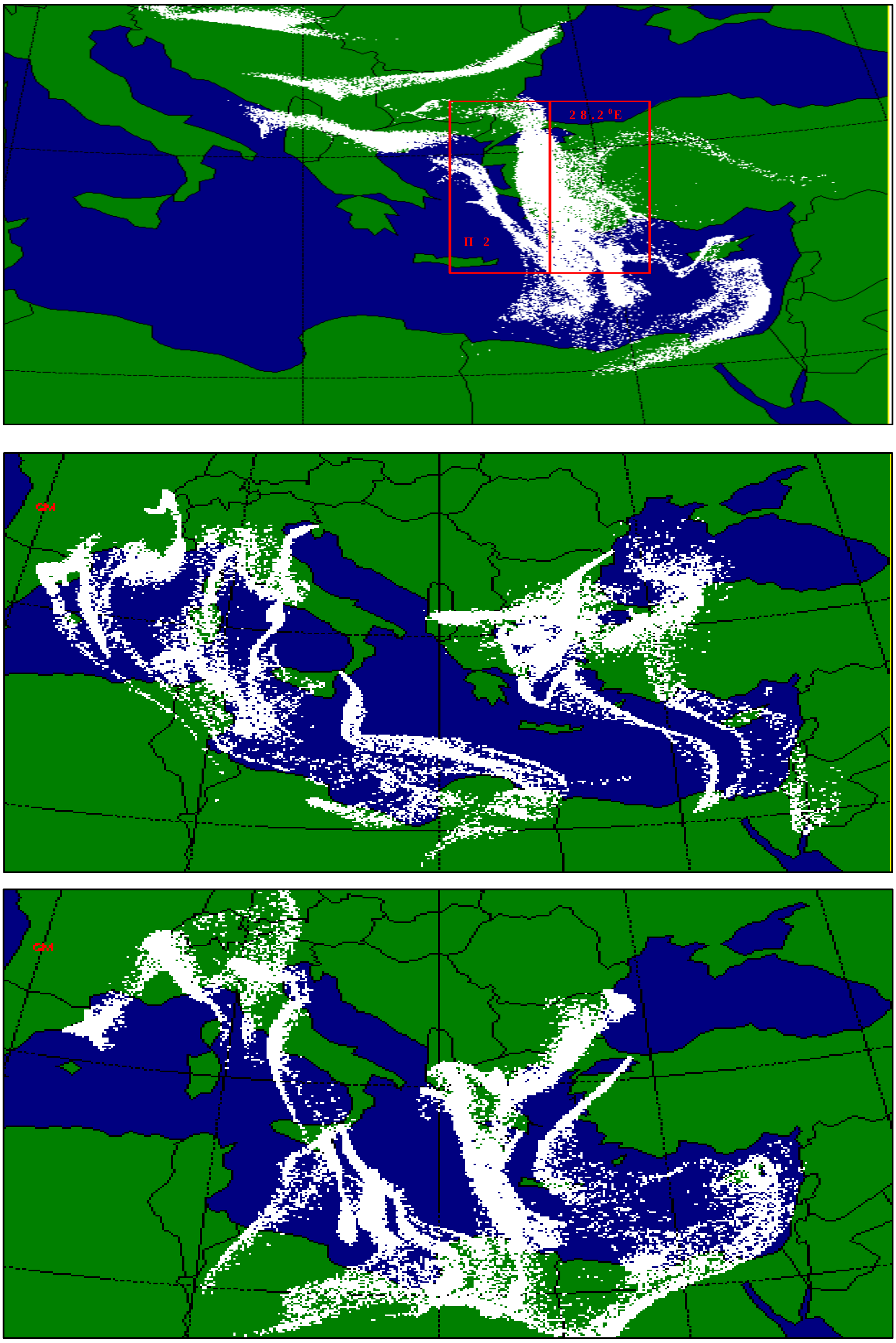


Figure 4.2. Dispersion patterns of air polluted air masses released from various sources located in Europe.

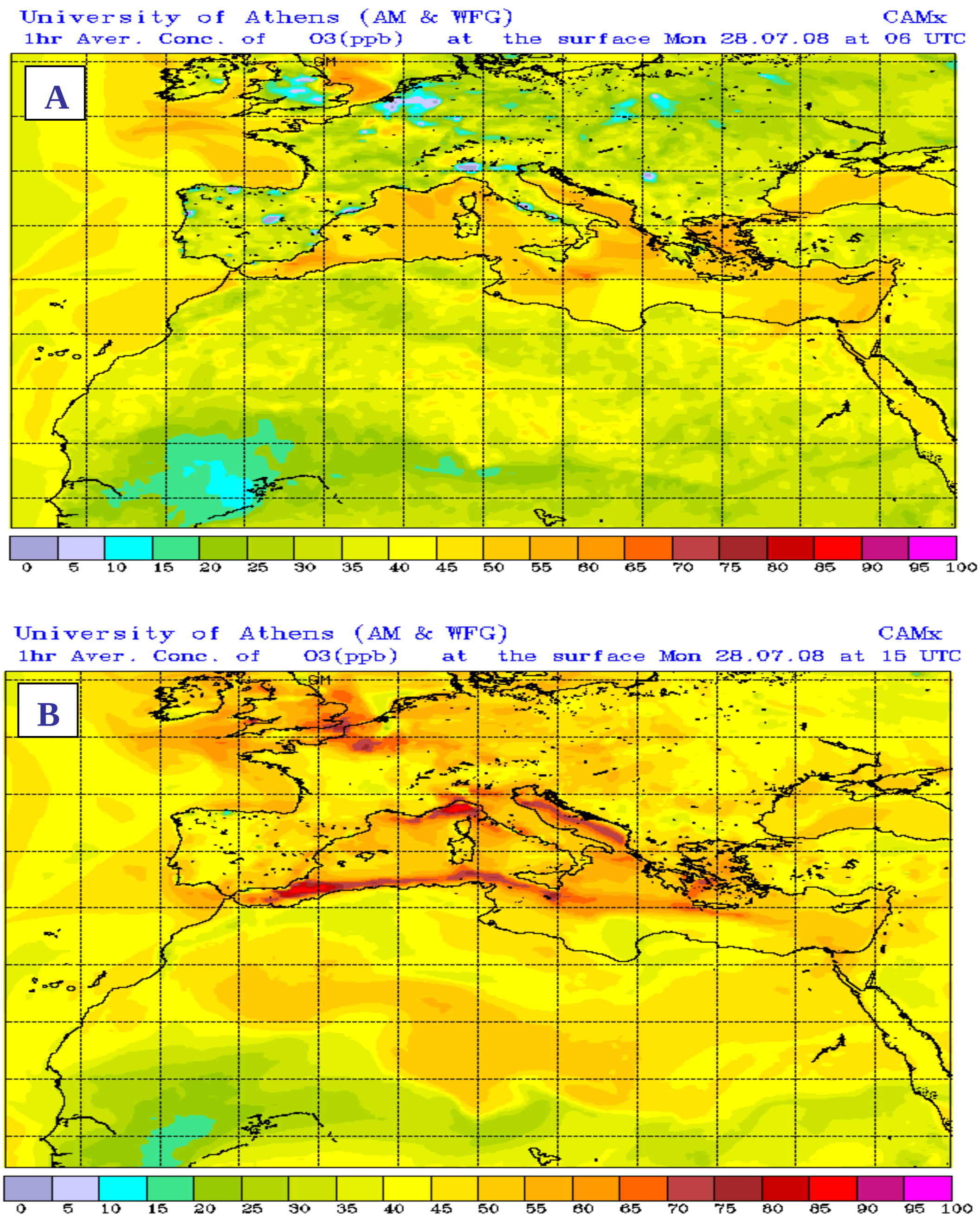


Figure 4.3. Ozone (O_3) concentrations in the Mediterranean Region during morning (A) and afternoon (B) hours.

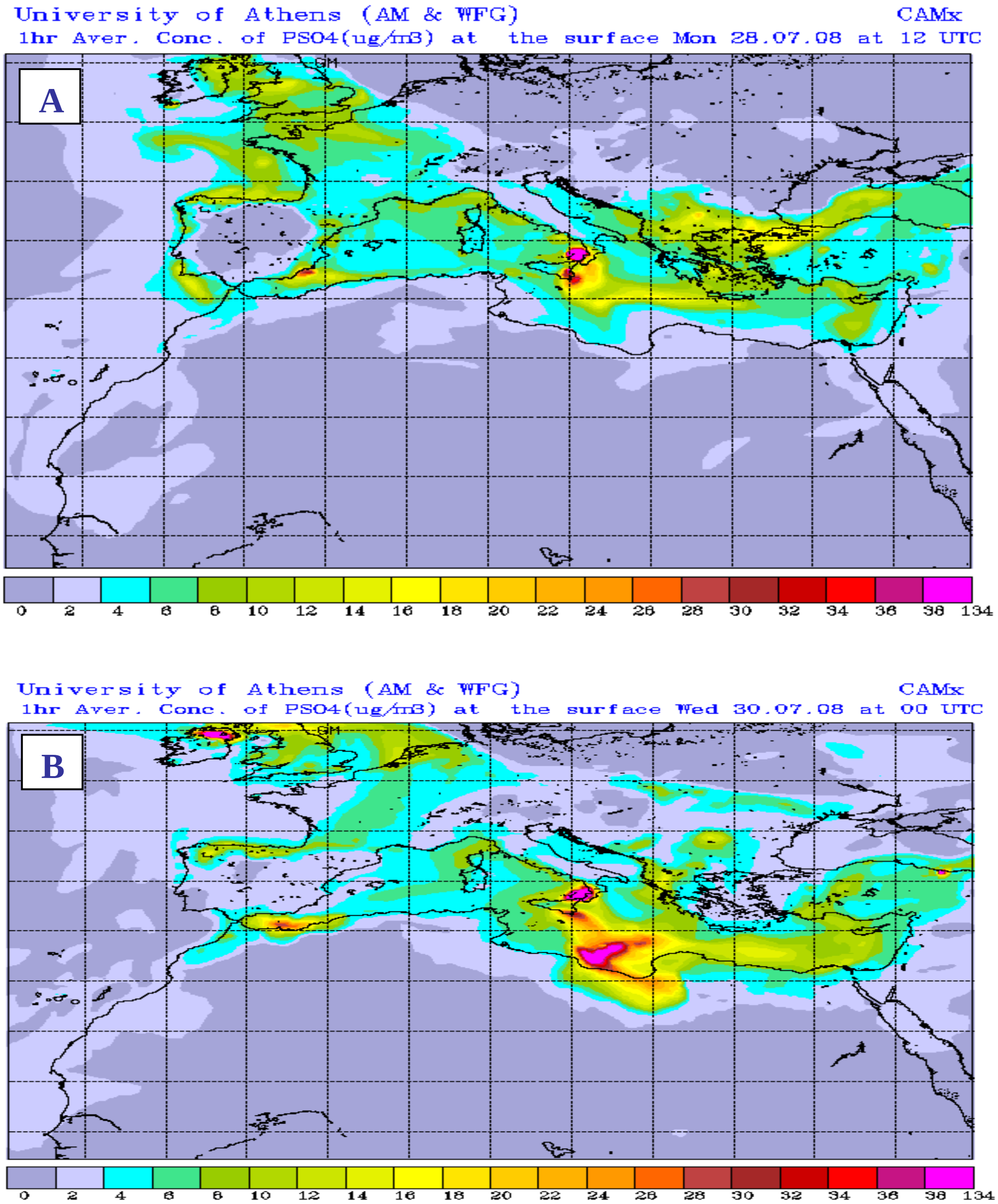


Figure 4.4. Sulphate PSO_4 concentrations in the Mediterranean at noon (A) and midnight (B).

4.1.2 Bathymetry and Topography

4.1.2.1 Water Depths

The Ministry of Commerce, Industry and Tourism provided some bathymetry data for the exploration blocks (542 964 points covering the 13 blocks). The coordinates have been transformed from the WGS84/Zone 36 projection form to regular longitude/latitude coordinates with CoordTrans Pro software. The two-way-time (TWT) data (seismic waves in ms) have been used to calculate bathymetry in metres using the following formula: (1480 x TWT/2)/1000 (i.e., the seismic wave's velocity in water was taken equal to 1480 m/s). The positions of all points are shown in **Figure 4.5**.

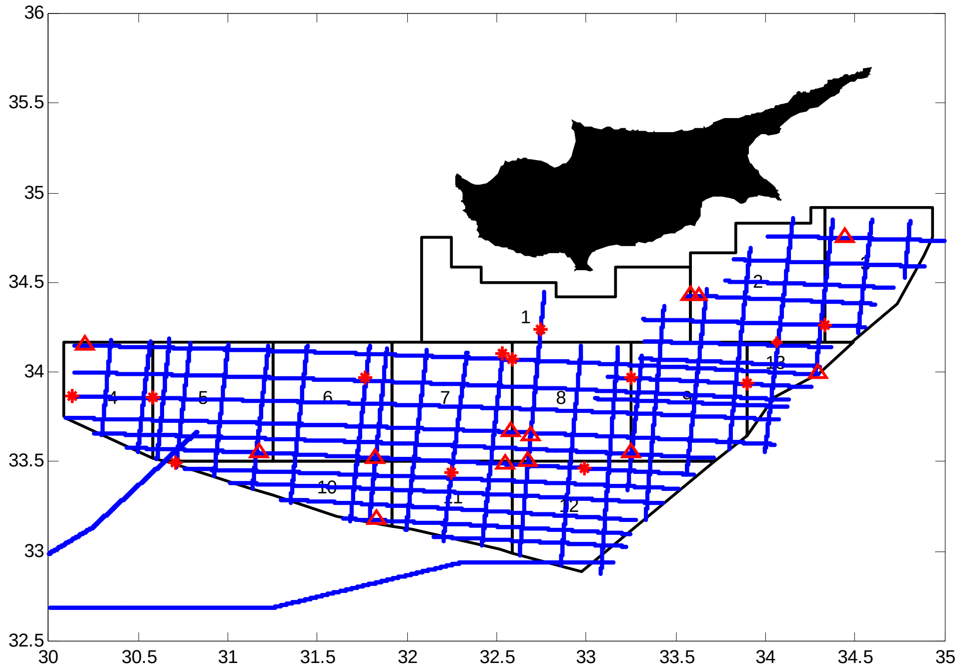


Figure 4.5. Bathymetry data points (blue lines) and positions of minimum (triangles) and maximum (stars) depths in each exploration block (data provided by the Ministry of Commerce, Industry and Tourism).

Table 4.2 summarises some important bathymetry characteristics for each exploration block obtained from the data provided by the Ministry (i.e., average depth and minimum and maximum depths and their locations). The positions of minimum and maximum depths in each block according to these data are shown in **Figure 4.5**.

Table 4.2. Bathymetry data for the 13 exploration blocks (data provided by the Ministry of Commerce, Industry, and Tourism).

Block	**Average Depth (m)**	**Bathymetry Range Minimum – Maximum (m)**	**Maximum Depth Position (Latitude°N, Longitude°E)**	**Minimum Depth Position (Latitude°N, Longitude°E)**
1	1798.4 (8498 pts)	397 – 2574	(32.742328, 34.238406)	(33.583066, 34.429553)
2	1575.4 (37 979 pts)	248 – 2051	(34.067269, 34.168741)	(33.631294, 34.427618)
3	1481.1 (26 152 pts)	782 – 2020	(34.333411, 34.264683)	(34.441750, 34.751602)
4	2678.3 (26 980 pts)	2449 – 2866	(30.128106, 33.866474)	(30.201382, 34.151642)
5	2470.6 (55 165 pts)	2201 – 2750	(30.583354, 33.858286)	(31.176872, 33.554480)
6	2389.1 (46 870 pts)	2002 – 2619	(31.766307, 33.967544)	(31.820320, 33.522039)
7	2195.8 (44 638 pts)	846 – 2613	(32.529693, 34.107103)	(32.582520, 33.670215)
8	1764.0 (45 099 pts)	730 – 2588	(32.583366, 34.073988)	(32.686248, 33.649092)
9	2108.6 (60 237 pts)	1887 – 2351	(33.250022, 33.970227)	(33.251520, 33.547630)
10	2044.9 (31 973 pts)	1652 – 2475	(30.708088, 33.498095)	(31.827992, 33.178014)
11	1621.7 (35 438 pts)	1194 – 2186	(32.244896, 33.443173)	(32.546960, 33.491532)
12	1633.9 (56 051 pts)	1185 – 2026	(32.991247, 33.467558)	(32.672350, 33.500000)
13	2068.1 (18 434 pts)	2010 – 2124	(33.894577, 33.938580)	(34.290505, 33.989811)
Total	**1970.0**	**248 – 2866**	**(30.128106, 33.866474)**	**(33.631294, 34.427618)**

For comparison and in order to plot bathymetry contours, GEBCO data also have been used on a 1-minute grid (GEBCO, 2008). **Figure 4.6** shows bathymetry contours of the GEBCO data together with the 13 hydrocarbon licensing exploration blocks. **Table 4.3** lists important bathymetry and other data for each exploration block based on the GEBCO 1-min data. These compare well with their counterparts in **Table 4.2**. It should be noted that GEBCO data are of higher global resolution, whereas the Ministry data are of higher resolution only along certain trajectories (**Figure 4.5**). Detailed contours for each plot along with the minimum and maximum depth points in each block are provided in **Appendix C**.

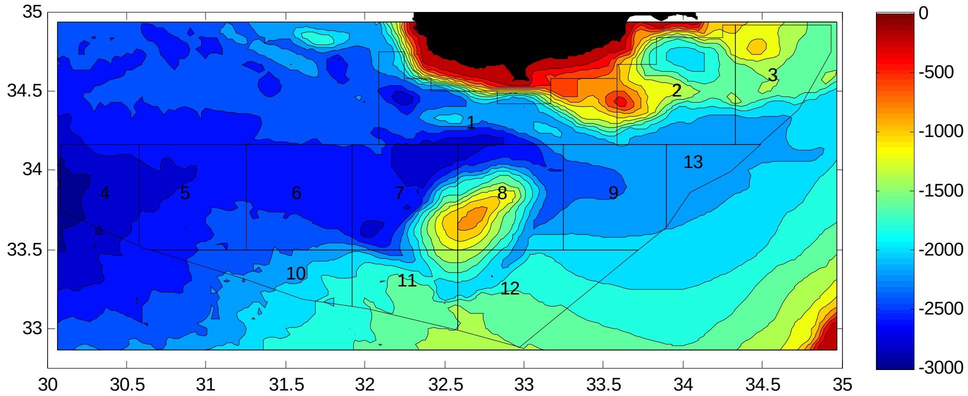


Figure 4.6. Bathymetry contours in the Exclusive Economic Zone of the Republic of Cyprus (hydrocarbon licensing blocks are also shown) (From: GEBCO, 2004).

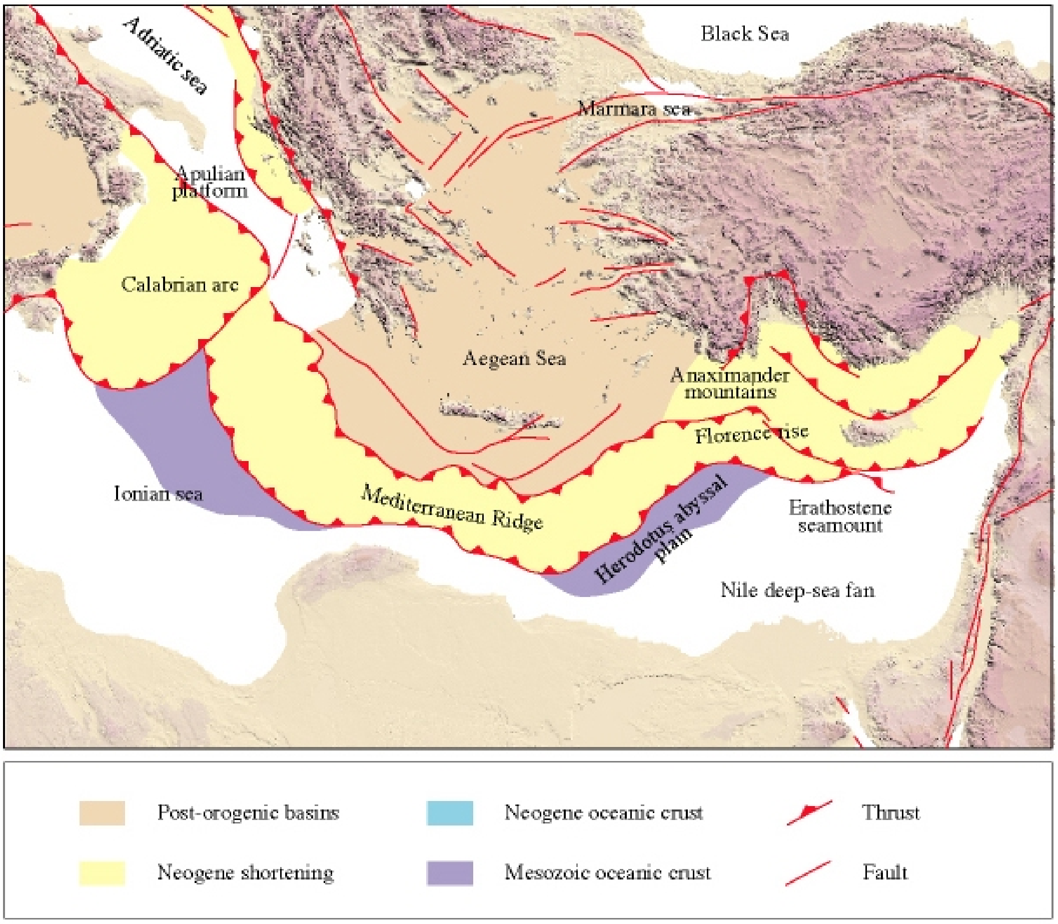
Table 4.3. Bathymetry data for the 13 exploration blocks based on the GEBCO 1-min data.

Block	Average Depth (m)	Bathymetry Range Minimum – Maximum (m)	Maximum Depth Position (Latitude°N, Longitude°E)	Minimum Depth Position (Latitude°N, Longitude°E)
1	1924.8	310 – 2734	(32.200000, 34.450000)	(33.583333, 34.433333)
2	1549.1	266 -2082	(33.800000, 34.166667)	(33.616667, 34.433333)
3	1495.6	869 – 2057	(34.333333, 34.316667)	(34.466667, 34.750000)
4	2712.1	2521 – 3005	(30.083333, 33.933333)	(30.583333, 34.166667)
5	2506.1	2280 – 2704	(30.583333, 33.900000)	(31.250000, 33.500000)
6	2401.2	2033 – 2539	(31.916667, 33.666667)	(31.916667, 33.500000)
7	2262.6	786 – 2703	(32.583333, 34.133333)	(32.583333, 33.633333)
8	1829.8	654 – 2771	(32.650000, 34.150000)	(32.733333, 33.733333)
9	2121.6	1871 – 2403	(33.250000, 34.000000)	(33.250000, 33.500000)
10	2075.0	1671 – 2515	(30.700000, 33.500000)	(31.916667, 33.200000)
11	1674.7	1207 – 2366	(32.133333, 33.500000)	(32.566667, 33.500000)
12	1669.8	1208 – 2119	(32.950000, 33.466667)	(32.583333, 33.500000)
13	2061.9	2020 – 2117	(33.900000, 34.050000)	(33.900000, 33.666667)
Total	**2009.6**	**266 – 3005**	**(30.083333, 33.933333)**	**(33.616667, 34.433333)**

4.1.2.2 Sea Floor Morphology

The physiography of the Eastern Mediterranean sea floor is complex, being under various geodynamic regimes resulting mainly from the convergence of the African and Eurasian plates (Benkhelil et al., 2000). The major feature of the Eastern Mediterranean sea floor is a large arcuate swell, the Mediterranean Ridge, which extends over 1500 km between the southwest of Peloponissos and southern Turkey in an area that includes Cyprus (French Research Institute for Exploitation of the Sea [IFREMER], 2008). Other prominent topographic features include the Nile cone or fan (off Egypt), the Anaximander Mountains (off southern Turkey and northwest of

Cyprus), and the Eratosthenes Seamount and Florence Rise (south and west of Cyprus, respectively). A tectonic sketch of the Eastern Mediterranean is shown in **Figure 4.7**.



Tectonic sketch of the Eastern Mediterranean
(adapted from Barrier, E., Chamot-Rooke, N. and Giordano, G., 2004,
Geodynamic Map of the Mediterranean, Commission for The Geological Map of the World, CCGM)

Figure 4.7. Tectonic sketch of the Eastern Mediterranean (Barrier et al., 2004).

The Mediterranean Ridge is a wide (100 to 200 km) and voluminous sedimentary construction (up to 10 km thick) that results from the accretion and deformation of thick piles of sediment as a consequence of the subduction during at least the last 20 Ma of Africa beneath southern Europe (IFREMER, 2008). According to Robertson and Shipboard Scientific Party (1996), the Mediterranean Ridge is an example of a mud-dominated accretionary complex, while Huguen et al. (2006) describe it as a large, arc-shaped sedimentary wedge, more than 1500 km long and 200 to 250 km wide, which consists of a thick pile (up to 12 km) of offscrapped and stacked elements lying to the west of the exploration area. The Eratosthenes Seamount is the most prominent bathymetric feature between Cyprus and Egypt. It is a large, submerged massif situated on the sea floor of the Eastern Mediterranean about 100 km south of Cyprus, from which it is separated by a deep trough (Mart and Robertson, 1998). It is almost elliptical in shape, nearly 120 km long and 80 km wide, and its major axis is oriented northwest-southwest (**Figures 4.6** and **4.8**). The morphologic relief of this seamount exceeds 2000 m, measured from the peak, at 690 m depth, to the Eratosthenes Abyssal Plain to the west, at 2700 m (Hall et al., 1994). The Seamount is located in the centre of the exploration region and covers most of Blocks 7 and 8, extending southwards to Blocks 11 and 12 (**Figure 4.6**).

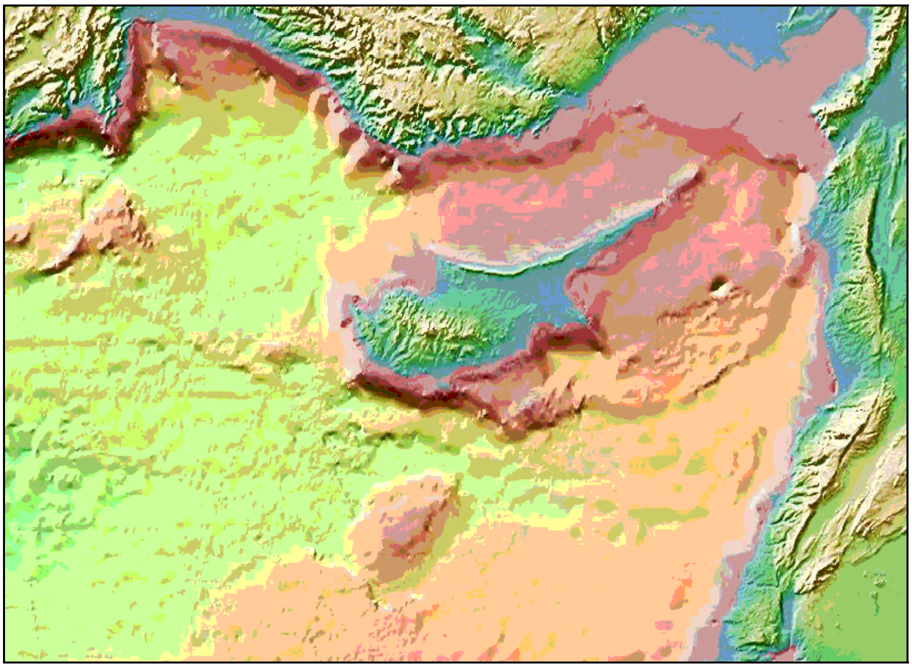


Figure 4.8. Morphobathymetry of the Eastern Mediterranean Sea (Scripps Institution of Oceanography, 2008).

The upper part of the Eratosthenes Seamount, above the 1100-m isobath, is divided into northern and southern level summit areas by prominent fault-controlled declivities, extending as far as the eastern and western flanks (Krasheninnikov et al., 1994; Limonov et al., 1994). The crest of the southern summit is at a depth of 690 m, whereas a subsidiary, northern summit is located at greater depth, above a steeper slope.

Robertson and Shipboard Scientific Party (1996) reported the following: The southern and eastern margins (of the Eratosthenes Seamount) are steep to locally very steep. The northern and northwestern flanks are markedly terraced. The summit area is broadly undulating, with an east-northeast-west-southwest trend. Early seismic data revealed that the northern and southern margins of the seamount are bordered by thick sedimentary basins, here termed the northern and southern basins. Seismic evidence suggests that Messinian evaporites were probably not deposited on the crest of the seamount, but they can be seen pinching out against the southern and western margins. There is no clear seismic evidence that thick evaporites were formed in the northern basin between the Eratosthenes Seamount and Cyprus. Successions of nannofossil muds with sapropels and tephra were cored near the crest of the seamount.

Mart and Robertson (1998) reported that the presence of shallow-marine limestones of Miocene age on the Eratosthenes Seamount indicates uplift before, or during, the Miocene, whereas the overlying Pliocene-Pleistocene successions comprise unlithified hemipelagic sediments that accumulated in deeper water following tectonic subsidence.

Benkhelil et al. (2000) reported that the Eratosthenes Seamount is flat-topped, slightly northward sloping (1%), and pear-shaped, with a tip looking toward the northeast. The surface of the plateau appears to be irregular due to numerous scarps with differences in height ranging between 150 and 200 m. The scarps follow two main directions (N70E and N85E) that reflect the underlying structural grain of the seamount. The seamount slopes show well-marked bathymetric variations, especially on the western side where a cleft shows a difference in height of about 1500 m between the top surface and the adjacent abyssal plain. The southern and eastern flanks are much smoother than those on the north and west. However, the eastern slope is rugged and highly dissected by a dense net of ravines attesting to an important recent erosional phase.

4.1.3 Hydrography and Oceanography

4.1.3.1 Physical Oceanography

Hydrography

The region south of Cyprus covered by the 13 exploration blocks is considered part of the Levantine Basin, which is bounded by the Cretan Passage, and the Africa, Middle East, and Asia Minor coasts. There are four major water masses in the Levantine: Levantine Intermediate Water (LIW), Atlantic Water (AW), Levantine Surface Water (LSW), and Eastern Mediterranean Deep Water (EMDW). The mean properties and main characteristics of the water masses of the southeastern Levantine are discussed in Hecht et al. (1988) and Zodiatis et al. (1998). To describe these water masses it is best to examine the distribution of the thermohaline variables, particularly their vertical profiles and corresponding temperature-salinity (T-S) diagrams.

Figure 4.9 shows T-S profiles and diagrams from a cruise carried out by the Cyprus Oceanography Centre (CYBO-19, September 2005). For this summer cruise, a thin surface layer (approximately 40 m) of very warm and salty water (up to 27^{o}C and 39.5 psu) is visible, a result of extensive evaporation and intense solar radiation during the summer season. In winter (November to March), winds and convective mixing processes homogenize the water column from the surface downward to subsurface and intermediate layers, in some cases even down to 200 to 350 m (Zodiatis et al., 2001). Surface salinity and temperature throughout the year range from approximately 39.0 to 39.5 psu and 17^{o}C to 28^{o}C, respectively, based on remote sensing averages of temperature over the Levantine and upper 10-m averages of temperature and salinity from cruises (Samuel-Rhoads et al., 2008) (**Figure 4.10**). The annual cycle of surface water properties can also be seen by examining a time series of upper ocean temperature and salinity from Block 7, just west of the Eratosthenes Seamount (**Figure 4.11**). This figure shows that near-surface (17-m) temperature peaks in late July and has a minimum in mid-February. The deeper sensors show that from April to October, the upper 38 m are stratified (because of surface heating), while for the remainder of the year the sea is well-mixed over these depths (because of winds and surface evaporation).

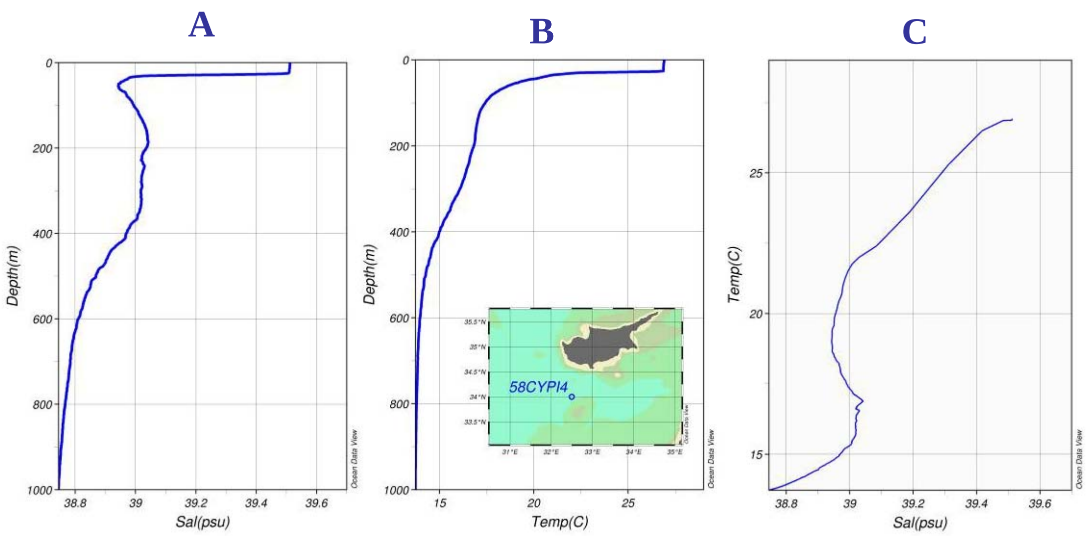


Figure 4.9. *In-situ* (A) salinity and (B) temperature profile data from Cyprus Oceanography Centre cruise CYBO-19 in September 2005. (C) Temperature-salinity diagram. Water masses are Levantine Surface Water (LSW), Atlantic Water (AW), Levantine Intermediate Water (LIW), and Eastern Mediterranean Deep Water (EMDW).

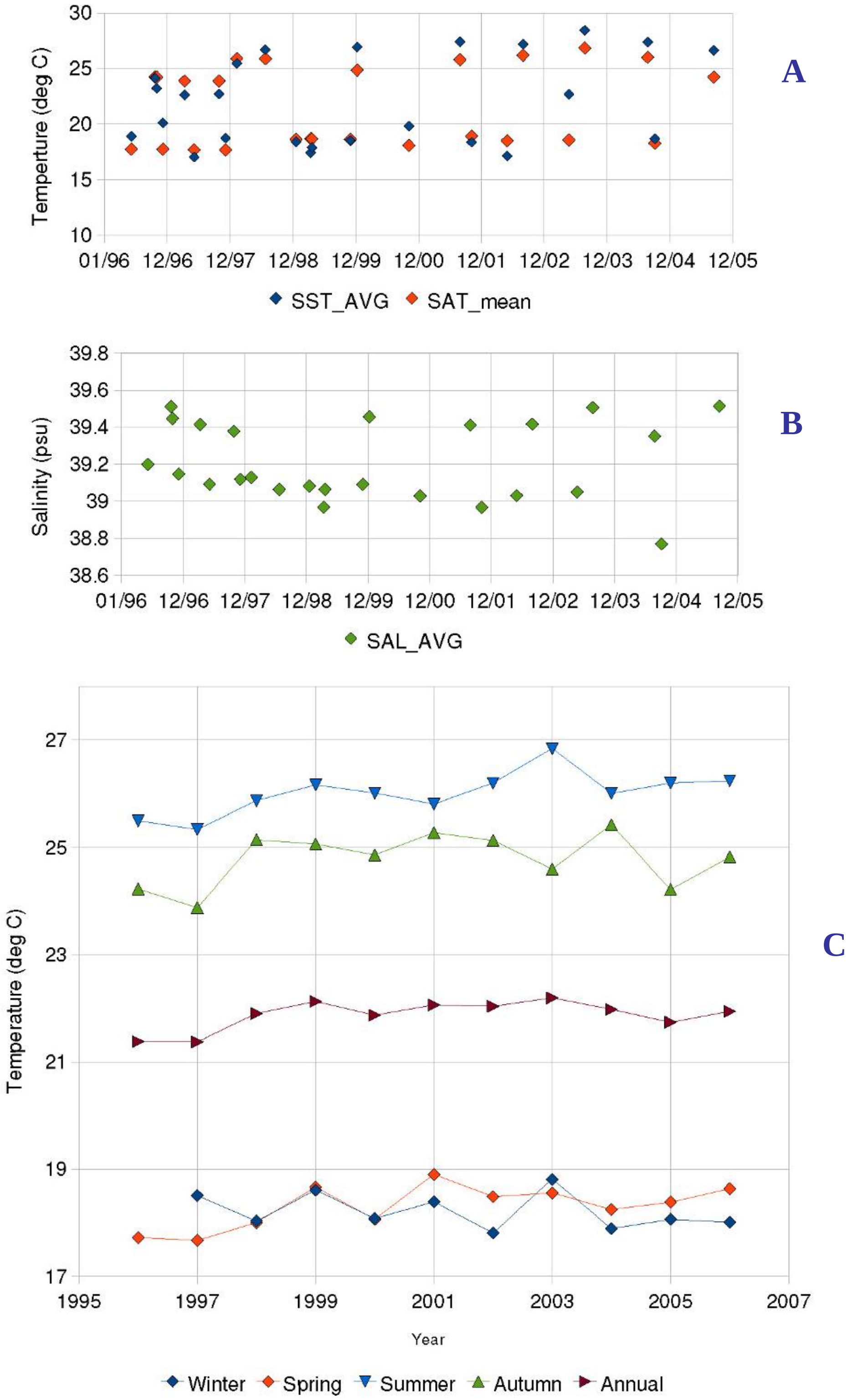


Figure 4.10. (A) Mean surface temperature from the National Oceanic and Atmospheric Administration 2006 (NOAA AVHRR) satellites calculated over the Mediterranean east of 28ºE (orange) and from Cyprus Oceanography Centre cruises (blue); (B) Salinity averages from Cyprus Oceanography Centre cruises; (C) Seasonal and annual means of surface temperature from the NOAA AVHRR satellite data (east of 28ºE).

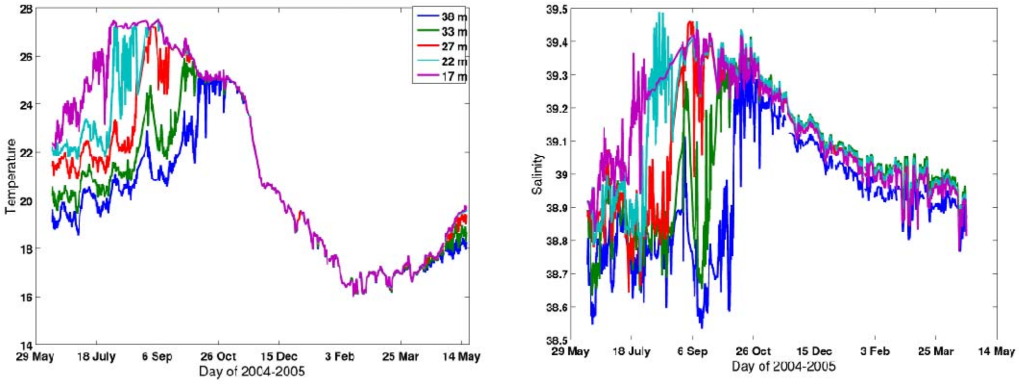


Figure 4.11. Temperature (left) and salinity (right) measured at five depths in the top 38 m at the CYCOFOS MedGOOS-3 Observatory located just west of the Eratosthenes Seamount. During the winter period, all five levels report nearly the same water properties, while during the summer, stratification develops.

In some regions, a meandering jet can be found below the surface mixed layer transferring water of AW origin, identified by a salinity minimum, from the Strait of Gibraltar to the Cretan Passage and into the Levantine (Lacombe and Tchernia, 1960; Oren, 1971; Morcos, 1972). There the AW is most often well-pronounced as a subsurface layer with minimum salinity, spanning 40 to 80 m, with salinity in the range of 38.60 to 38.95 psu (Ovchinnikov et al., 1976; Hecht et al., 1988; Ozsoy et al., 1991). However, surface AW has also periodically been found in the western part of the Levantine with similar salinity values. AW is more often found in summer, since in winter vertical mixing often reaches deeper than its vertical extent. The relatively warm and saline LIW is found from about 200 to 400 m and is the result of winter cooling and sinking of LSW at various locations, including the primary source of the Rhodes Gyre and northern Levantine (Morcos, 1972). LIW has a salinity of about 39.0 to 39.1 psu and temperature of 15^{o}C to 16^{o}C, and it is recognised as a subsurface salinity maximum. The LIW spreads from the Levantine Basin throughout the Mediterranean and finally exits from the Strait of Gibraltar into the northeast Atlantic Ocean. AW is distributed sparsely as a jet intertwined in a field of propagating and interacting eddies, in which is found the more widespread, but patchy, LIW. Both clearly are closely tied to the general circulation.

While most of the dynamic activity and subsequent variability of water masses occurs in the upper 500 m and data are sparser than for the deeper layers, some interesting transient changes have taken place in the deep basins recently. The Eastern Mediterranean deep water has formed for decades to perhaps centuries in the Adriatic Sea (Pollak, 1951; Roether and Schlitzer, 1991; Schlitzer et al., 1991). It does not communicate with the adjacent deep waters of the Western Mediterranean because of the shallow sill in the Straits of Sicily. Sometime between the cruises of the *METEOR* in 1987 and 1995, the Eastern Mediterranean thermohaline circulation experienced a switch of deep water source from the Adriatic to the Aegean, which consequently altered the EMDW from a 13.38^{o}C, 38.66 psu water mass (Schlitzer et al., 1991) to a warmer and saltier (13.88^{o}C, 38.8 psu) water mass (Roether et al., 1996; Klein et al., 1999). The potential density (σ_θ) of the EMDW also increased from below 29.18 to above 29.2. This change is too large to be accounted for by a change in surface evaporation or precipitation alone (Roether et al., 1996), and turns out to be related to a small change in surface buoyancy loss in combination with a number of extreme winters over the Aegean that resulted in the diversion of LIW from the Adriatic to the Aegean (Wu et al., 2000). Thus, the Aegean could be more productive as a deep water formation site. The wider effects on the thermohaline circulation of the Eastern Mediterranean remain to be seen. It has been observed (Hainbucher et al., 2006) that deep water formation has returned to the Adriatic as of 2003, but in 2006, the deep water was seen to exhibit yet another set of T-S properties never before observed (Rubino and Hainbucher, 2007).

General Circulation

The Levantine Basin circulation was first depicted in the early 20th century by Nielsen (1912), who described a surface circulation bound to the coast and following a counter-clockwise (cyclonic) path around the basin. Later work by Ovchinnikov et al. (1976) based on hydrographic sampling suggested a system of counter-rotating gyres in the interior of the peripheral cyclonic flow. The flow was reported to be stronger in winter. A similar peripheral flow was identified by Lacombe and Tchernia (1972), with a bifurcation of one branch off the Libyan coast northeastwards towards Cyprus.

In the 1980's, knowledge of the system of gyres and currents of the Levantine Basin increased dramatically with the Physical Oceanography of the Eastern Mediterranean (POEM) cruises (Ozsoy et al., 1989, 1991, 1993; Robinson et al., 1991, 1992; the POEM Group, 1992). One gyre (known as the Shikmona gyre system) was identified in the present exploration region south of Cyprus: a clockwise (anticyclonic) flow bounded to the north by an eastward flowing current carrying fresher, cooler AW (see **Figure 4.12**). In this currently accepted scheme, AW enters the Levantine Basin through the Cretan Passage and then follows the coast as the North African Current before detaching and flowing northward and eastward towards Cyprus as the Central Levantine Basin Current (Oszoy et al., 1989), also known as the Mid-Mediterranean Jet (MMJ) (Robinson et al., 1991). The Rhodes Gyre, rotating in the opposite sense, was identified on the northern side of this near-surface current. A second anticyclonic system was observed south of Cyprus, but farther to the west than the Mersa Matruh gyre. Seasonal differences between summer and winter regimes were noted, specifically that anticyclonic activity south of Cyprus generally weakened in the winter, except perhaps near the eastern coast (Oszoy et al., 1989). It was also noted in these first two POEM cruises that cyclonic gyre intensity lessened with depth while anticyclonic intensity tended to increase with depth (Oszoy et al., 1989). The key conclusion, however, was that the Levantine Basin is a dynamic, evolving region, with some persistent features and a rich, interacting mesoscale eddy field. Robinson et al. (1991) went one step further to classify a number of features of the dynamically active upper thermocline as permanent (MMJ, Mersa Matruh gyre), recurrent (Shikmona gyre), or transient (southeast Levantine jets and eddies).

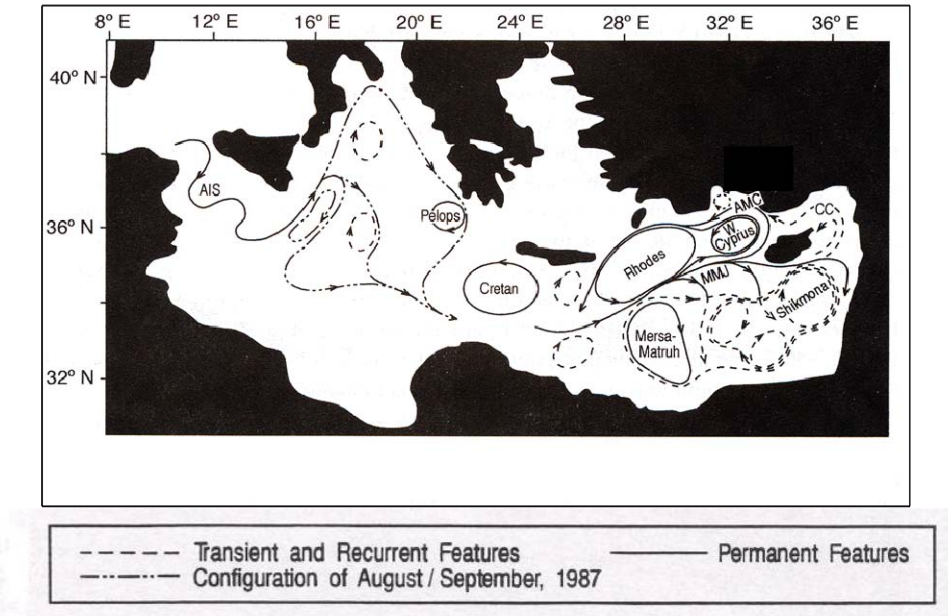


Figure 4.12. Levantine Basin general circulation as depicted during the 1980's, consisting of a mesoscale flow structure with anticyclonic eddy activity south of Cyprus and the Mid-Mediterranean Jet (MMJ) meandering eastward transferring the Atlantic Water (AW) (POEM Group, 1992).

Since POEM, a number of studies have elucidated more details on the structure and variability of the Levantine Basin. In general, they support the schematic structure set out by the POEM studies, even if they further emphasise the spatial variability and transient nature of the features described. Some notable exceptions exist in which the historical view of the AW tightly hugging the periphery of the Levantine Basin is promoted (Hamad et al., 2005; Millot, 2005; Millot and Taupier-Letage, 2005). These studies tend not to be based on *in situ* salinity measurements, which would provide direct information on the origin of the observed water mass; however, even these studies recognise the instability of such a current and the resulting field of mesoscale eddies in the basin interior. For example, expendable bathythermograph (XBT) observations made during the Mediterranean Forecast System (MFS) programme confirmed the persistence of the sub-basin anticyclonic gyres in the southern part of the basin but did not find definitive evidence of the MMJ (Fusco et al., 2003). AW has also been observed to continue along the African coast, based on satellite observations (Ayoub et al., 1998; Hamad et al., 2005). Remotely-sensed sea surface temperatures (SST) can aid in interpretation of coarse resolution data sets, however (e.g., main features of the POEM schematic are often visible [**Figure 4.13**]).

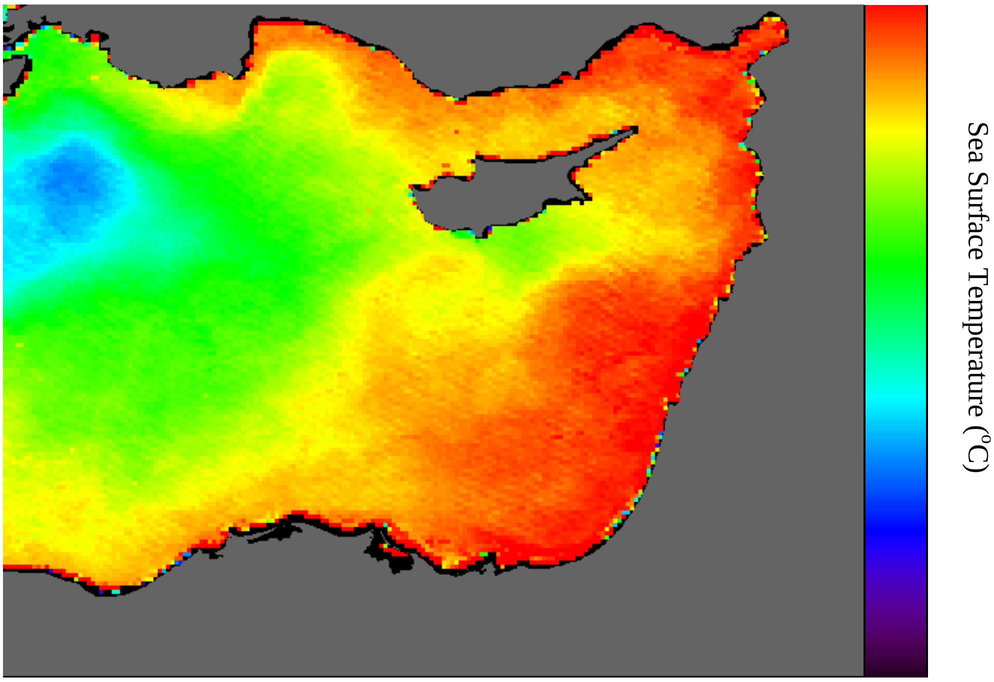


Figure 4.13. Average sea surface temperature for 2006 as measured by the NOAA AVHRR satellites. Suggestions of the cool centre of the Rhodes Gyre west of Cyprus (anti-clockwise) can be seen as well as an anticyclonic eddy (or two) south of Cyprus and the Mid-Mediterranean Jet (MMJ) meandering between the two from southwest to northeast south of Cyprus.

It is clear that more detailed *in situ* observations are needed to resolve the debate of near-surface currents in the Levantine Basin. This has been addressed in the last 12 years for the northern Levantine Basin, particularly in a broad area including the Cyprus EEZ, by more than 20 cruises carried out by the Cyprus Oceanography Centre. Published results describe the approach from the southwest of the MMJ, its bifurcation into a stream diverted to the north before reaching Cyprus, and another stream that continues eastward, south of Cyprus (**Figure 4.14**) (Zodiatis et al., 2008). The MMJ meanders, encircling clockwise warm-core eddies to its south, such as the Cyprus Eddy (Zodiatis et al., 1998, 2005a, 2008). To the north of the MMJ and near the south Cyprus coast, anti-clockwise eddies and westward current are often observed.

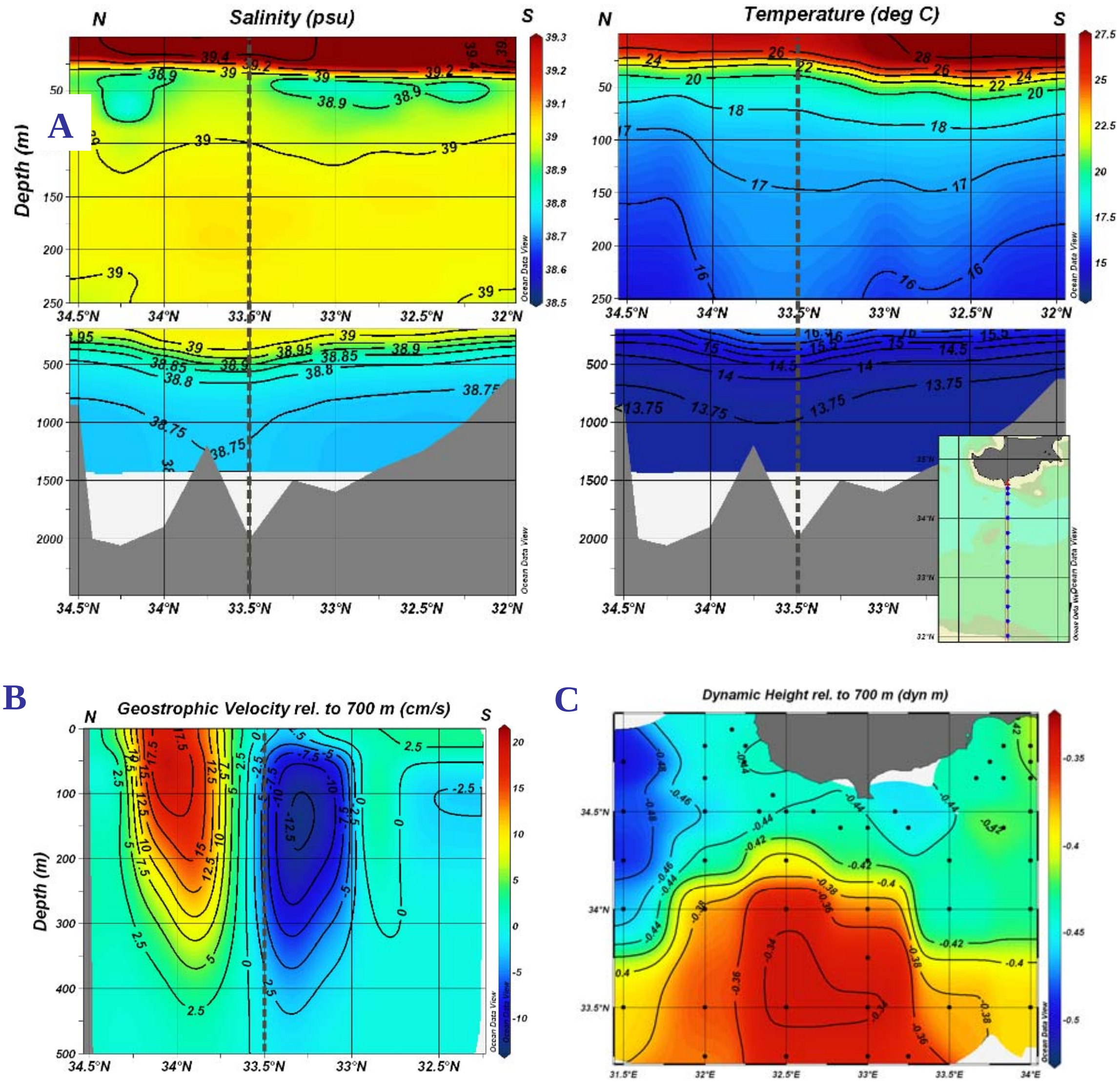


Figure 4.14. (A) *In situ* salinity and temperature on a north-south section along 33°E during the CYBO-19 cruise of the Cyprus Oceanography Centre in September 2005. Note the four main water masses of the basin evident in the salinity section as four layers. (B) The geostrophic velocity profile relative to 700 m depth shows the eastward (red) flow north of 33.5°N and westward flow south of 33.5°N. (C) The dynamic height relative to 700 m shows the clockwise depth-average flow south of Cyprus (around the red centre) and the eastern edge of the anti-clockwise Rhodes Gyre west of Cyprus. Station locations are marked with a black dot.

It is also observed that this general picture varies from year to year, and even seasonally. For example, the Cyprus warm core eddy shifted westwards during the period from 2000 to 2001 and the Shikmona gyre was re-established during the summer period 2001-2003 (Zodiatis et al., 2005a). During the CYBO and CYCLOPS experiments carried out in 2001 and 2002, a significant seasonal spatial displacement of the Cyprus warm core eddy was found to the west at about 60 to 80 nmi from its original position (Zodiatis et al., 2001, 2005a). This caused an even more complicated flow path for the MMJ. In particular, in April-May 2001 the northward extent of the Cyprus eddy caused, for a short period, the restriction of the eastward transfer of AW. The main flow path of the MMJ became northward offshore west Cyprus, as opposed to its usual eastward direction offshore south Cyprus. In August 2001, the southern relaxation of the Cyprus warm-core eddy for about 20 nmi and a secondary new anticyclonic eddy that established between southeast of Cyprus and offshore Lebanon resulted in the re-establishment of the eastward MMJ flow, with velocities up to 45 cm/s, along the northern peripheries of these two warm-core eddies. The co-existence of these two warm anticyclones until summer 2003 contributed to the re-appearance of the well known Shikmona gyre (Zodiatis et al., 2005a). During this period the AW also was observed below the secondary anticyclone, at greater depth than usual, down to 200 m. The latter suggests that the AW, after its eastward advection along the Cyprus eddy, was then picked up by the new (secondary) anticyclone, which was more intense at the upper surface layers as compared to the Cyprus eddy.

The spatial and temporal variations of the dominating dynamic flow features of the southeast Levantine Basin are illustrated in three schematics of circulation shown in **Figure 4.15.** The schematics characterise three periods: 1995-1999, 2000-2001, and summer 2001-2003 (Zodiatis et al., 2004). **Figure 4.15A** shows the Cyprus warm-core eddy as located east of the meridian of 33ºE, while **Figure 4.15B** shows the significant westward shift (about 60 to 80 nmi) of the Cyprus warm-core eddy at the end of 2000 to early 2001. Finally, **Figure 4.15C** shows the re-establishment of the Shikmona gyre that constituted from warm-core eddies, similar to those found during the 1980's by POEM cruises.

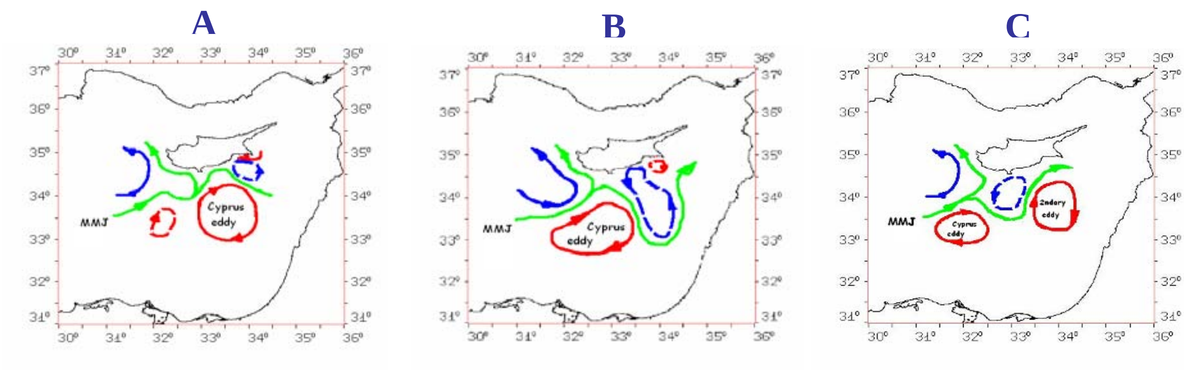


Figure 4.15. Schematics of the dominated general circulation in the upper 200 m in the Southeast Levantine, based on CYBO and CYCLOPS cruises, for the time periods (A) 1995-1999, (B) 2000-2001, and (C) summer 2001-2003.

Additionally, coastal upwelling south of Cyprus is often observed in summertime, with a cool water tongue advecting offshore to the southeast (**Figure 4.16**). Surface temperature in the upwelling area is up to 4ºC cooler compared to other coastal sea areas of Cyprus. Remote sensing of surface temperature (instantaneous images or summer averages) and *in-situ* data sets reveal this phenomenon, which is driven by the offshore transport caused by strong and steady westerly winds.

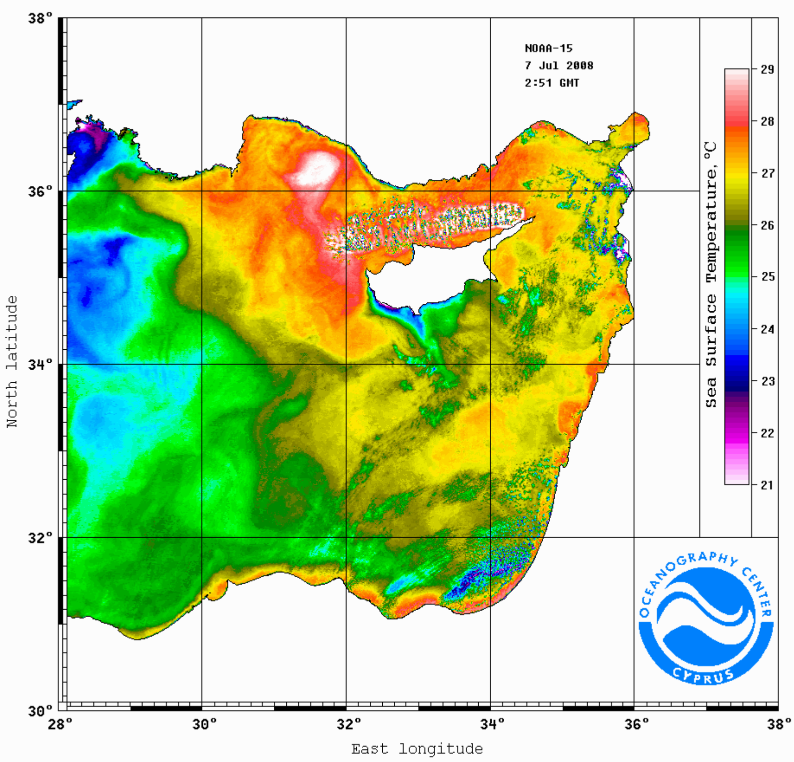


Figure 4.16. A single passage NOAA-AVHRR image on 7 July 2008 from the CYCOFOS ground satellite receiving station at the Cyprus Oceanography Centre, showing the upwelling phenomena and its offshore extension south Cyprus.

Improved observation programmes such as the ongoing autonomous ocean glider project (Hayes et al., 2008) will certainly contribute to our knowledge on the general circulation. However, numerical models are becoming increasingly important in covering large areas and time scales simply not possible with observations. In particular, the spatial distribution of ocean currents is difficult to observe instantaneously or in a quasi-synoptic period, especially over wide open deep sea areas. For this reason, oceanographic centres are developing and continuously updating their numerical models, often upgrading to operational forecast centres such as the Cyprus Coastal Ocean Forecasting and Observing System, known as CYCOFOS (**Figure 4.17**). The present forecasting ability of CYCOFOS has been proven to be adequate to the EU response and decision agenies for successful operational oil spill predictions during the largest oil pollution event to date in the Eastern Mediterranean, that of the Lebanese oil pollution crisis in summer 2006 (**Figure 4.18**), through the operational application of MEDSLIK-Medeiterranean oil spill and trajectory model (Zodiatis et al., 2007). As an example, one might fill a data gap of deep ocean currents by calculating the annual mean of near-bottom currents (**Figure 4.19**). This sort of analysis can be extended to include any desired region or period of interest for the Levantine Basin. Many models have already been used to understand the general circulation in the Mediterranean (Malanotte-Rizolli and Bergamasco, 1991; Zavatarelli and Mellor, 1995; Wu and Haines, 1998; Zodiatis et al., 2003, 2008). For example, in a study focused on the Levantine seasonal circulation, Alhammoud et al. (2005) found that during summer, the cyclonic coastal circulation gets weaker and the basin interior is dominated by detached coastal current eddies and other meanders and that the eddies in the Mersa-Matruh and Shikmona areas vary greatly in extent, shape, strength, and position from winter to summer. Zodiatis et al. (2008) have shown favourable comparisons between *in situ* and forecast fields for the Levantine Basin north of 33^{o}N. These results truly improve our knowledge of the relevant physical processes, especially their evolution over weeks, months, and years. The present forecasting ability has been shown to be adequate for a number of applications from search and rescue to oil spill trajectories (Zodiatis et al., 2007).

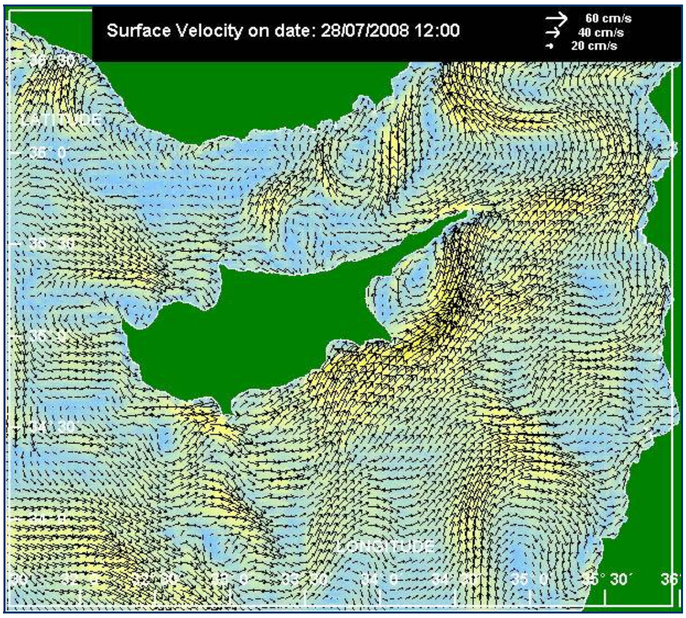


Figure 4.17. Example of the 6-hourly averaged current predictions in the broader sea area of Cyprus, including the Cyprus EEZ, provided daily by the CYCOFOS system, showing the anti-clockwise flow around Cyprus at 12:00 GMT on 28 July 2008.

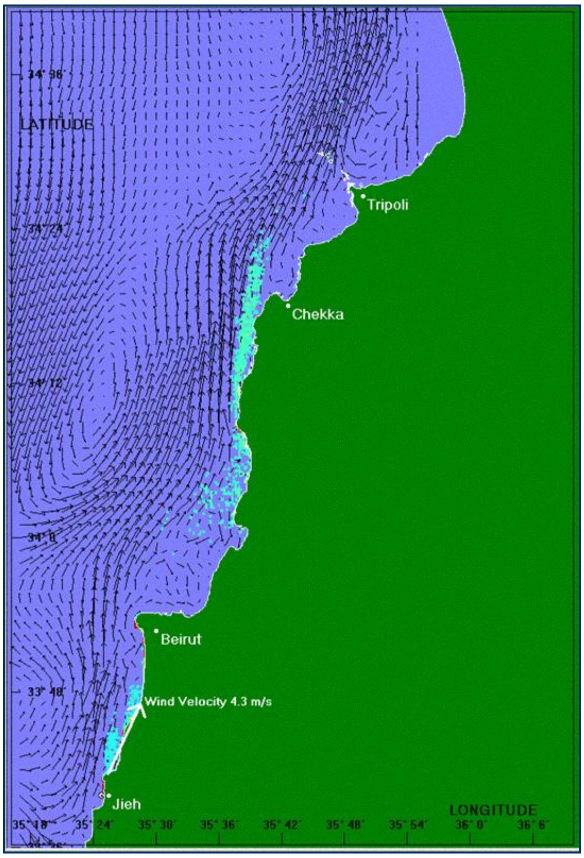


Figure 4.18. MEDSLIK oil spill predictions during the fifth day of the Lebanese oil pollution crisis, summer 2006, based on CYCOFOS ocean forecasting data and SKIRON wind fields.

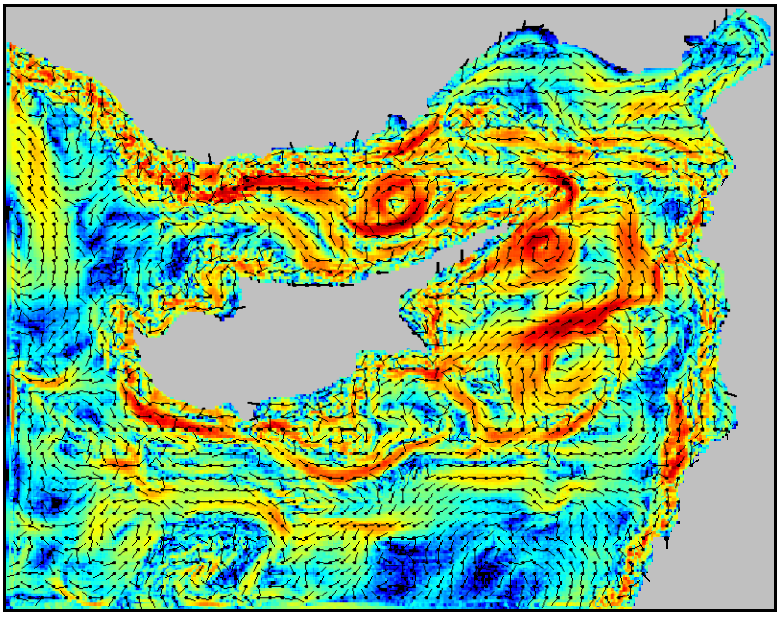


Figure 4.19. Numerical simulation of currents near the ocean bottom for 25 April 2007 derived from CYCOFOS. A log scale is used in order to display the wide range of values. Current intensity varies from 0.002 to 0.2 m/s and the vectors are shown (flow is from dot toward thin end of stick). Note the flow from west to east in the southern part of the domain, with a detour around the Eratosthenes Seamount, and a return flow to the west in a thin stream closer to the coast of Cyprus. These streams generally follow bathymetry contours.

Waves and Tides

Wave heights in the region of the exploration blocks are generally lower than in the large ocean basins because storms are generally weaker in the region of the blocks. The Cyprus Oceanography Centre, within the framework of CYCOFOS, runs an operational wave model (three-hourly output, 1/16-degree resolution, daily forecast for 96 hours) that can be used to estimate wave statistics at a point or points in the Mediterranean and the Levantine Basin (**Figure 4.20**) based on the SKIRON wind fields. Of course, actual wave measurements are preferred, but these require significant infrastructure to achieve in the open sea and are presently not available in the Levantine Basin.

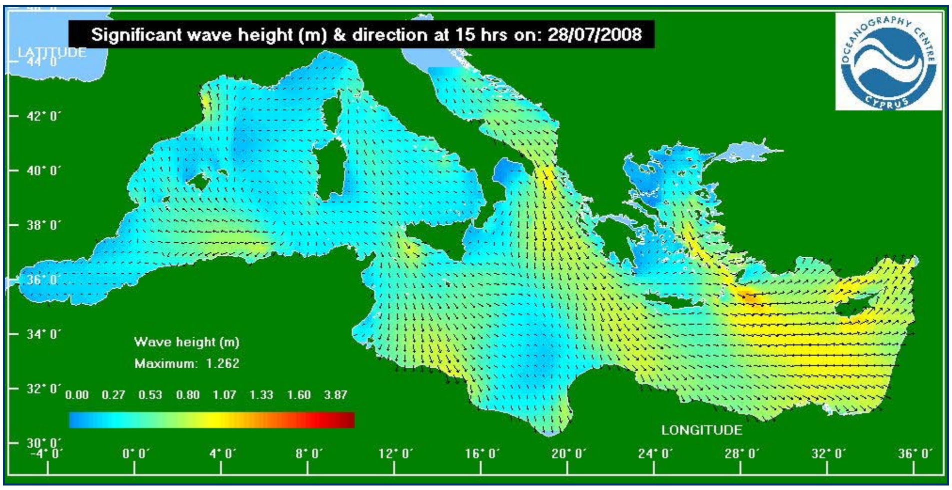


Figure 4.20. Example of the 3-hourly wave forecasts in the Mediterranean provided by the CYCOFOS system, using the SKIRON wind fields, at 15:00 GMT on 28 July 2008.

Table 4.4 presents significant wave height distribution for a point near the CYCOFOS MedGoos-3 buoy (33°42'N, 32°08'E) in the Cyprus EEZ, extracted for the period of July 2005 to February 2008. Nearly all of the waves are less than 1.5 m in height. Wave direction is also available and is nearly always due eastward at this location (mean of 116°T, standard deviation of 53°) because of the strong westerly winds. While wave height and direction vary across the basin on a given day, these yearly statistics can be regarded as representative values for the entire basin (**Figure 4.21**).

Table 4.4. Significant wave heights and their frequency of occurrence at an open ocean point west of the Eratosthenes Seamount from July 2005 to February 2008.

Wave Height Range[1] (m)	Frequency	Percentage
0-0.2500	91	1.5230
0.5000	1132	18.9456
0.7500	2183	36.5356
1.0000	1388	23.2301
1.2500	565	9.4561
1.5000	261	4.3682
1.7500	140	2.3431
2.0000	69	1.1548
2.2500	52	0.8703
2.5000	21	0.3515
2.7500	14	0.2343
3.0000	10	0.1674
3.2500	11	0.1841
3.5000	4	0.0669
3.7500	7	0.1172
4.0000	11	0.1841
4.2500	9	0.1506
4.5000	6	0.1004
4.7500	1	0.0167
Total	5975	100%

[1] Upper limit of bin.

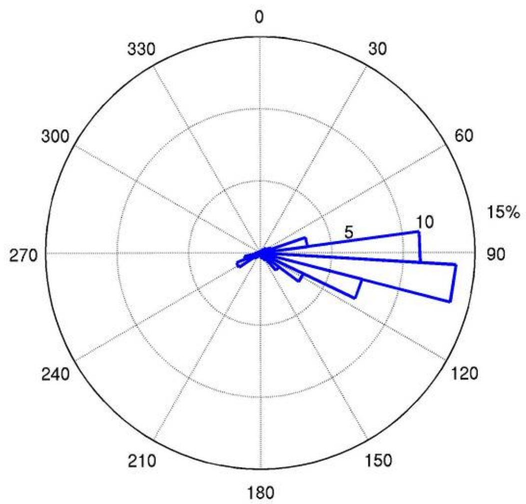


Figure 4.21. Rose diagram for annual frequency of wave direction per 10° sector. Most of the time, waves travel towards the east.

Tides in the Eastern Mediterranean are in the range of 0.3 to 0.4 m peak-to-peak at the coastal ports of Cyprus. Open ocean tides from a tidal model are of similar magnitude. One report presents results for numerical modelling of tidal constituents with data assimilation from tide gauges. For the Levantine Basin, tides are purely astronomically driven (not affected by other ocean basins) and the co-amplitude summed over the first eight constituents is about 30 cm (Kantha et al., 1994). The dominant frequency is the M2 frequency, of which the co-amplitude is shown in **Figure 4.22** (Kantha et al., 1994). The current associated with this frequency was shown by the same author to be 0.01 m/s in a purely east-west direction for the Levantine Basin.

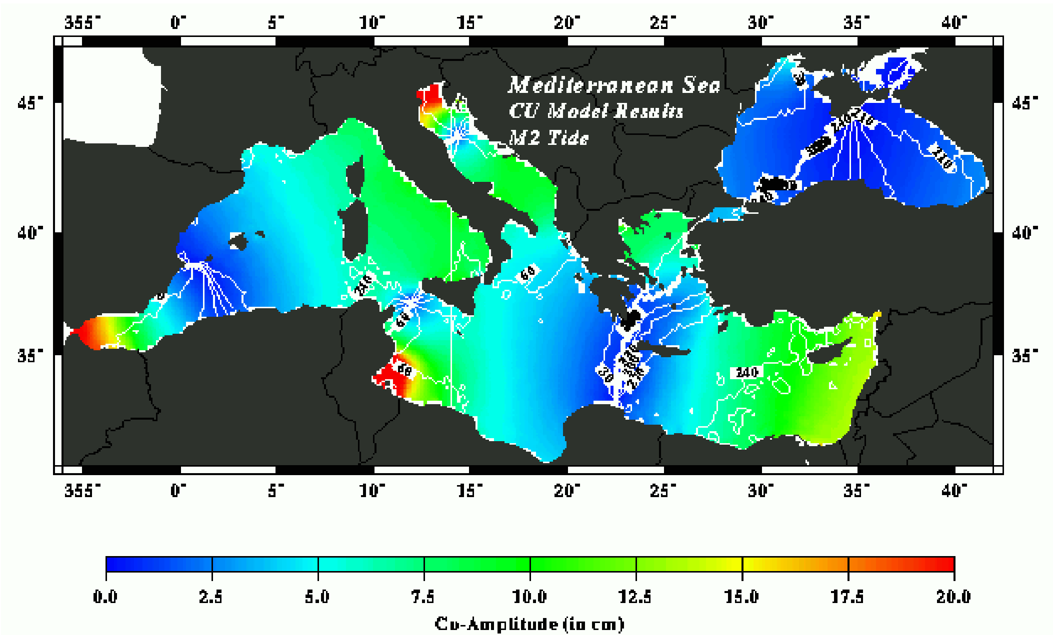


Figure 4.22. Model prediction for the co-amplitude of the M2 tidal signal in the Mediterranean (Kantha et al., 1994). In the Levantine Basin, the amplitude is about 0.12 m. Note that another seven constituents have been calculated and their amplitudes sum to about 0.3 m (out of phase).

4.1.3.2 Chemical Oceanography

The geochemistry of the eastern Levantine Basin in the exploitation block region is characterised by high oxygen levels throughout the water column and extremely low concentrations of nutrients in surface waters. Oxygen levels in the exploitation block region are highest in surface waters (**Figure 4.23**), where phytoplankton are the most productive (see **Section 4.2.1.1**). During all seasons, oxygen levels are close to saturation. Oxygen levels decline with depth through the mid-water region (250 to 500 m), largely due to microbial and zooplankton consumption of sinking organic material and respiration. However, there is only a very small oxygen minimum in mid-waters, in contrast to the large oxygen minimum observed in many other marine systems (Krom et al., 2005). This is because the amount of organic material sinking from surface waters in this system is very small and, consequently, microbial respiration is restricted (Krom, 1995). Deep waters (>500 m) are oxygenated at constant levels (**Figure 4.23**; Krom et al., 2005). Overall oxygen concentrations in the upper 3000 m of the water column range from 170 to 250 µM (Yacobi et al., 1995; Kress and Herut, 2001; Krom et al., 2005).

The eastern Levantine Basin in the exploitation block region has extremely low levels of nutrients, and the region is considered "ultra-oligotrophic." Nitrate and phosphate concentrations in surface waters (LSW, see **Section 4.1.3.1**) in the Eastern Mediterranean (**Figure 4.23**) are one-half their concentrations in the western basin (Bethoux et al., 1992). This severe nutrient depletion is due to the very low net supply of nutrients to the Mediterranean Basin, as the Atlantic inflow brings in nutrient-depleted surface waters and there is very little nutrient input from rivers in the eastern Levantine Basin (Krom, 1995). Although nutrient concentrations change seasonally (**Table 4.5**), measurements of surface water (0 to 200 m) nitrate concentrations are at detection limits (typically 0.3 to 0.6 μM), and phosphate levels are typically undetectable by conventional methods (**Figure 4.23**; <0.1 μM; Krom et al., 1991, 2005). A nutricline, or rapid change in nutrient concentrations, begins at 130 to 160 m (**Figure 4.23**), and concentrations of all major nutrients (nitrate, phosphate, and silicate) increase simultaneously through intermediate waters (LIW, see **Section 4.1.3.1**) to a mid-water maxima at approximately 500 m (the position of the oxygen minimum, **Figure 4.23**). Nutrient concentrations are then constant or decrease slightly in deep waters (EMDW, see **Section 4.1.3.1**). The only nutrients that do not follow this profile are ammonium, which is relatively high in surface waters and decreases below the nutricline, and nitrite, which forms a sharp peak just above the beginning of the nutricline (Krom et al., 2005). In the deep water of the eastern Levantine Basin, and during the winter months, nitrogen-to-phosphorus ratios can be very high (**Table 4.5**).

Chemical oceanographic research in the eastern Levantine Basin has focused on the warm-core eddy to the south of Cyprus (Krom et al., 1991, 2005) and stations at the southern edge of the EEZ (e.g., Yacobi et al., 1995; Kress and Herut, 2001). Oxygen and nutrient distributions at the centre and western and eastern borders of the EEZ are less well known.

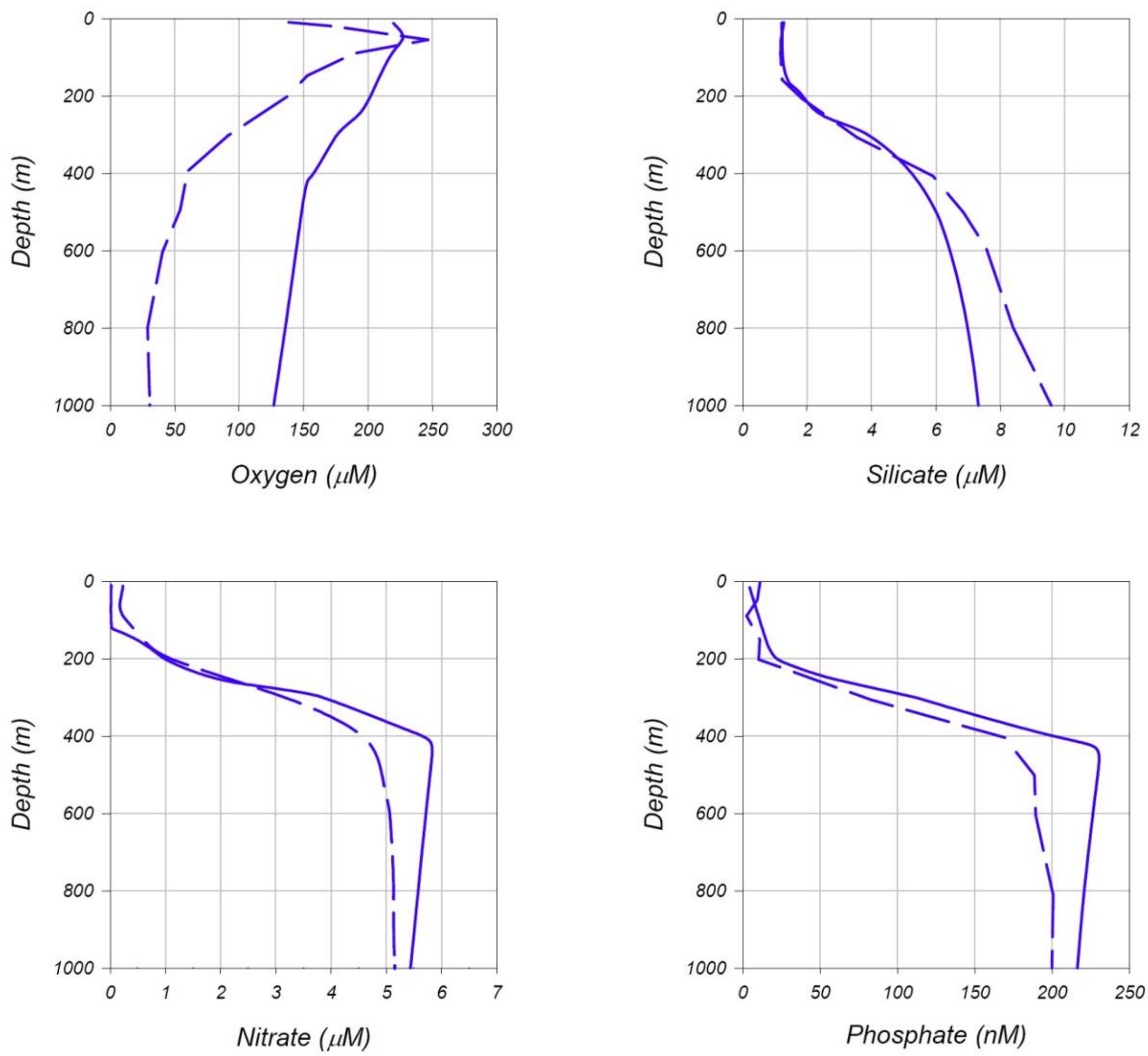


Figure 4.23. Vertical profiles of oxygen and nutrient concentrations in the exploitation block region. Data from Yacobi et al. (1995) (dashed line: 33°30' N, 30°30' E, autumn) and Krom et al. (2005) (straight line: 33°43' N, 32°13' E, early summer).

Table 4.5. Chemical characterization of water masses in the exploitation block region. Average values (with standard deviation) are shown for nutrient concentrations (µmol kg^{-1}) and N:P ratios. Data from Kress and Herut (2001).

Water Mass	Season	$Si(OH)_4$	NO_3	PO_4	N:P
Surface	Summer	1.09 (0.36)	0.06 (0.11)	0.02 (0.02)	5.2(8.5)
Surface	Spring	1.16 (0.41)	0.20 (0.15)	0.02 (0.03)	14.2 (10.7)
Surface	Winter	1.23 (0.48)	0.60 (0.50)	0.01 (0.01)	52.2 (55.7)
Intermediate	Summer	1.20 (0.50)	0.55 (0.65)	0.03 (0.02)	20.5 (16.8)
Intermediate	Spring	1.81 (0.87)	1.99 (1.02)	0.05 (0.04)	54.0 (32.9)
Intermediate	Winter	1.70 (1.17)	1.19 (1.22)	0.03 (0.04)	44.3(13.1)
Deep	All	10.44 (0.60)	5.57 (0.30)	0.23 (0.03)	24.7 (2.7)

4.1.4 GEOLOGY

4.1.4.1 Geology of the Eastern Mediterranean and Cyprus

The area of the Eastern Mediterranean has been shaped by the interactions of the African, Arabian, and Eurasian plates since the Permo-Triassic. It has been affected by a multitude of processes such as rifting, sea floor spreading, subduction, strike-slip faulting subduction, and continental collision. Its study has raised and still raises many controversies and has proven to be a veritable geological laboratory.

The evolution of the Eastern Mediterranean Basin is linked to the formation of Neotethys that developed along the northern end of Gondwanaland in response to the opening of the central Atlantic in the Late Triassic. A number of scenarios have been proposed for the formation of Neotethys, but here only three will be discussed. Updated versions have been published and more data, on land and offshore, are available.

- Robertson and Dixon (1984) prefer a breakup of the Gondawana margin for the Mid-Triassic dominated by north-northeast trending dextral faults with spreading ridges almost orthogonal to them (**Figure 4.24**). The continental blocks that would subsequently become the jigsaw pieces in the geologic collage that is now Turkey are quite evident. According to the authors, the Eastern Mediterranean Basin owes its formation and shape to sea floor spreading and dextral strike-slip faulting. As such then it should most probably have an oceanic crustal basement. By the Early Cretaceous, Neotethys in the Eastern Mediterranean is made up of two rather narrow east-west trending ocean basins. Spreading in the southern basin remained somewhat narrow either because of an extremely low spreading rate or because spreading stopped (Robertson and Dixon, 1984) (**Figure 4.24**).

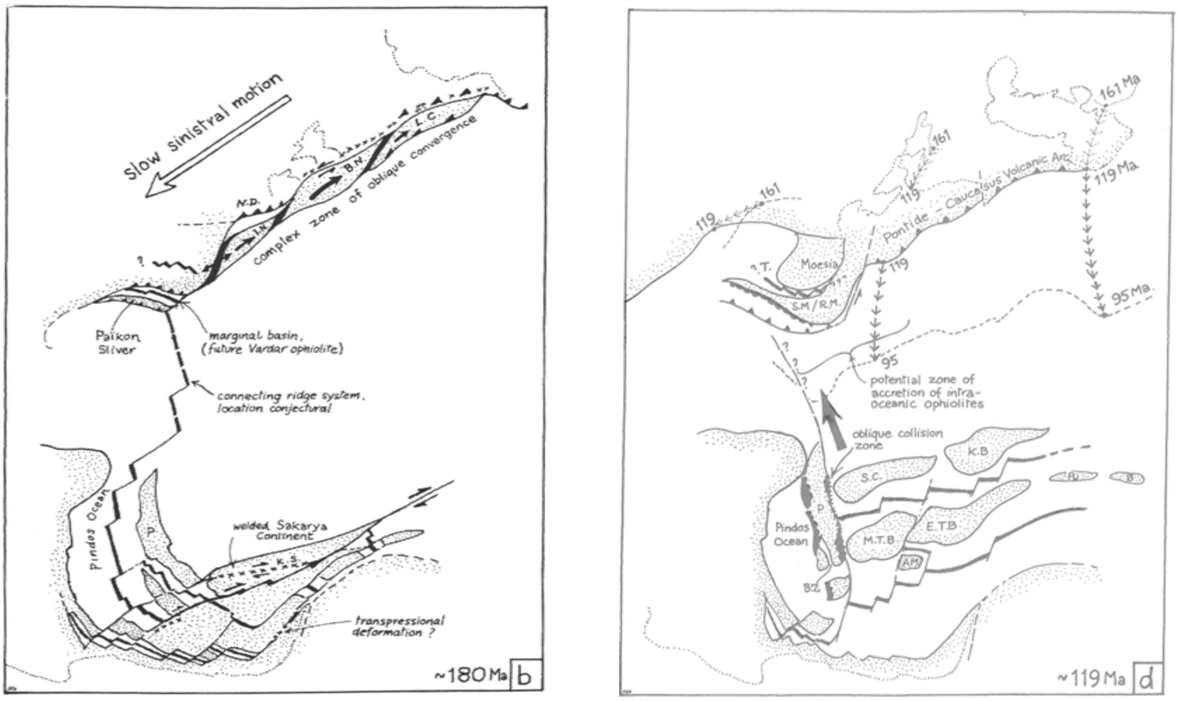


Figure 4.24. Schematic diagrams showing two stages, at 180 and 119 my, in the evolution of Neotethys (From: Robertson and Dixon, 1984).

- A more recent variation of the same theme is given by Stampfli and Borel (2004). Again, the Eastern Mediterranean Basin is envisaged as having been formed by strike-slip faulting, albeit sinistral in their reconstruction. A puzzling detail on their reconstruction is a small continental protrusion on the Levantine passive margin, presumably the Eratosthenes Seamount, which in later diagrams is seen to be in the initial stages of being rifted from the Arabian plate in the Maastrichtian. Another point of note in this diagram is the collision of the Arabian plate with a north-dipping subduction that led to the obduction of ophiolites along the northern edge of Arabia. To the west of the Arabia promontory, the Troodos Ophiolite, in the absence of a continental margin, was not obducted but merely rotated (Moores and Vine, 1971; Malpas et al., 1992).

- Garfunkel (1998) proposed, on the basis of on-land studies, that the Eastern Mediterranean Basin was formed by rifting of the Levantine passive margin in the Late Permian, accompanied by thinning of the continental crust to the west. The Eratosthenes Seamount would then be a product of the Levantine passive margin by the Levantine Basin. The size of the Levantine Basin precludes continuous extension or spreading since the Late Permian. Recent seismic investigations (Abdel Aal et al., 2001) show the deep geology in the area of the Nile Delta and beyond (NE Mediterranean Deepwater Block, NEMED) to be dominated by fault-bounded blocks, some of which have been rotated. This would be consistent with the structure determined offshore of Israel and the Gaza Strip. It is the scenario favoured in this report.

It is the accepted norm to divide Cyprus into four geologic zones or terranes on the basis of their origin, lithology, and evolutionary geology. These zones are the Troodos Ophiolite Complex that forms the island's backbone, the Mamonia Complex to the southwest of Troodos that is composed of completely deformed and tectonised Mesozoic accretionary mélanges, the Kyrenia Range to the north comprising a thin arcuate zone of southward-thrusted Permian to Lower Cretaceous shallow-water platform carbonates, and lastly the Mesaoria Plain between the Kyrenia and Troodos Ranges that is filled by Maastrichtian to Recent pelagic, hemipelagic, and fluvial sediments (**Figure 4.25**).

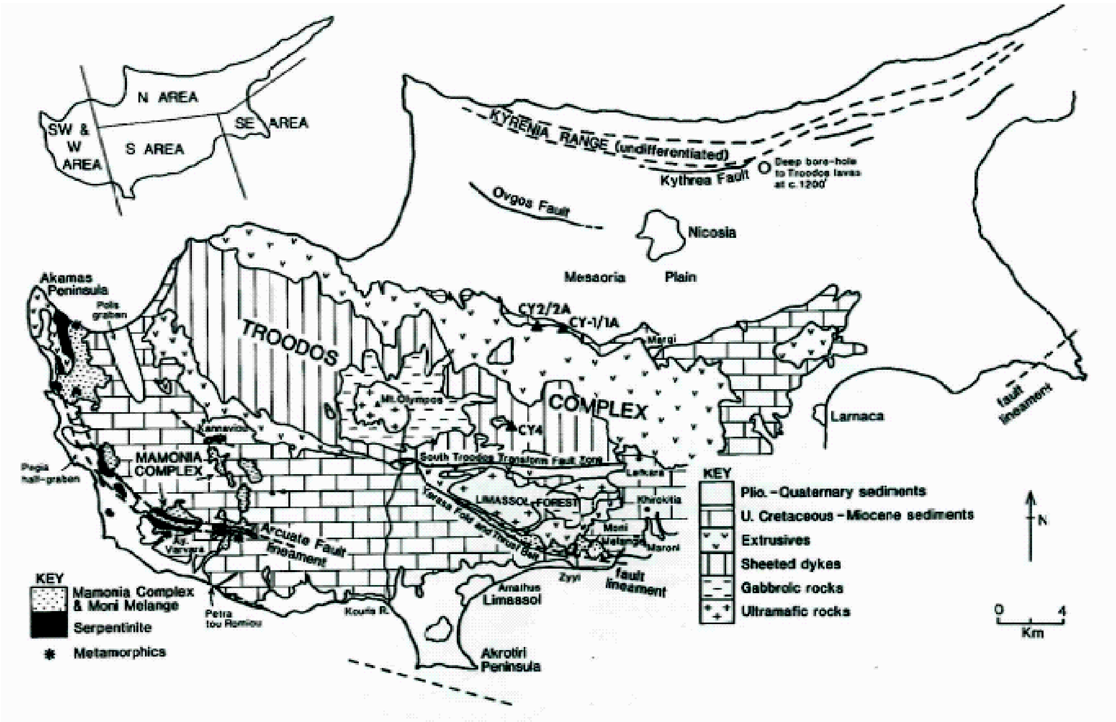


Figure 4.25. Tectonic terranes shown on a geologic map of Cyprus (From: Robertson, 1998).

4.1.4.2 Tectonostratigraphic Elements of the Eastern Mediterranean Basin

The Troodos massif is one of the most intact and best studied ophiolites in the world. It is the westernmost of a string of ophiolites that east of Cyprus were obducted onto the edge of the Arabian Plate from northwestern Syria (Baer Bassit) to Oman and what Ricou (1971) termed "le croissant ophiolitique pêri-arabe." The geochemistry of its extrusives differs from that of lavas forming at mid-ocean ridges and is similar to lavas found in intra-oceanic island arcs.

The Troodos Ophiolite Complex

As all the ophiolites of the croissant arc, the Troodos Ophiolite is believed to have formed within the southern strand of Neotethys above a north-dipping subduction zone in the Mid- to Late Cretaceous (Robertson and Xenophontos, 1993). Subduction was abruptly stopped by the collision of the African Plate along its north Arabian boundary with the trench. Ophiolitic fragments together with trench accretionary mélanges were thrust over, dismembered, and emplaced onto the Arabian platform. In the area of Cyprus there was no obduction, and instead the Troodos oceanic crust broke off and rotated anticlockwise by some 90º (Moores and Vine, 1971).

The Mamonia Complex

The Mamonia Complex is a tectonic mélange accreted onto the hanging wall of the subduction zone above which the Troodos crust formed (Malpas et al., 1993). It has been juxtaposed with (by strike slip) and partly overthrust onto the Troodos Ophiolite. Exposures are to be found in western Cyprus, at the tip of the Akrotiri Peninsula and in the southeast near Paralimni. It contains volcanic and plutonic rocks that are overlain by shallow thrust sheets of shallow to deepwater Late Triassic Mid-Cretaceous sediments.

The Mesaoria Plain

The Mesaoria Plain lies between the Troodos and Kyrenia Ranges and is floored by the ophiolite that, according to borehole evidence, extends as far as the Kyrenia Range. Following the palaeorotation of the Troodos microplate, deepwater and tectonic quiescence prevailed in this part of the Mediterranean, at least until the Miocene, allowing mostly pelagic carbonate sedimentation (Robertson, 1976). These Maastrichtian to Miocene sediments extend beyond the Mesaoria Plain, covering southern and western Cyprus. At the eastern end of the plain, a very thin sequence of chalk and reef limestone is seen to rest directly on a mélange similar to the Moni Melanges (Campanian-Maastrichtian) further west in the Limassol area.

Extensional tectonics with downthrows to the north dominated much of the Mesaoria Plain during the Miocene, giving rise to smaller fault-controlled basins and allowing reef formation on uplifted and rotated fault blocks in the Messinian. Gypsum deposits, also characteristic for this period, are deposited in restricted small basins.

Following the Messinian salinity crisis and the return of more open seas, the Lower to Mid-Pliocene of the Mesaoria Plain is dominated by muds with sandy intercalations and channelised conglomerates. These sediments pass upwards into shallow marine sediments of the Upper Pliocene that mark the final infill of the basin, having an estimated maximum thickness of 1000 m (McCallum and Robertson, 1990, 1995). A higher uplift rate of the Troodos and the emerging Kyrenia Range caused sea recession and allowed a prograding sequence of fan-type conglomerates to cover the whole of the Mesaoria Plain.

The Kyrenia Range

The Kyrenia Range lies to the north of the Mesaoria Plain and is separated from it by the Ovgos Fault (**Figure 4.26**). This narrow, arcuate, and elongate range has a long and chequered geologic history.

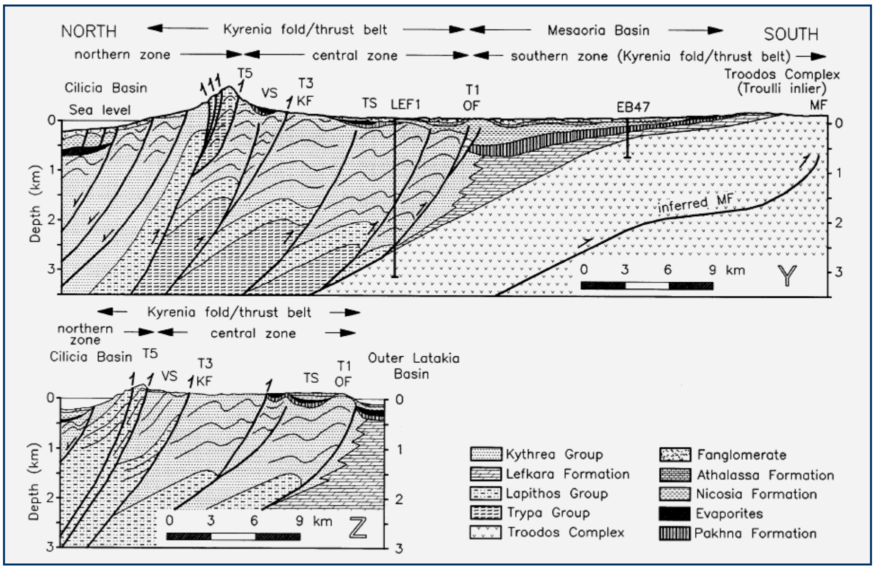


Figure 4.26. Geological cross-section across the Kyrenia Range and the Ovgos Fault (Calon et al., 2005).

The oldest rocks in the range are Permian shallow-water platform carbonates that originated close to the northern margin of the Neotethys during the initial rifting event. Younger, Triassic, Jurassic, and Early Cretaceous limestones exposed in the western and central parts of the Kyrenia Range formed on a gradually subsiding carbonate platform (Robertson and Woodcock, 1986).

These Mesozoic platform carbonates were brecciated and in places metamorphosed between Early Cretaceous and Campanian time, appearing in clasts in the overlying Maastrichtian sediments. Less deformed Campanian volcaniclastic sediments and rhyolitic tuff overlie the deformed carbonates. They have calc-alkaline affinities and most probably are derived from Andean-type volcanism in southern Turkey (Robertson and Woodcock, 1986; Huang, 2008). From the Maastrichtian to the Late Paleocene, the Kyrenia area was a region of deepwater pelagic carbonate deposition. The Maastrichtian section, however, has significant intercalations of basaltic pillow lavas that have an intraplate geochemical signature (Huang, 2008). Their extrusion, in a transtensional environment, coincides with the paleorotation of the Troodos microplate.

A later Eocene deformation event left the Kyrenia Range subdued in a basinal environment that received enormous amounts of mostly turbiditic sediements (the Kythrea Formation), which are topped by small evaporitic basins exposed along the southern flank of the range. The Kyrenia Range was thrust southwards, strongly uplifted, finally joining the island terranes in the Late Pliocene-Pleistocene (**Figure 4.26)**.

The present geotectonic framework of the region is dominated by the collision of the Arabian and African plates with the Anatolian plate. Northward subduction of the African plate beneath Anatolia takes place along the Hellenic and Cyprus arcs. Further east the Arabian plate, separated from Africa since the opening of the Red Sea in the Mid-Miocene, is moving at a much faster rate (18 to 25 mm/yr) than the north-northwest African plate, which is moving north at 10 mm/yr. This differential movement between the African and Arabian plates has caused Anatolia to escape westward along two major strike-slip faults: the North Anatolian Fault and the South Anatolian Fault (**Figure 4.27**). Further west in the Aegean, extension is dominant in the overlying plate as a result of this westward motion.

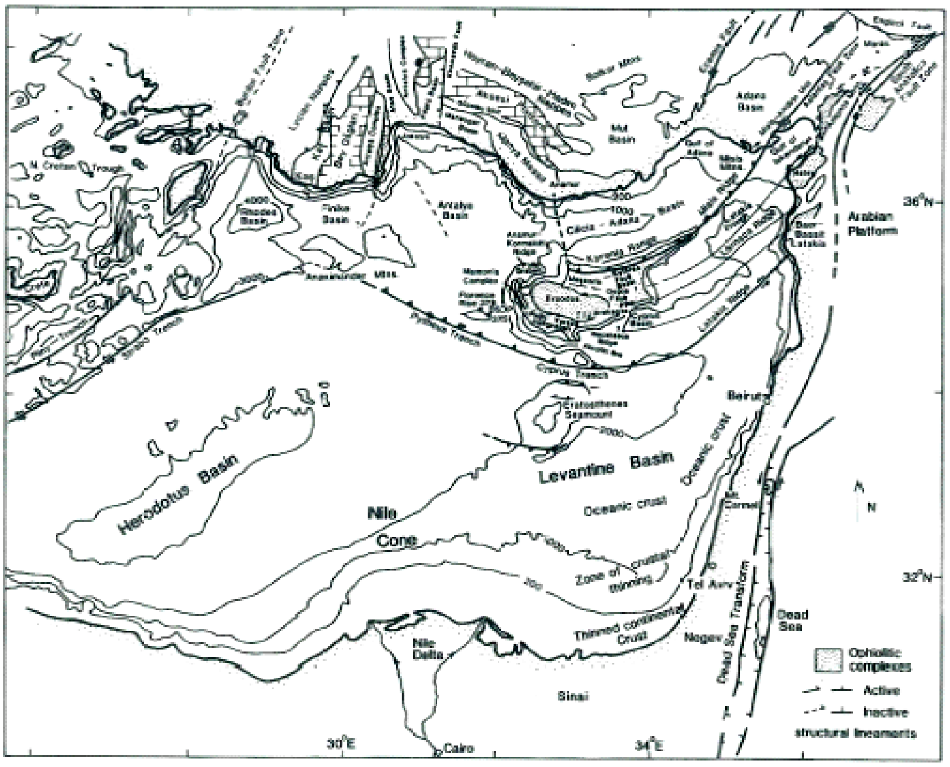


Figure 4.27. Geological and bathymetric map of Cyprus and the surrounding regions (From: Robertson, 1998).

The Cyprus Arc

The Cyprus Arc developed in the Mid- to Late Miocene to accommodate further crustal shortening after subduction stopped in central Turkey and in response to the northward motion of the Arabian plate created by the opening of the Red Sea. It marks the present location of the plate boundary between Africa and Anatolia. The Cyprus Arc is divided into western, central, and eastern sections (**Figure 4.28**). The Cyprus Arc and the Dead Sea fault form the main earthquake generating structures in the Eastern Mediterranean Basin. In the west its location was established mainly from earthquake, seismic, and drilling studies (DSDP Leg 42 Sites 375, 376). It runs from just south of Cyprus, between the Eratosthenes Seamount and the island, northwest along the southern boundary of the Florence Rise, and joins the Hellenic Arc at the Anaximander Seamount close to the Antalya Basin. Fault-plane solutions along this part of the Arc show compression with an element of strike-slip motion.

The central part of the Cyprus Arc is placed, by general consensus, between the island and the Eratosthenes Seamount, an uplifted faulted continental block, and marks the ongoing subduction of the Eratosthenes block beneath the Troodos massif. Thus, the 25 km-thick continental crust beneath Cyprus is thought to be part of the Eratosthenes block and to have been the main cause of the island's uplift since the Mid-Miocene.

In the east, seismic activity is considerably less and without any clear evidence of subduction. The compression evident in the central and western sections is here replaced by two sinistral strike-slip faults. The more southerly of the two is immediately south of the Hecateus and Latakia Rises and extends into northwestern Syria in the Baer Bassit area (Vidal et al., 2000; Al-Riyami et al., 2000; Pilidou et al., 2004). The northern fault bifurcates from the one to the south immediately east of the Hecateus Rise and then follows and bounds the Larnaka Rise towards the Gulf of Iskenderum (Vidal et al., 2000) (**Figure 4.28**).

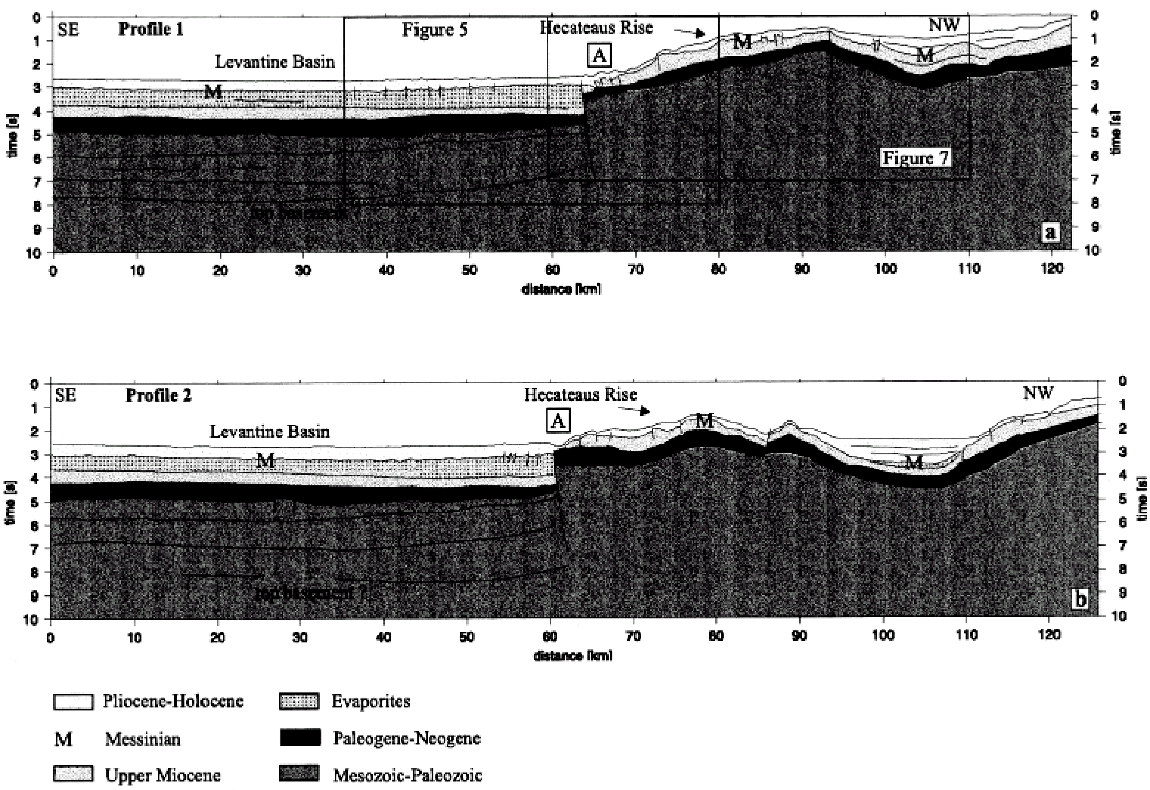


Figure 4.28. Seismic cross-section across the Hecateus Rise showing the bounding fault and Messinian and younger sediments (From: Vidal et al., 2000).

The Eratosthenes Seamount

The Eratosthenes Seamount is a continental fragment within Neotethys currently undergoing incipient subduction beneath Cyprus at the African-Anatolian plate boundary. It has been investigated and drilled by the Ocean Drilling Programme (ODP Leg 160), and this part of the report draws heavily on the results of that investigation. The Eratosthenes Seamount is about 1500 m high and 150 to 200 km wide. Its rather flat top is some 700 m below sea level. Shallow-water platform carbonates and pelagic carbonates make up the top several hundred metres of the succession drilled during ODP Leg 160 (Roberts, 1998). Messinian evaporites are either extremely thin or absent, and palaeosols indicate exposure above sea level accompanied by erosion and soil formation. There is no direct evidence as to its components below the section reached by ODP Leg 160, but a distinct and offset magnetic anomaly may well represent either the presence of lavas or of igneous intrusives. A number of northeast-west trending normal faults point to the seamount's break-up as it enters the Cyprus trench.

The Levantine Margin

All available information relating to the nature of the Levantine margin comes from its southern portion through the work carried out for on-land and offshore exploration in Israel. Garfunkel (2004) has proposed that north-trending normal faults with large throws to the west, active since the Late Permian, provide the mechanism for the formation of the Levantine Basin. The structural pattern of the Eratosthenes Seamount is indeed in agreement with this hypothesis.

As rifting continued, the underlying continental crust would thin and form the basement to the Levantine Basin instead of oceanic crust as proposed by Makris et al. (1983). The Eratosthenes Seamount would then be a larger continental block rifted off the Levantine margin (**Figure 4.29**). There is little if any information to the north of Israel, and to the south it is covered by the Nile Delta, but there is no reason to believe that it would be any different.

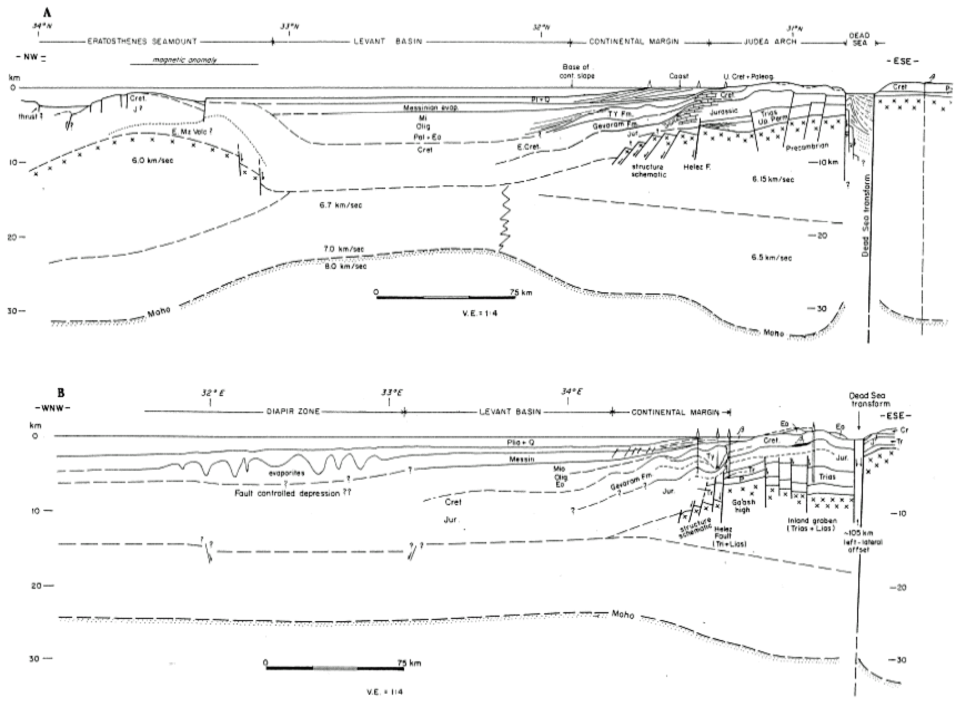


Figure 4.29 (A) Evolution of the Levantine Basin from the Levantine margin to just beyond the Eratosthenes Seamount; (B) Schematic section of the Eastern Mediterranean Basin and its eastern margin.

The Levant Basin and Nile Delta

Garfunkel's (2004) and Abdel Aal et al.'s (2001) work has shown the basement of the Levantine Basin to consist of faulted blocks making a horst and graben basin floor topography covered by 10 to 15 km of sediments with an age range from the Late Permian to Recent. Their evolutionary model is generation of the Basin by intercontinental rifting and extension that stops short of sea floor spreading and oceanic crust formation. As such, it means that the basal sediments everywhere would be shallow water clastics and carbonates. In deeper water, turbidites and pelagic carbonates with shales would be dominant, with basin floor sediments being mostly shales and distal turbidites (sheet sands).

The Nile Cone is chiefly a post-Upper Miocene sedimentary wedge that covers a much older marginal basin sequence. Together they have a thickness of 9 to 10 km, including 1.5 km of Messinian evaporites (Mascle et al., 2006). These post-Messinian sediments, supplied by the Nile River, have undergone significant thin-skin deformation due to downslope movement along slip-surfaces in the underlying evaporites. In the north, the Levantine Basin ends abruptly at the Hecateus and Latakia Rises (**Figure 4.30**).

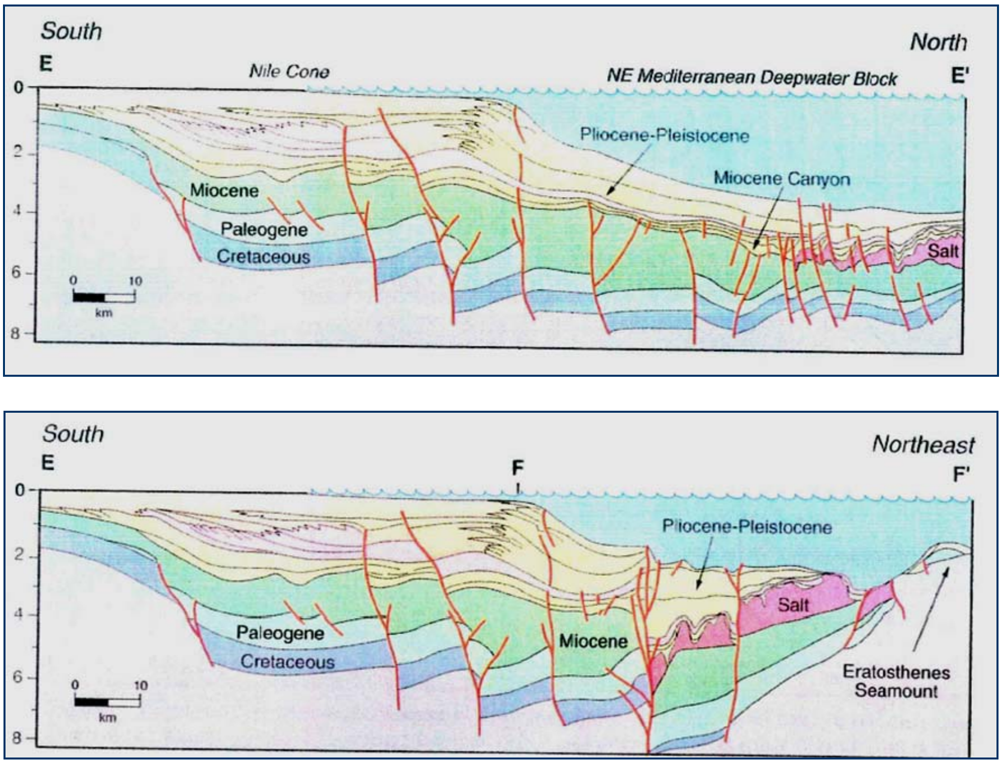


Figure 4.30. Geological cross-sections through the Nile Cone and the Northeastern Mediterranean (From: Abdel Aal et al., 2001).

The Messinian and Plio-Pleistocene sediments continue over both rises with little if any change in thickness but are faulted and deformed. This would suggest that both the Hecateus and Latakia Rises have been uplifted recently along the eastern segment of the Cyprus Arc.

4.1.4.3 Miocene and Younger Events

Deep marine conditions with pelagic carbonate sedimentation (chalks and marls) mark the period between the Maastrichtian and the end of the Oligocene. The Mid-Miocene to the Pleistocene is a period of shallowing seas over Cyprus culminating in the final emergence of the island at the end of the Pleistocene.

Subduction and crustal shortening continued north of Arabia after its collision with the trench of the north-dipping subduction zone over which the ophiolites of the "croissant" formed. By the Miocene, however, most of the slack had been taken up, and this, accompanied by the opening of the Red Sea and by the approach of the Eratosthenes Seamount, led to the establishment of the Cyprus Arc as Africa and Arabia continued moving north (Robertson, 1978).

4.1.4.4 Sediments and Hydrocarbon Potential

In the absence of any deep drillhole information, any predictions will, of necessity, be speculative and based on peripheral data from the Upper Nile Delta, the Israel Passive Margin, and the ODP results from the Eratosthenes Seamount.

The sedimentary succession in both the Levantine and Herodotus Basins is on the order of 10 to 15 km thick. Most of the succession predates the Messinian Salinity Crisis and is the least known, being underneath 1 to 2 km of salt deposits.

A three-fold subdivision of the succession is made possible by the presence of the ubiquitous evaporate deposits noted below:

1. Plio-Pleistocene;

2. Messinian evaporites; and

3. Pre-Messinian (Miocene-Triassic?).

Pliocene-Pleistocene Sediments

Pliocene-Pleistocene sediments are unlithified sands and clays with intercalations of organic-rich, thin beds termed sapropels. Almost all of the clastic material reaching the basin floor of the Levantine and Herodotus Basins comes from the Nile Delta. Successful wells have been drilled in the Pliocene turbidites of the shallow-water areas of the Nile Delta. The Pliocene deposits are slope and basin-floor turbidites in the form of channel, channel-levées, and sheet sands. Channels originate on the Delta and funnel turbidite sands down the slope, giving rise to sheet sands on the basin floor. In **Figure 4.31**, swath bathymetric studies (Mascle et al., 2006) show northwest-flowing channels entering the western part of the Cyprus EEZ inside the Herodotus Basin. These channels and sheet sands would make attractive targets in this area.

In the central part of the zone, south of the Eratosthenes Seamount, the Plio-Pleistocene sediments are highly deformed and folded as megaslumps generated by the down-slope movement of the underlying salt. Such folds could presumably make good traps for hydrocarbons. To the east, in the Levantine Basin, distal turbidites in the form of sheet sands would be the main reservoirs.

Pliocene sapropels are the main source rocks in the Plio-Pleistocene succession. Their formation is thought to be climate controlled, with warm periods giving rise to high organic productivity in the photic zone, while stagnant anoxic conditions on the basin floor led to their preservation. Their total organic carbon content varies from 5% to 25%.

A word of caution is needed at this point. Dependence on distal turbidite sands assumes that they would be clean and have high porosity. Often, however, the sands are finer and silty with reduced porosity.

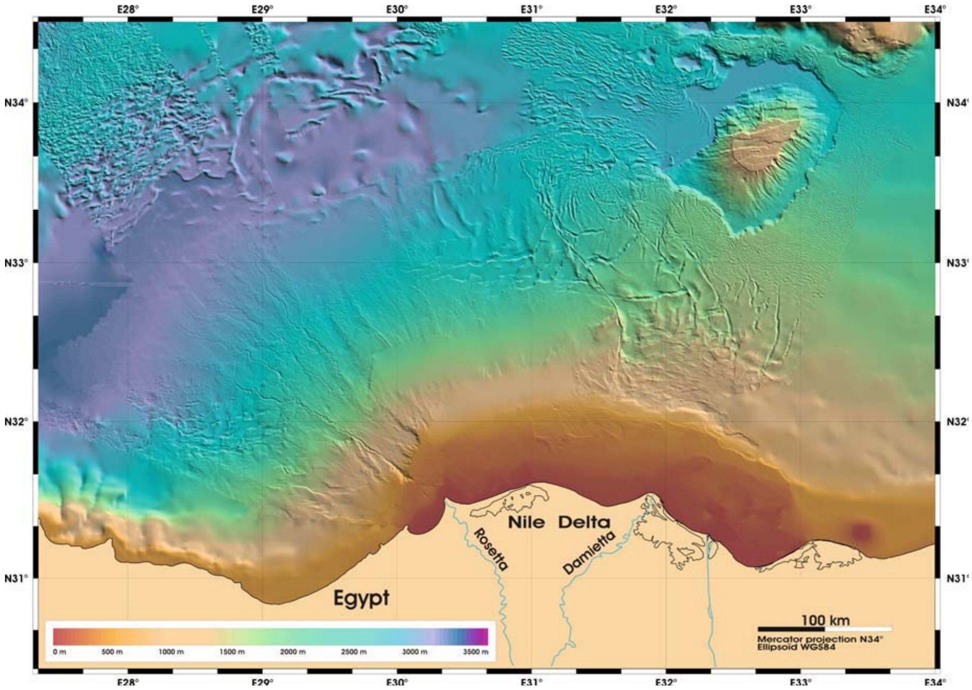


Figure 4.31. Bathymetric map of the Nile Delta and Deep Sea Fan. Note northwest-trending channels sweeping around to the western part of the Eratosthenes Seamount (From: Mascle et al., 2006).

Closer to Cyprus, smaller basins bordered by the Latakia and Larnaka Rises are possible extensions of the Mesaoria Basin on Cyprus (Calon et al., 2005). Two exploration wells drilled in the Mesaoria Basin (the Lefkoniko and Lakatameia boreholes) were dry. Plio-Pleistocene sediments in both cases were thin, less than 150 m, marls capped by conglomerates. Messinian evaporites in the form of gypsum were less than 10 m in the Lakatameia well and absent in Lefkoniko.

The pre-Messinian succession differed remarkably between the two wells. Predominantly pelagic and hemipelagic carbonates are seen at Lakatameia, but at Lefkoniko the sequence consists of an extremely thick package of Miocene turbidites (2150 m), sandstones and shales, underlain by 420 m of pelagic carbonates and marls. Both wells bottomed out in extrusives of the Troodos Ophiolite. Without any firm data, it would not be prudent to dismiss these basins on the evidence of on-land drilling.

The Messinian Salinity Crisis

The Messinian Salinity Crisis is not only the most unique oceanic event in the last 20 million years but it is also significant for the purpose of this report as sediments deposited during this event form a perfect seal to any hydrocarbons present offshore. These evaporite sediments were first discovered by Hsü et al. (1973). Their formation is attributed to the periodic restriction of sea-water inflow from the Atlantic, leading to hypersalinity and deposition of gypsum in shallower basins and halite in the deep basins. The Mediterranean did not dry completely, but at times the sea level dropped by as much as 1500 m. This fall led to dramatic erosion, with the formation of large canyons and deposition of coarse sediments that make good reservoir rocks.

A recent bulletin published on 21 February 2008 by the Mediterranean Science Commission (CIESM) presents a new consensus from the Messinian Salinity Crisis Workshop. The new scenario divides this very short-lived event into three stages:

- **Stage 1.** The stage from 5.96 to 5.60 my, when evaporitic conditions became established in small embayments of the Mediterranean. Under these conditions, mainly gypsum accumulated, forming the "Lower Evaporites."

- **Stage 2.** During this stage, which lasted only 50,000 years (from 5.6 to 5.55 my), the connection with the Atlantic was completely severed, causing a dramatic drop in sea level that led to the formation of thick halite deposits in the deep parts of the basins. These deposits are as much as 1500 to 2000 m thick in the Levantine Basin. As a consequence of this sea-level drop, much of the Nile Cone and most of the Eratosthenes Seamount were exposed and heavily eroded. In the Nile Delta area, large canyons were incised into the Delta sediments and channeled sands to the basin floors, especially in the Herodotus Basin. This progradation of sand deposition in deep water makes these sheet sands good exploration targets. In the case of the Eratosthenes Seamount, the canyons emanating from it were filled with coarse carbonate clastics that could prove to be good reservoirs.

- **Stage 3.** The stage from 5.53-5.33 my is marked by gradually increasing fluvial input, Lago Mare deposits, and development of gypsum and halite in deeper water.

Pre-Messinian to Cretaceous sediments have yielded oil in the Gulf of Suez and both oil and gas from wells in the Western Desert. In the Nile Delta, gas was struck in Miocene sediments and oil found in Eocene deltaic sandstones. Marine shales and shaly limestones are the most likely source rocks for these finds. Within the Herodotus and Levantine Basins, Cretaceous black shales could be a good source for oil. Data on the pre-Messinian successions within the Levantine and Herodotus Basins are extremely scarce or unavailable so any predictions must be speculative, but the fact that oil has been found in more shallow-water facies is encouraging.

The Eratosthenes Seamount rifted off the Levant margin in the Late Permian. ODP drillholes (Robertson, 1998) show the mount to be capped by Miocene and older shallow-water and pelagic carbonates. Similar sediments are to be expected in the surrounding smaller basins and on uplifted blocks. Deep canyons developed on the sides of Eratosthenes during the Messinian lowering of the sea level and were filled with coarse carbonate clastics. These clastics and the *in situ* shallow-water and pelagic carbonates are good reservoir rocks and make possible exploration targets.

4.1.4.5 Earthquakes and Geological Hazards

Cyprus is located close to the triple junction where the East Anatolian Fault, the Dead Sea Transform Fault, and the Cyprus Arc (Latakia and Larnaka Rise Faults) meet in northwestern Syria and southern Turkey. All of the faults mark plate boundaries – the East Anatolian Fault between the Anatolian and Arabian plates, the Dead Sea Transform Fault between the Arabian and African plates, and the Cyprus Arc between the Anatolian and African plates (Dewey and Sengór, 1979). Although all three plate boundaries are seismically active, the Cyprus Arc is the one most likely to affect the study area.

The seismicity in the area of Cyprus is shown in **Figure 4.32** (Ambrasseys and Adams, 1992). Note the large concentration of earthquakes just northwest of the Eratosthenes Seamount. Shallow and deep earthquakes occur in this region, including the earthquake of October 1996, which at a magnitude of 6.8 was the largest in the Cyprus region since 1953 (Pilidou et al., 2004). South and east of the Eratosthenes Seamount seismicity is considerably less, with only a few events along the Hecateus and Larnaka Rises. Fault-plane solutions from a number of events show the western and part of the central part of the Cyprus Arc to be in compression (**Figure 4.33**).

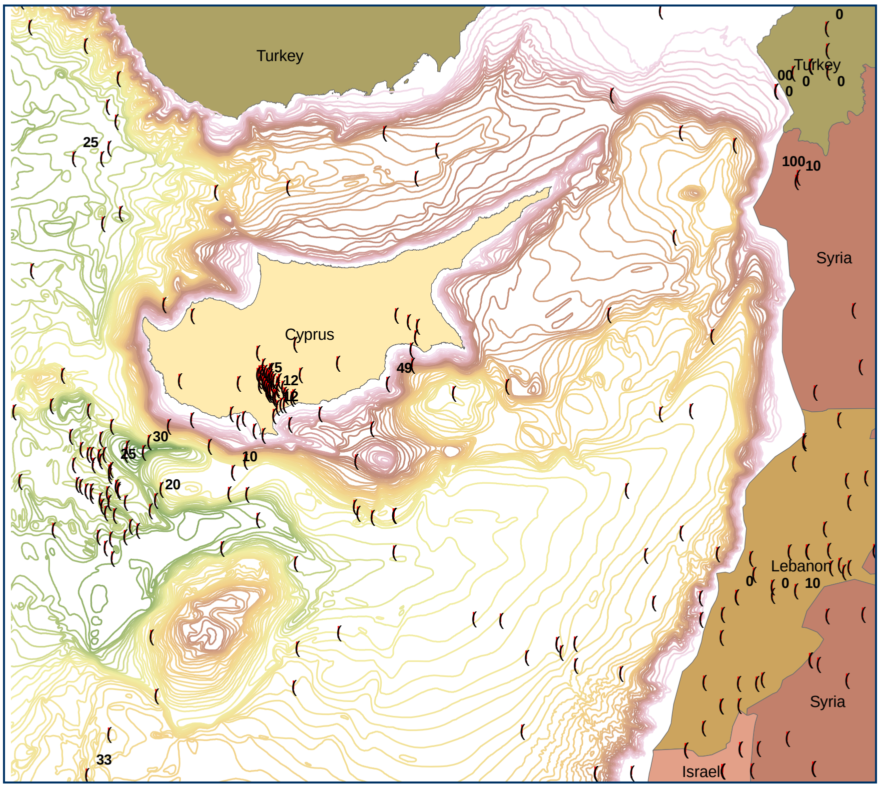


Figure 4.32. Distribution of earthquakes in the Eastern Mediterranean >M4. Note concentrations to the northwest of the Eratosthenes Seamount (Source: Geological Survey Department, Cyprus).

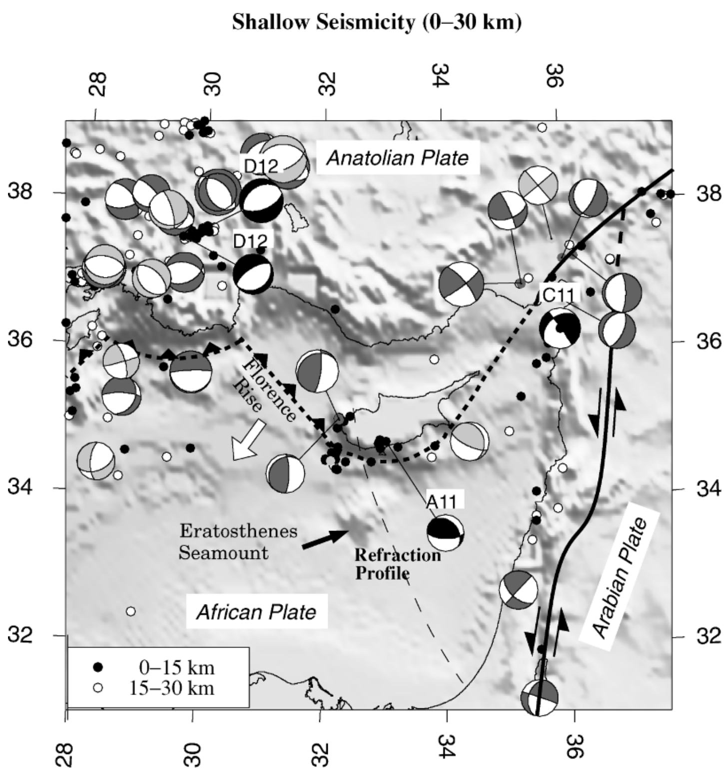


Figure 4.33. Fault plane solutions of earthquakes in the eastern Mediterranean Basin; note compressional region and the central and western parts of the Cyprus Arc. Large arrow shows direction of motion (From: Pilidou et al., 2004).

It is difficult to assess the effects that an earthquake of a similar magnitude with an epicentre closer to the study area would have without any details of the geomorphic and subsurface conditions in the area. However, the presence of evaporites on the sides of the Eratosthenes Seamount would provide good slip surfaces for mass flaws to occur. Saturated sand layers on slopes, especially when confined, would also be prone to failure.

Information on seismic sea waves is meagre. Ambrasseys (1962) conducted a survey of reported sea waves from Antiquity to 1961 and came to the conclusion that the region from Cyprus to Jubeil and Acre on the Levantine coast is prone to sea waves of light to rather strong intensity. The term "rather strong" on this intensity scale means that the waves would flood gently sloping slopes. The height and destructive power of such waves is by far greater in coastal areas, where they traverse shallow water, than out in the open seas. Kelletat and Schellmann (2002) have examined the western and southeastern coasts of Cyprus for tsunami evidence and reported movement of boulders weighing several tons by an event that took place over 200 years ago. Seismic sea waves and tsunamis are not likely to affect operations at sea.

4.1.5 Acoustic Environment

Ambient noise is sound received by an omni-directional sensor that is not from the sensor itself or a result of the manner in which the sensor is mounted. Ambient noise is made up of contributions from many sources, both natural and man-made. These sounds combine to give the continuum of noise against which all acoustic receivers have to detect required signals.

Ambient noise is generally made up of three constituent types – wideband continuous noise, tonals, and impulsive noise. Ambient noise covers the whole acoustic spectrum from below 1 Hz to well over 100 kHz (Urick, 1983). Above this frequency, the ambient noise level drops below thermal noise levels.

4.1.5.1 Natural Sources of Airborne and Waterborne Sound

There are a number of basic mechanisms by which ambient noise is generated from natural sources. All ambient noise sources involve one or more of these basic generation mechanisms.

Impact Noise

Impact noise occurs when water strikes water (e.g., breaking waves), water strikes solid (e.g., waves hitting a rock), solid strikes water (e.g., hail hitting the water surface), or solid strikes solid underwater (e.g., sediment noise [saltation]). It is usually a broadband, transient noise, possibly with resonant peaks if solids are involved.

Bubble Noise

There are several types of bubbles in sea water. Passive bubbles are quiescent and do not generate noise. Active bubbles are formed during an energetic process such as breaking waves or rain striking the surface. These bubbles oscillate and generate comparatively narrowband signals centred on the resonant frequency of the bubble, typically in the range 15 to 300 kHz. Collective oscillations of bubble clouds, particularly under breaking waves, can have resonant frequencies that are much lower than this.

Turbulence

Turbulence associated with surface disturbance or turbulent tidal flow around an obstruction generates low frequency continuous noise.

Seismic

Movement of the seabed can be coupled into the water column and generate very low frequency noise.

Wind-sea Noise

Noise is generated by the interaction between wind and the sea surface. At higher wind speeds, this results in breaking waves that produce noise by impact and bubble mechanisms (Medwin and Beaky, 1989; Medwin and Daniel, 1990). At lower wind speeds, noise results from flow noise as the wind passes over the sea surface and from bubbles entrained at the sea surface. There is likely to be a diurnal and annual cycle in the contribution from wind-sea noise due to changes in meteorological conditions.

Precipitation Noise

Precipitation hitting the sea surface generates noise by impacting the sea surface and, in some instances, by oscillation of the bubbles entrained by the impact. Small raindrops generate noise with a spectral peak around 15 kHz due to the entrained bubbles, while large raindrops only generate impact noise. Hail generates a spectrum with a broad peak between 2 and 5 kHz. Heavy snow produces a rising spectrum above 20 kHz. The noise from all forms of precipitation can be modified by increasing winds. In particular, the bubbles formed by small raindrops are less likely to form, so the level of bubble oscillation noise drops significantly as wind speed increases.

Surf Noise and Sediment Transport

Noise generation in the surf zone is a highly complex process, but the resulting noise can be heard up to 9 km offshore. The noise results from individual and collective bubble oscillation in the water column, sediment transport in the backwash, splashing, pounding, and turbulence (Voglis and Cook, 1970; Thorne, 1985). The character of noise from surf is dependent on the beach profile, wave direction relative to the beach, and sediment size. If the dominant beach material is cobble, pebble, or gravel, then sediment transport noise will dominate. For small sediment sizes such as sand or clay, bubble noise will dominate. The noise characteristics are further modified by the immediate offshore bathymetry, which will determine the acoustic propagation conditions for the sound out into deeper waters. Sediment transport can also occur away from the shoreline if the water is very shallow (<10 m) and a current is running and/or there is a significant wave height to disturb the seabed.

Biological Noise

Many marine organisms can generate noise. Fishes and cetaceans make sounds that contribute to ambient noise levels.

Thermal Noise

In the absence of all other sources of noise, thermal noise will dominate. This originates from the thermal agitation of molecules. The noise rises at 6 dB/octave and in a real environment is only important above 100 kHz.

4.1.5.2 Man-made Sources of Airborne and Waterborne Sound/Noise

There are a number of basic mechanisms by which ambient noise is generated from man-made sources. All of the sources of ambient noise involve one or more of these basic generation mechanisms.

Cavitation

Propellers and other fast moving objects in the water can cause cavitation noise when the pressure in the flow around the moving object goes sufficiently negative. This causes a cavitation bubble that very quickly collapses, causing a loud transient sound. The resulting spectrum is wideband but generally has a peak between 100 Hz and 1 kHz.

Machinery Noise

Machinery generally produces a broadband continuous spectrum with tonals superimposed resulting from the rotation rates of the various parts of the machinery. There may also be impulsive sounds.

Tonals

Some systems either deliberately, or as a by-product, generate high levels of tonal signals (e.g., sonar systems and seal scarers).

Man-made sources of airborne and waterborne sound/noise include:

Aggregate Extraction

The noise resulting from aggregate extraction is made up of three contributions: ship noise, dredge noise, and sediment noise. Dredge noise is that noise from the dredging machinery over and above normal ship noise, while sediment noise results from the movement of the seabed material across the seabed and through the suction tube.

Commercial Shipping and Leisure Craft

Commercial shipping, ferry traffic, and leisure craft also contribute to ambient noise (Wharam et al., 2004). The contribution of commercial shipping to ambient noise has been well studied, particularly in deep water, and the resulting spectra are well understood. The noise spectrum from all powered craft is composed of a low frequency broadband spectrum with a number of tonal lines resulting from the rotating machinery. Above 1 kHz, machinery noise diminishes and the dominant noise source is caused by water displacement and the resulting entrained bubbles. The noise of distant shipping tends to dominate the 50- to 300-Hz part of the spectrum.

Away from the main shipping lanes, a major contribution is likely to come from fishing boats. There are a variety of fishing activities in the study area, ranging from inshore potting to offshore deepwater trawling. As the fishing boats move around the area, they are likely to provide a significant contribution to shipping noise. Shipping noise will vary on a diurnal cycle (ferry and coastal traffic) and an annual cycle (seasonal activity).

Industrial Noise

Industrial noise can result from a number of offshore activities, including oil and gas production. The military can generate underwater noise by the use of ships, aircraft, explosives, and active sonar transmissions.

Sonar

Active sonar generates a high power pulse in the water and then listens for the echo from a desired target to determine range and direction. The most common sonar in use is the echosounder carried by most ships. Other sonars in use include fish finders and fishing gear control sonars, acoustic modems, air guns for seismic geological exploration, and military sonars.

The study area is a true deepwater area for acoustic propagation, and seismic surveys can result in basin-scale reverberation.

Aircraft

The noise of aircraft can couple into the water, particularly in the case of helicopters operating low over the surface of the water (Urick, 1972).

Fishing Activity

The act of dragging a trawl across the seabed is an inherently noisy operation. Other contributions are from ship noise and fishing sonars.

Dominant Noise Sources

Based on the information gleaned during this study, from the experience of the authors when working in the study area, and from a much wider experience of studying the various sources of ambient noise over many years of sonar trials, the most likely sources of ambient noise across the study area are mapped in **Figure 4.34**.

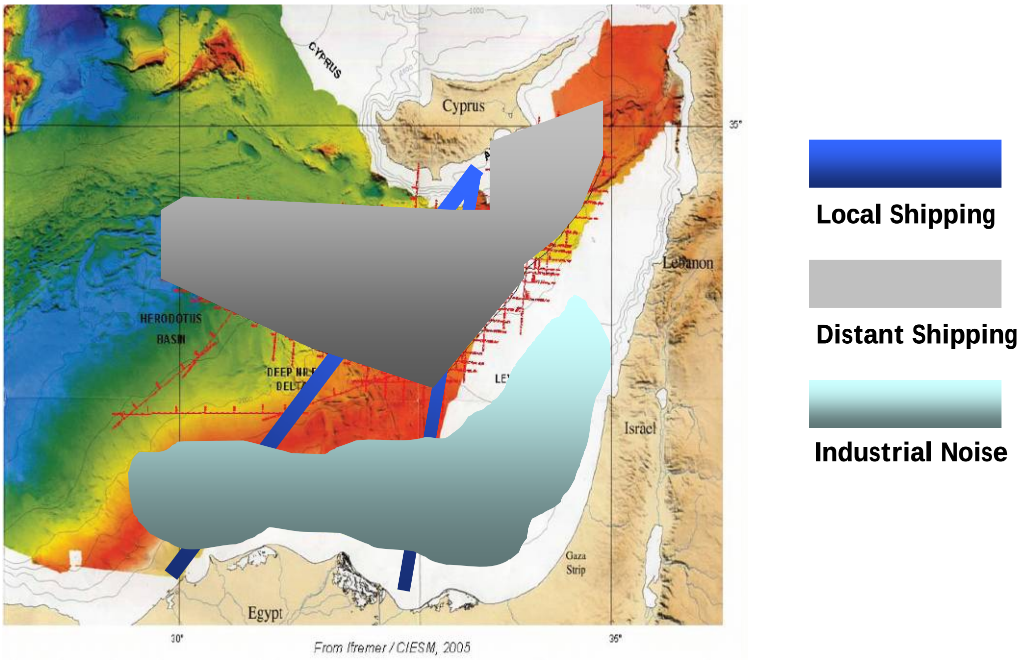


Figure 4.34. Dominant noise sources in the study area (little or no wind and precipitation).

The study area comprises deep, offshore waters in which the dominant noise source will be distant shipping in the absence of wind and precipitation. It should also be noted that the areas affected by different noise contributions will vary throughout the year, as acoustic propagation loss varies throughout the seasons. From **Figure 4.34**, it can be seen that distant shipping noise is likely to dominate across large parts of the study area. It is also anticipated that under the right conditions, industrial noise (from existing and future offshore oil production installations) could propagate into the study area. It should be noted that just because a particular noise source is dominant in a given area does not necessarily mean that other sources may be neglected in that area: the total noise level from all sources may be significantly higher than the level due to the dominant source alone, different sources may dominate in different parts of the spectrum, and bio-receptors may be more sensitive to a less dominant noise source in a different frequency range.

4.2 BIOLOGICAL ENVIRONMENT

4.2.1 Plankton (Spatial and Temporal Distribution)

Marine plankton are organisms with limited swimming capabilities that drift with the prevailing currents. Plankton range in size from <0.2 μm (marine viruses) to >20 mm (large jellyfish) and may derive energy from sunlight (i.e., "plant plankton," or phytoplankton) or from the consumption of organic material (i.e., "animal plankton," or zooplankton). In marine systems, phytoplankton form the base of the food web, while zooplankton link phytoplankton to fish production. Zooplankton also mediate the transfer of organic material from the surface ocean to the deep sea and thus are indirectly responsible for maintaining benthic community production in most deep ocean ecosystems.

4.2.1.1 Phytoplankton

Phytoplankton productivity in the Mediterranean Sea is nutrient-limited (Longhurst, 1998). In contrast to other marine systems, Mediterranean phytoplankton production is co-limited by phosphorus and nitrogen (Krom et al., 1991; Thingstad et al., 2005). An west-to-east decrease in nutrient concentrations in the Mediterranean Sea results in extremely nutrient-poor ("ultraoligotrophic") surface waters in the eastern Levantine Basin (see **Section 4.1.3.2**) and correspondingly low phytoplankton biomass and productivity relative to the Western Mediterranean (Tanaka et al., 2007).

Phytoplankton in the study area are primarily found in the surface ocean (0 to 150 m) where light levels are sufficient for growth (the euphotic zone, **Table 4.6**). However phytoplankton pigments (chlorophyll *a*) have been found to 500 m in the deep mixed layer of a warm-core eddy to the south of Cyprus (Krom et al., 1991). On average, the vertical distribution of phytoplankton pigment concentrations (chlorophyll *a*) in the eastern Levantine Basin reaches a maximum at 90 to 120 m, just above the nutricline (**Table 4.6**) (Yacobi et al., 1995; Krom et al., 2005). Phytoplankton productivity is greatest in the surface mixed layer, typically at a depth of 0 to 50 m (Tanaka et al., 2007).

Table 4.6. Inventories and concentrations of chlorophyll *a* (Chl), a phytoplankton pigment, during autumn (October-November) in the licence area region. The depth of the deep chlorophyll maximum layer (DCM) is also given (From: Yacobi et al., 1995).

Latitude (°N)	Longitude (°E)	Chl integrated (mg m^{-2})	Surface Chl (ng L^{-1})	DCM depth (m)	DCM Chl (ng L^{-1})
30.51	33.49	17.4	63	90	235
31.00	33.48	20.7	57	90	250
31.49	33.48	21.5	55	110	274
31.98	33.48	21.0	59	90	229
32.50	33.49	31.3	71	100	253
33.54	33.48	30.8	85	100	248

Phytoplankton dynamics in the eastern Levantine Basin in the region of the licence area vary on a seasonal cycle. Phytoplankton bloom in the winter and early spring (November to March) because deep winter mixing brings nutrients to surface waters (Vidussi et al., 2001). Phytoplankton growth during this season rapidly depletes phosphorus, and nutrient levels remain low during the summer when the surface ocean stratifies. Thus, the summer phytoplankton biomass is low (i.e., pigment concentrations [chlorophyll *a*]) in the surface mixed layer and up to an order of magnitude lower than observed during the winter (Krom et al., 1991).

The dominant phytoplankton in eastern Mediterranean assemblages is *Synechococcus* spp. (Pitta et al., 2005), a small (<2 μm) cell that outcompetes larger plankton for the limited amount of available nutrients. Analysis of phytoplankton accessory pigments in the eastern Levantine Basin also indicates the importance of prymnesiophyte nanoplankton (2 to 20 μm) and the presence of coccolithophorids, diatoms, and dinoflagellates (Psarra et al., 2005). Diatom populations in the study by Psarra et al. (2005) were dominated by *Thalassionema frauenfeldii*.

Studies of phytoplankton in the licence area region, including those cited above, have primarily focused on the warm-core eddy to the south of Cyprus (e.g., Krom et al., 1991; Pitta et al., 2005; Psarra et al., 2005; Tanaka et al., 2007). Studies of phytoplankton in the eastern or western sectors of the EEZ are more rare, but do include stations occupied during the POEM-BC project (e.g., Yacobi et al., 1995; Vidussi et al., 2001).

4.2.1.2 Zooplankton

Zooplankton in the eastern Mediterranean can be categorised by size into microzooplankton (20 to 200 µm) and mesozooplankton (>200 µm). Micro- and mesozooplankton in surface waters rely on a phytoplankton-based food web, whereas zooplankton in the deep sea rely on a food web based on organic particulate material sinking out of the surface ocean.

Microzooplankton in the study area are a diverse assemblage of small cells that consume bacteria and small phytoplankton such as *Synechococcus* spp. The microzooplankton community includes heterotrophic nanoflagellates (2 to 10 µm) and ciliates (10 to 350 µm), as well as autotrophic nanoflagellates (2- to 10-µm microzooplankton that have chloroplasts and can derive energy from sunlight, and are thus “mixotrophic”) (Pitta et al., 2005). Both ciliates and autotrophic nanoflagellates are found in surface waters. Ciliate abundances are maximal in the surface mixed layer (0 to 50 m) where phytoplankton production is highest, while autotrophic nanoflagellate abundances are maximal just above the nutricline, at approximately 100 m depth (Tanaka et al., 2007). In contrast, no consistent pattern is found for heterotrophic nanoflagellates in surface and deep waters of the eastern Levantine Basin, although their abundance and bacterial abundances decrease with depth (Tanaka et al., 2007).

Mesozooplankton in the eastern Levantine Basin are extremely diverse. In surface waters, zooplankton communities are dominated by copepods (**Table 4.7**; Mazzocchi et al., 1997), specifically the small copepods *Clausocalanus furcatus, C. paululus, Oithona plumifera*, and *Farranula rostrata* (Siokou-Frangou et al., 1997). None of these dominant species have been found to contribute more than 22% of total copepod numbers, and another 91 copepod species were also enumerated in the licence area region (Siokou-Frangou et al., 1997). In addition to copepods, at least 21 other zooplankton taxa are found in the eastern Levantine Basin, including medusae, siphonophores, ctenophores, heteropods, pteropods, molluscan larvae, polichaetes, cladocerans, ostracods, euphausiids, decadpod larvae, isopods, amphipods, chaetognaths, echinoderm larvae, appendicularians, pyrosomes, doliolids, salps, and fish eggs and larvae (**Table 4.7**; Mazzocchi et al., 1997). Thus, zooplankton biodiversity in the licence area region is extremely high.

Table 4.7. Distribution of the main zooplankton taxonomic groups (%) and total zooplankton abundance in the eastern Levantine Basin in the licence area region (From: Mazzocchi et al., 1997).

Taxa	% Contribution and Total Zooplankton Abundance
Copepoda	82.91%
Ostracoda	5.57%
Appendicularia	4.17%
Chaetognatha	1.52%
Pteropoda	1.37%
Salpida	1.06%
Medusae	0.86%
Polychaeta	0.82%
Total zooplankton (individuals per m^3)	114
Total zooplankton (individuals per m^2)	23 097

Mesozooplankton abundance in the eastern Mediterranean is highest in the surface mixed layer (0 to 50 m) where phytoplankton are most productive and decreases in mid-water depths (Böttger-Schnack, 1997; Mazzocchi et al., 1997). In the licence area region, zooplankton abundance has been characterised only to water depths of 450 m. Copepods dominate the samples to water depths of at least 300 m. Cladocerans and appendicularians are found primarily in surface waters (0 to 100 m), and ostracods and chaetognaths are more abundant at depth (100 to 300 m) (Mazzocchi et al., 1997). At the species level, the copepods *C. furcatus*, *C. paululus*, and *F. rostrata* were most abundant in the surface mixed layer (0 to 50 m), while *Haloptilus longicornis*, *Spinocalanus* spp., *Mormonilla minor*, and *Oithona setigera* became relatively more important with depth (Siokou-Frangou et al., 1997). Smaller mesozooplankton in the licence area region were collected by Böttger-Schnack (1997) using a fine mesh (0.055-µm) plankton net during the *METEOR* Cruise 5 (MINDIK). Copepods again dominated the smaller mesozooplankton, but the dominant species were small *Oncaea* spp., especially *O. zernovi*.

Mesozooplankton in the deep Levantine Basin (>500 m) have been sampled primarily near Crete (Böttger-Schnack, 1997; Weikert et al., 2001). These studies indicate the presence of a secondary maximum in mesozooplankton abundance in the deep-sea abyssopelagic zone (>2250 m) that comprises primarily *Eucalanus monachus*. It is unknown whether this secondary maximum is present in the licence area region, although one study found a reduction in *E. monachus* numbers in mid-water depths (500 to 1000 m) near Cyprus (Trinkhaus, 1988, in Bottger-Schnack, 1997). Deep-sea fine mesh (0.055-µm) plankton net samples have been collected only near Crete and Israel, and these indicate that the community of deep smaller mesozooplankton are dominated by multiple *Oncaea* species in Levantine Basin waters (Böttger-Schnack, 1997).

Despite previous research efforts, microzooplankton and mesozooplankton communities remain poorly characterised in the study area.

4.2.2 Benthos (Spatial and Temporal Distribution)

The benthos refers to animals (benthic fauna) and plants (benthic flora) that are found on, in, or near the seabed. Benthic fauna are often sorted according to size into meiobenthos (<1 mm) and macrobenthos (>1 mm). Specific data on composition and ecology of benthic ecosystems in the study area surrounding Cyprus are scarce, particularly in continental shelf, slope, and deep-sea habitats.

4.2.2.1 Continental Shelf

Continental shelf environments (approximately 50 to 150 m depth) are not with the licence area but are considered in this Environmental Report because of their proximity. Benthic ecosystems along the continental shelf of Cyprus also remain relatively underexplored, as studies have either focused on nearshore environments (**Section 4.2.2.4**) or the deep sea (**Section 4.2.2.2**). What is known concerning benthos along eastern Mediterranean continental shelves is derived from studies of nearby continental margins (e.g., the CINCS study site off Crete) (Tselepides and Polychronaki, 2000). This study found macrofaunal species composition to be similar to that of the western Mediterranean and neighboring Atlantic environments, and species were dominated by surface deposit feeding polychaetes (Tselepides et al., 2000). Benthic faunal biomass and abundance were much higher on the continental shelf than on the continental slope or in the deep sea in this region, due to the extreme oligotrophy of the eastern Mediterranean (Tselepides et al., 2000).

4.2.2.2 Slope and Deep Sea Habitats

Benthic fauna in continental slope and deep-sea habitats in the Mediterranean Sea are characterised by the fact that (1) they live across a wide range of water depths (are eurybathic), (2) they comprise very few true deepwater species, and (3) the number of endemisms generally declines with increasing depth (Cartes et al., 2004). The first two characteristics are the result of extinctions of deepwater fauna in the Quaternary Period during recurring stagnant (dysoxic and anoxic) episodes (Van Harten, 1987). Stagnation would have precluded colonization by fauna until less than 6000 years ago (Galil and Goren, 1994), although the eastern deep basins formed approximately 2 million years ago (Por and Dimentman, 1989). Deep-sea fauna now found in the eastern Levantine Basin are extremely impoverished in terms of species number, in part because the deep eastern basin is separated from the western Mediterranean by the Siculo-Tunisian sill (approximately 400 m; Pérès, 1985). The low diversity and species richness are also due to differences in temperature, salinity, and food supply between Atlantic and Mediterranean waters.

The abyssal basins of the Eastern Mediterranean are extremely unusual deep-sea systems. With water temperatures at 4000 m in excess of 14°C (rather than <4°C for other deep oceanic basins), the entire benthic environment is as hot as the water around a hydrothermal vent system, but lacks the vents' rich chemical energy supply. The Mediterranean also differs from other deep-sea ecosystems in terms of its species composition, notably the absence of the near-ubiquitous deepwater grenadier fish *Coryphaenoides armatus* and the amphipod *Eurythenes gryllus*. Instead, *Acanthephhyra eximia* appears to have functionally replaced *E. gryllus*, the dominant deep-sea scavenging crustacean throughout most of the world's oceans (Christiansen, 1989). Overall, mean benthic biomass, abundance, and diversity decrease drastically with depth in the eastern Mediterranean, with major faunal transitions occurring at 200, 500, and 1000 m (Tselepides et al., 2000).

Few studies have examined deepwater benthic fauna in the study area region, but, based on existing evidence, Galil (2004) has characterised these communities as diverse but scarce, consisting of "autochthonous, self-sustaining populations of opportunistic, eurybathic species." Results from Cruise 25/1 of the R/V *METEOR* in 1993 revealed a strong dependence of meiofaunal abudance on depth, distance from the coast, and food (labile organic carbon) availability (Tselepides and Lampadariou, 2004). The meiofaunal community was dominated by nematodes, harpacticoid copepods, and polychaetes (**Table 4.8**). In general, measured meiofaunal abundances were very low, as was the case for macrofaunal abundances inferred from bioturbation proxies during a different study (Basso et al., 2004). These facts, as well as microbial enzyme activity data obtained during Cruise 25/1 of the R/V *METEOR* (Boetius et al., 1996), point directly to the ultra-oligotrophic nature of the eastern Levantine Basin.
As described in Galil (2004) and Jones et al. (2003), the major species recorded in the deep (1000 to 4264 m) Levantine Sea in the region of the exploitation blocks are discussed in the following subsections.

Table 4.8. Relative abundance (%) of nematodes and the less abundant meiofaunal taxa (individuals/10 cm^2) collected in the study area region (From: Tselepides and Lampadariou, 2004).

Taxa	**Location**		
	33°19.94'N, 33°24.92'E	**34°26.06'N, 32°36.83'E**	**33°59.89'N, 32°10.70'E**
Nematoda	64.4	41.4	50.5
Copepoda	13.3	24.3	25.2
Copepoda nauplii	15.3	29.0	10.4
Polychaeta	2.8	4.2	11.7
Gastrotricha	0.3	---	0.5
Ostracoda	0.1	0.2	---
Tardigrada	0.3	---	---
Turbellaria	3.3	0.7	1.4
Tanaidacea	---	---	0.5
Sipuncula	0.1	---	---

Fishes

A total of 566 specimens from 31 fish species was collected. *Bathypterois mediterraneus* and *Nezumia sclerorhynchus* were the most common, representing 38% and 27% of the specimens, respectively. *Cataetyx laticeps*, *Chauliodus sloani*, and the ubiquitous *Bathypterois mediterraneus* were photographed at a depth of 2900 m.

Sharks

Off Cyprus at 1490 m depth, the sharks *Centrophorus granulosus* and *Etmopterus spinax* were the most abundant, occurring in 83% of the recordings. Other sharks found in the eastern Mediterranean at depths of ≤2300 m were *Hexanchus griseus*, *Galeus melastomus*, *Centrophorus* spp., *Centroscymnus coelolepis*, and *Etmopterus spinax*.

Decapod Crustaceans

A total of 2819 specimens was collected from 19 species of decapod crustaceans. The Mediterranean endemic geryonid crab *Chaceon mediterraneus* was photographed southwest of Cyprus at a depth of 2900 m. *Polycheles typhlops*, *Acanthephyra eximia*, *Aristeus antennatus*, and *Geryon longipes* were the most common decapod species, accounting for 48%, 25%, 14%, and 7% of the specimens, respectively.

Amphipod Crustaceans

A total of 673 specimens was collected from 22 species of amphipod crustaceans. Four of the 22 deep-sea amphipod species collected were Mediterranean endemics, two of which (*Ileraustroe ilergetes* and *Pseudotiron bouvieri*) represented 40% and 15% of the specimens, respectively. The next most common were *Rhachotropis rostrata* and *Stegophaloides christianiensis*, representing nearly 11% of the specimens.

Cumaceans

A total of 575 specimens were collected from 12 cumacean species. *Procampylaspis bonnieri* was the most frequently collected, representing 33% of the specimens. *Campylaspis glabra* was the next most common species with nearly 13%, followed by *Makrokylindrus longipes*, *Platysympus typicus*, and *Procampylaspis armata*, each accounting for nearly 11% of the specimens.

Molluscs

A total of 4580 specimens were collected from 42 species of molluscs. In depths greater than 1000 m, the most common benthic mollusks were *Yoldia micrometrica*, *Kelliella abyssicola*, *Cardyomia costellata*, *Entalina tetragona*, *Benthomangelia macra*, *Benthonella tenella*, and *Bathyarca pectunculoides*.

This section described organisms found in soft-bottom slope and deep-sea habitats. Another type of habitat present in the study area region is the Eratosthenes Seamount (**Section 4.2.2.3**). A third type of habitat, chemosynthetic benthic communities driven by the biological oxidation of sedimentary methane, has not yet been fully documented in this region but reports from the Hotspot Ecosystems Research on the Margins of European Seas (HERMES) project map such habitats in proximity to the westernmost block (Block 4; Weaver et al., 2004).

4.2.2.3 Seamounts

The study area (specifically, Blocks 7 and 8) includes a seamount of considerable proportions, the Eratosthenes Seamount, which measures 120 km in length by 80 km in width at the base and rises from the Eratosthenes abyssal plain (2700 m depth) in the west to within 690 m of the sea surface (Hall et al., 1994; Mart and Robertson, 1998). Although the geology of the seamount has been extensively studied, very little is known about the biological communities inhabiting the seamount region. Cruise 5 of the R/V*AKADEMIK NIKOLAJ STRAKHOV* in 1987 recovered samples of organisms that were briefly itemised in reports from that expedition (Krasheninnikov and Hall, 1994).

The most systematic, targeted, and extensive study of organisms of the Eratosthenes Seamount took place during Cruise 201/2 of the R/V *POSEIDON* in 1994 (Galil and Zibrowius, 1998). Galil and Zimbrowius (1998) documented the presence of a diverse and rich fauna on the top of the seamount (collected by beam trawl and box core) and found invertebrate abundances to be higher than those at sites of comparable depth in the eastern Levantine Basin (Cartes et al., 2004). The same study also documented the presence of deep-sea scleractinian corals (*Caryophyllia calveri* and *Desmophyllum cristagalli*) as well as commercially important shrimp species (*Aristaeomorpha foliacea*, *Aristeus antennatus*, and *Plesionika martia*). The presence of benthopelagic, commercially-important fish populations is highly likely, as is common in other seamounts around the world (Cartes et al., 2004).

There is a dearth of information concerning the biological communities inhabiting the Eratosthenes Seamount (Galil and Zibrowius, 1998), and this topographic feature of the study area should be considered for further investigation.

4.2.2.4 Nearshore, Intertidal, and Subtidal

The nearshore coastal zone of the Mediterranean Sea (here we characterise intertidal and subtidal environments as "nearshore") is characterised by high species diversity due to variable climatic and hydrological conditions, the existence of specific biotopes, and the geological history of the basin. Exotic species also contribute to the observed species richness, e.g., due to migration and shipping from the Suez Canal (Fishelson, 2000). A total of 10 000 to 12 000 marine species (approximately 8500 macroscopic faunal species and 1300 floral species) has been identified and recorded from the Mediterranean, representing 8% to 9% of the total number of species in the world's seas (European Economic Area, 2006). As new areas are explored and new technological developments are used, additional species are continuously added to the list.

Nearshore coastal environments of Cyprus are not technically within the study area; however, due to their proximity to the licensing block region, they have been considered in the environmental study. In general, much more is known concerning the nearshore region than the surrounding continental shelf, slope, or deep sea. Based on a summary given in the Integrated Marine and Coastal Area Management (IMCAM) plan (UNEP-MAP RAC/SPA, 2007), soft bottom and rocky reef benthic communities dominate the nearshore environments of Cyprus. Important and vulnerable marine biocoenoses (and their dominant species) include littoral organogenic concretions (*Dedropoma petraeum*, *Lithophyllum trochanter*, and *Tenarea undulosa*), fucales forests (*Cystoseira cf. humilis*, *C. foeniculacea*, *C. spinosa v. tenuior*, *C. spinosa*, and *C. zosteroides*), maërl beds (*Lithothamnion*, *Phymatolithon*, and *Lithophyllum* spp.), circalittoral ("coralligenous") biogenic formations (the algae *Lithophyllum*, *Mesophyllum*, and *Peyssonnelia* spp. and sponges *Agelas*, *Clathrina*, *Axinella*, *Ircinia*, *Dysidea*, and *Calyx* spp.), submarine caves (*Mesophyllum alternans*, *Lithophyllum stictaeforme*, and *Peyssonnelia* spp.), and seagrass meadows (*Posidonia oceanica* and *Cymodocea nodosa*).

A diverse community of invertebrate and vertebrate organisms utilises nearshore Cyprus habitats. For example, the triton *Charonia tritonis,* juvenile sea groupers (*Epinephelus* and *Mycteroperca* spp.), and parrotfishes (*Sparisoma* spp.) utilise *Cystoseira* forests, reproductive groupers (*Epinephelus* and *Mycteroperca* spp.) are found in the region of coralligenous formations, and groupers (*Epinephelus* spp.), the brown meagre (*Sciaena umbra*), and slipper lobster (*Scyllarides latus*) shelter in submarine caves (UNEP-MAP RAC/SPA, 2007). On average, gastropods, crustaceans, bivalves, polychaete worms, and echinoderms dominate Cypriot soft bottom macrofaunal communities (Hadjichristophorou et al., 1997; Argyrou et al., 1999). However, in terms of their conservation status, a few species of sponges (Porifera), molluscs, bryozoans, crustaceans, and echinoderms are especially important (**Table 4.9**).

Table 4.9. Marine invertebrate species of special interest in Cyprus nearshore environments (From: UNEP-MAP RAC/SPA, 2007).

Taxa	
Porifera	**Crustacea**
Axinella cannabina	*Maia squinado*
Axinella polypoides	*Ocypode cursor*
Spongidae spp.	*Palinurus elephas*
Mollusca	*Scyllarides latus*
Charonia lampas lampas	*Scyllarus arctus*
Charonia tritonis variegata	*Scyllarus pygmaeus*
Dendropoma petraeum	**Bryozoa**
Erosaria spurca	*Hornera lichenoides*
Lithophaga lithophaga	**Echinodermata**
Luria lurida	*Centrostephanus longispinus*
Pholas dactylus	*Ophidiaster ophidianus*
Pinna nobilis	*Paracentrotus lividus*
Pinna rudis (= *P. pernula*)	
Tonna galea	

Biodiversity loss in the nearshore coastal zone of Cyprus is, in part, attributed to fishing pressure (EEA, 2006). Physical disturbance of the seabed by trawling affects the number and diversity of nontargeted species and can cause long-term changes to fragile habitats (e.g., stony corals *Caryophylia smithii* and *Desmophyllum cristagalli*, the sea pens *Funiculina quandrangularis*, *Pennatula rubra*, and *Kophobelemnon leucarti*, the sea fan *Isidella elongata*, and the soft coral *Alcyonium palmatum*). Intense trawling pressure on maerl grounds also affects associated macrobenthos and important commercial species. Exotic species may also reduce biodiversity by altering the surrounding marine ecosystem. A well-documented case is that of *Caulerpa racemosa*, which has colonised the entire Mediterranean within a time span of 15 years and has had important effects on the Cypriot nearshore benthic communities (Argyrou et al., 1999). Additional environmental problems affecting the nearshore environment of Cyprus include coastline alteration and industrial activities.

Overall, the nearshore coastal ecosystem of Cyprus is in relatively good condition, with minor environmental impacts. The coastal ecosystem continues to support turtle migration and nesting and provide habitat for various flora and fauna of special interest. The coastline is subjected to various environmental pressures, particularly urban and infrastructure development, tourism, recreation, etc. Sewage treatment plants are currently operating in all four large coastal cities, and in conjunction with limiting industrial development, are significant factors in sustaining quality of the coastal waters. Moreover, the application of various biotic indices developed within the implementation of the Water Framework Directive (2000/60/EC) revealed that the coastal waters of Cyprus have good/high ecological status.

4.2.3 Nekton (Fish) (Spatial and Temporal Distribution)

The Mediterranean gets most of its nutrient salts from surface layers of the Central Atlantic, which also are not very nutrient rich. The Atlantic Water that enters the Mediterranean through the Strait of Gibraltar follows the North Coast of Africa, with various branches on the way, and reaches the East Mediterranean, where water travels mainly in an anticlockwise rotation around Cyprus. On the way to the east Mediterranean, nutrients enter into various life cycles and are either landed as fish or sink, ultimately, to the lower layers of the sea, with the East Mediterranean receiving whatever nutrients are left over.

On its way to the Mediterranean, the sea water becomes not only less nutrient-rich but also warmer and very salty, hence denser. In the area southwest of Cyprus, this water (known as Mediterranean Water) sinks to the deeper layers and moves west during the winter. Ultimately, it flows out of the Mediterranean and into the Atlantic through the lower strata of the Strait of Gibraltar. With it, it takes any nutrients that have dropped into it as organic debris.

With this general pattern, the productivity of the sea around Cyprus is seen as having about the same productivity as the rest of the East Mediterranean. The presence of a strong thermocline has significant effects on the vertical distribution of the marine life of the island.

The Mediterranean has its own specific fauna and flora as a result of its origins and peculiar hydrography. Characteristic of the marine sea life around Cyprus is the large variety of species found in relatively small quantities. For example, fisheries in Cyprus depend on a very large variety of fish that exceeds 80 species. No single species prevails as is the case elsewhere in the Mediterranean, where a small number of small pelagic fish species dominate the scene.

4.2.3.1 Nearshore and Demersal Species

Perhaps the sole exception is picarel (Marida), *Spicara smaris*, which replaces sardines and sardinellas in the coastal pelagic ecosystem around Cyprus. Picarel is the most abundant commercial fish in Cyprus. Large quantities of males are caught in shallow waters with gill nets in early spring. The females were the basis of the catches of trawlers before these boats were fitted with the Blue boxes, required by the EU, to track their activity. As trawling is prohibited in waters shallower than 50 m, fishing for picarel has now practically ceased. The reduction of the trawler fleet that fishes on the continental shelf of the island from eight to four boats has also contributed to the reduction of fishing for this species, as has the introduction of larger mesh sizes for trawler nets. Picarel is a protogynous hermaphrodite living as a female in its first year of life before changing to a male.

Demetropoulos and Neocleous (1969) list most of the fishes of Cyprus with notes on their distribution around the island with depth records and abundance. The inshore fishery (an artisan fishery) mainly uses trammel nets and bottom-set long-lines. The catch consists of a variety of demersal fishes such as red and striped mullets (*Mullus surmuletus* and *M. barbatus*), parrotfish (*Euscarus cretensis*), several species of bream, two siganids *(Siganus luridus* and *S. rivulatus)*, some species of grouper (mainly *Epinephelus marginatus* and *E. alexandrinus* [*E. costae*]), and, seasonally, quantities of *Spicara smaris* and *Boops boops.* There also are significant catches of cephalopods (squid, octopus, and cuttlefish), some slipper lobsters (*Scyllarides latus*), and occasionally on the west of the island, crawfish (*Palinurus elephas*). The last is very rare elsewhere on the island. Some trolling also takes place, mainly for mineri (amberjack, *Seriola dumerili*), palamida (frigate tuna, *Auxis thazard),* tounaki (albacore tuna, *Thunnus alalunga*), and dakanomouttas (dolphinfish, *Coryphaena hippurus*). The last one is caught mainly in autumn, mostly by trolling and occasionally on floating long-lines.

4.2.3.2 Offshore and Pelagic Species

Albacore tuna (*T. alalunga*) make a seasonal passage off the south coast of Cyprus starting in late spring at Cape Greco and heading for Paphos, which is usually reached in June/July. They are fished mainly with surface long-lines up to about 15 km out at sea.

Bluefin tuna (*T. thynnus*) are usually caught with purse seines. Some catches are aimed for stocking fish farms for fattening for the Japanese market. EU/ICCAT (tradable) country quotas are in place for landings of this species.

Swordfish (*Xiphias gladius*) were caught in some quantities in the late 1980's and in the 1990's as well as early in the current decade. At its peak in the late 1980's and early 1990's, catches peaked at 34 tons in 1990 and dropped to about 10 tons per annum since 1995. Overfishing has caused fishing operations to be put on hold for the time being. This fishery also caught a small quantity of open sea sharks (*Isurus oxyrinchus*, etc.). Fishing for swordfish was mainly in the open sea, 10 to 30 km from land.

Deepwater biota, including fishes in deep waters south of Cyprus, have not been studied to any degree. The sharks *Centrophorus granulosus* and *Etmopterus spinax* were the most abundant species found in a study of this area (Gilat and Gelman, 1984). A study of the benthos of the area by Galil (2004) recorded three fish species, *B. mediterraneous*, *Cataetyx latipes*, and *Chauliodes sloani*. The study confirmed "the icthyofauna scarsity of the Levantine Basin compared not only with the adjacent Atlantic Ocean (Haedrich and Merrett, 1988) but also with the Western Mediterranean."

4.2.3.3 Alien or Non-native and Nuisance Species – the Lessepsian Migration

The opening of the Suez Canal in 1869 led to the connection of the Mediterranean with the Red Sea. For the first time, the Mediterranean's pure Atlantic-origin fauna faced competition from invading Indo-pacific animals and plants that established themselves first in the Suez Canal and later in the Mediterranean Sea. Several hundred species have since established themselves in the Eastern Mediterranean, and the number is growing fast. This migration, which has been named the Lessepsian migration, after Ferdinand De Lesseps, the Frenchman that built the canal, has been the subject of many studies during the last half of last century (e.g., Steinitz, 1967). These Indo-pacific species now form over 12% of the marine fauna of the East Mediterranean and 5% of the entire Mediterranean marine fauna (Fredj., 1990; Bellan-Santini et al., 1992; Fredj et al., 1992). Many species, such as the well-known red soldierfish and two siganids (rabbitfish), are now common in the commercial fish catches of Cypriot fishermen. Many species of benthic organisms have also colonised the island (Hadjichristophorou et al., 1997). Several other species are common in the catches of fishermen fishing off the Levant coast, such as *Upeneus moluccensis*, which has been replacing the more valuable local red and striped mullets in some areas. The spread of Indo-pacific species in the Levantine Basin seems to follow an anticlockwise pattern, no doubt following the prevailing coastal currents. Many species, some of them nuisance species (e.g., some jellyfish) and some invasive (e.g., *Caulerpa racemosa*), are now well-established in the east Mediterranean.

The population explosion of a pufferfish, *Lagocephalus sceleratus*, in the last 3 to 4 years in Cyprus waters (and elsewhere in the east Mediterranean as far west as the Aegean) has been causing problems due to the toxicity of the fish and the large numbers caught. Its wider impact on the ecosystem is not clear as yet. Another pufferfish, *L. spadiceus*, that entered the Mediterranean earlier, is found only in small numbers.

Other recent immigrants to the Mediterranean that have established themselves in the coastal waters of Cyprus include the algaes *Caulerpa racemosa* and *Stypopodium shimperi*. Both algaes, especially *C. racemosa*, have spread extensively since about 1990, covering many very large areas of sea bed around the island (Argyrou et al., 1999). *C. racemosa* covers the sea bed and especially soft substrates in a mat a few centimetres thick, competing very successfully with other floral species such as *C. prolifera* and *Cymodocea nodosa* which it may replace. Apparently this species has no enemies as yet in the Mediterranean, and if its proliferation continues it is likely to revolutionise the entire East Mediterranean shallow-water ecosystem, with far-reaching effects not only on the native marine flora but also, and perhaps more significantly, on the marine fauna of the area. The reduction, for example, of *C. nodosa* in key feeding areas of the green turtle (*Chelonia mydas*) in the Levantine Basin will inevitably have an effect on the survival of this species in the Mediterranean. This marine turtle feeds almost exclusively on this seagrass in the Mediterranean, at least up to its sub-adult stage (Demetropoulos and Hadjichristophorou, 1995). *Caulerpa racemosa*, fortunately, for the time being at least, seems to have "lost vigour" and is apparently proliferating more slowly now. If anything, it is apparently retreating from the areas it covered earlier.

The great majority if not all the marine alien species found in Cyprus are Lessepsian immigrants. Introductions through other channels (fouling organisms on boats, in ballast water, or through aquaculture, etc.) have not been noted so far.

4.2.4 Marine Birds

Table 4.10 lists sea birds noted in the Barcelona Convention and protected by Cypriot legislation (Action Plan for Sea Birds – UNEP/MAP RAC/SPA). Not all these species occur in Cyprus (**Table 4.10**). The chasing, taking, shooting, killing, possessing, or selling of any of these species (all species in Annex VI) is illegal and offenders can be punished up to a maximum of 3 years in prison and/or up to 10 000 CYP fine. **Table 4.11** lists species for which Special Protective Areas have been established.

Table 4.10. Bird species protected by Cypriot legislation and listed in the Barcelona Convention.

Species	Remarks
Cory's Shearwater (*Calonectris diomedea*)	Passage migrant recorded occasionally
Yelkouan Shearwater (*Puffinus yelkouan*)	Passage migrant recorded occasionally
Balearics Shearwater (*Puffinus mauretanicus*)	Not recorded in Cyprus
Storm Petrel (*Hydrobates pelagicus*)	--
Shag (*Phalacrocorax aristotelis*)	Recorded during regular coastal observations
Pygmy Cormorant (*Phalacrocorax pygmeus*)	A very irregular and scarce passage migrant
White Pelican (*Pelecanus onocrotalus*)	Occurring in small numbers; recorded during monthly wetland counts
Dalmatian Pelican (*Pelecanus crispus*)	A rare passage migrant occasionally recorded during wetland counts
Greater Flamingo (*Phoenicopterus rubber*)	A winter visitors in large numbers; recorded during monthly wetland counts
Osprey (*Pandion haliaetus*)	Recorded during monthly wetland counts
Eleonora's Falcon (*Falco eleonorae*)	Recorded twice (September – October) during annual boat surveys
Slender-billed Curlew (*Numenius tenuirostris*)	--
Audouin's Gull (*Larus audouini*)	The only known colony is located on islets in Turkish-occupied northern Cyprus where access in restricted; breeding status is unknown
Lesser Crested Tern (*Sterna begalensis*)	Not recorded in Cyprus
Sandwich Tern (*Sterna sandvicensis*)	Recorded during monthly wetland counts
Little Tern (*Sterna albifrons*)	Scarce, but has recently been reported in breeding pairs (since 2002); recorded during monthly wetland counts

Table 4.11. Bird species for which Special Protective Areas (SPAs) have been established.

Species	Remarks
Shag (*Phalacrocorax aristotelis*)	Cape Aspro, a large coastal area with cliffs where shags breed is an SPA. Akamas peninsula will be designated in 2007 as an SPA and a Site of Community Importance (SCI)
White Pelican (*Pelecanus onocrotalus*)	Larnaca and Akrotiri salt lake; RAMSAR sites. Larnaca also an SPA
Greater Flamingo (*Phoenicopterus rubber*)	Larnaca and Akrotiri salt lake; RAMSAR sites. Larnaca also an SPA
Osprey (*Pandion haliaetus*)	Achna dam, a favourite osprey wetland, will be designated within 2007 as an SPA
Eleonora's Falcon (*Falco eleonorae*)	Cape Aspro, species major colony is an SPA
Little Tern (*Sterna albifrons*)	Larnaca and Akrotiri salt lake; RAMSAR sites. Larnaca also an SPA

4.2.5 Marine Mammals

The Mediterranean Sea supports a diverse marine mammal fauna, including several species listed by the International Union for Conservation of Nature (IUCN) as endangered (e.g., fin whale) or vulnerable (e.g., sperm whale). Common species are likely to include the bottlenose dolphin, common dolphin, Risso's dolphin, and striped dolphin. The rare, critically endangered Mediterranean monk seal may be present in nearshore Cyprus waters (Dendrinos and Demetropoulos, 1999) but is unlikely to be found in offshore waters of the licence area due to the depth and distance from shore.

All cetacean species are protected since 1971 on the basis of the Fisheries Law and Regulations (CAP 135 and 1990 Consolidated Regulations). All cetaceans also are protected under Annex IV of the Habitats Directive - Law 153(I) 2003. Additional conventions that apply to cetacean species include:

- ACCOBAMS Agreement (Bonn Convention) – applicable to all cetacean species;
- Barcelona Convention (R - 1979) Amendments (Acc. 2001). SPA Protocol (R – 1988). Protocol on Specially Protected Areas and Biological Diversity. (Ratification law N. 20 (III/2001)); and
- Bern Convention. Appendix II lists *inter alia* the common and the bottlenose dolphins.

Table 4.12 lists marine mammals potentially occurring in the Mediterranean Sea and their IUCN Red List status.

Table 4.12. Marine mammals potentially occurring in the Mediterranean Sea and their status according to the International Union for the Conservation of Nature and Natural Resources (IUCN) Red List (IUCN, 2008).

	IUCN Category
Mysticetes	
Minke whale (*Balaenoptera acutorostrata*)	LR/nt
Fin whale (*Balaenoptera physalus*)	EN
Sei whale (*Balaenoptera borealis*)	EN
Humpback whale (*Megaptera novaeangliae*)	VU
Odontocetes	
Sperm whale (*Physeter macrocephalus*)	VU
Blainville's beaked whale (*Mesoplodon densirostris*)	DD
Cuvier's beaked whale (*Ziphius cavirostris*)	DD
Short-beaked common dolphin (*Delphinus delphis*)	LR/lc
Striped dolphin (*Stenella coeruleoalba*)	LR/cd
Pygmy killer whale (*Feresa attenuata*)	DD
Short-finned pilot whale (*Globicephala macrorhynchus*)	LR/cd
Long-finned pilot whale (*Globicephala melas*)	LR/lc
Killer whale (*Orcinus orca*)	LR/cd
Common porpoise (*Phocoena phocoena*)	VU
False killer whale (*Pseudorca crassidens*)	LR/lc
Rough-toothed dolphin (*Steno bredanensis*)	DD
Bottlenose dolphin (*Tursiops truncatus*)	DD
Pinnipeds	
Mediterranean monk seal (*Monachus monachus*)	CR

[a] IUCN categories: DD = data deficient; EN = endangered; LR/CD = lower risk/conservation dependent; LR/LC = lower risk/least concern; LR/NT = lower risk/near threatened; VU = vulnerable.

4.2.5.1 Cetaceans

The main species of dolphin found in Cyprus is the bottlenose dolphin (*Tursiops truncatus*), which is found both in coastal waters in small groups (5 to 10 individuals) and in offshore waters in larger groups. There is no information or assessment of populations available. The coastal population is very tentatively estimated at 30 to 100 animals. Dolphins cause problems for fishermen as the dolphins find food in the nets and cause damage to the nets. Compensation has been paid to fishermen by the government for such damages, but has now stopped due to EU regulations.

The species is present in coastal waters particularly off the south coast (Limassol Bay to Cape Greco), but there are also records in other coastal areas. Very little or no information is available for the open sea, or for movement of the species to and from and between different areas.

Both the striped and the short-beaked common dolphins are also found in more open waters, seldom approaching coastal waters. Strandings of some other species of cetaceans denote the presence of these species in the area. These include Risso's dolphin and Cuvier's beaked whale, with the occasional stranding of juveniles of the latter. There is little information on the other whales apart from a stranding of a sperm whale on the northwest coast and a set of sightings of a group of fin whales in the same area at the edge of the continental shelf in 2004. There is, however, a great scarcity of information on them.

4.2.5.2 Monk Seals (*Monachus monachus)*

There are still a few monk seals found around Cyprus, and several colonies have existed there in the past. Monk seals migrate, and there may be connections between the Cyprus individuals and the populations in nearby coasts (Turkey and Syria). Monk seals breed in caves on the coast.

Two surveys were undertaken by the Cyprus Wildlife Society in cooperation with the Department of Fisheries and Marine Research (DFMR) in 1997 and 2005/6 to assess the status of monk seals in Cyprus and identify their breeding and resting caves. It has been estimated that about 6 to 10 seals are still found in Cyprus, though migrations around the island and between the island and the nearby mainland make it difficult to make such estimations. Work is ongoing in this field.

Monk seals, along with dolphins and turtles, have been protected in Cyprus since 1971. The relevant regulations were created under the Fisheries Law (CAP 135). The various Fisheries Regulations existing up through 1990 were consolidated into the 1990 Fisheries Regulations (Reg. 273/90). The relevant regulation (Reg. 13.(1)) foresees that:

> *"Without a special written permit from the Director of the Fisheries Service, it is prohibited:*
>
> *a) to kill, pursue, take, buy, sell or possess any aquatic turtle, seal, dolphin, freshwater crab or sand crab of the species Ocypode cursor;*
>
> *b) to attempt to kill, pursue, take, buy or sell any of the above species; or*
>
> *c) to buy, sell or possess turtle eggs or any part of a turtle, seal, or dolphin."*

The basic law provides for a fine of up to €8500 (£5000) or imprisonment for up to 6 months or both penalties, for any contravention of the regulations.

At present, there is no specific provision in the legislation for habitat protection for monk seals. It is foreseen that a portion of the Akamas peninsula will soon be included in the Natura 2000 network. Monk seals are a Priority Species in Annex II of the Habitats Directive, and Cyprus has to protect monk seal habitats. Akamas is expected to include several cave areas including Halavron and Thalassines Spilies, which are on the border of the Akamas area. It will include the caves on the north coast. The Ayia Napa caves are expected to be, in part at least, covered by the Cape Greco Natura 2000 site. There are also breeding caves at Akrotiri and Cape Pyla, which are in the British Bases.

The Minister of Agriculture Natural Resources and Environment may declare protected areas. On the basis of Paragraph 5A of the basic Fisheries Law (as translated from the Greek text) "The Minister of Agriculture Natural Resources and Environment may issue an Order to be published in the Gazette prohibiting fishing with any kind of fishing method and/or the navigation of any vessel in any sea area of the Republic for any reason concerning the security of the Republic, for any public safety or public interest reason, including reasons pertaining to the conservation of any fishery resource or of any aquatic species that will be specified in the Order to be issued, provided that this does not affect the provisions of the Law on the Protection of and Management of Nature and Wildlife of 2003."

4.2.6 Sea Turtles

Three sea turtle species occur in the Mediterranean Sea: green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), and loggerhead (*Caretta caretta*). The green and loggerhead turtles are listed by the IUCN as endangered, and the leatherback turtle is listed as critically endangered.

Both loggerhead and green turtles nest on several of the island's beaches. The first turtle nesting beach surveys were undertaken in 1976 and 1977. Conservation activities started in 1978 with the setting up of the Lara Turtle station. Conservation activities have continued without interruption since then. The turtle conservation project is a government project implemented by the DFMR. The Cyprus Wildlife Society helps with the project, which covers the part of the island that is under government control.

Exploitation of turtles in the Mediterranean that continued until about the 1970's has decimated turtle populations. Tens of thousands of turtles were shipped from the Eastern Mediterranean to mainly Europe where there was a large demand for turtle soup. Consumption of turtles in Egypt, in particular, has also had an impact.

The intensive use of beaches for tourism and recreational purposes is now threatening turtles in the Mediterranean by depriving them of their nesting grounds. Many turtles drown or are killed when caught in fishermen's nets or on long-lines. Turtles in the Mediterranean are endangered, especially the green turtle, which is on the verge of extinction in the Mediterranean.

4.2.6.1 Nesting

The main nesting grounds for loggerheads in the Mediterranean are in Greece, Turkey, and Cyprus, with some nesting in other countries in the east Mediterranean. The main green turtle nesting sites in the Mediterranean are in Turkey and Cyprus. The main nesting beaches in Cyprus are discussed in the following subsections.

- ***West Coast***: There are five main nesting beaches on the west coast (green and loggerhead turtle nesting). The 10 km of coastline is designated as the Lara/Toxeftra Turtle Reserve. There is also some minor nesting on other beaches on the west coast outside the Reserve. All beaches are monitored and all nests are protected. Loggerhead turtle nest numbers range from 50 to 170 per year, with annual fluctuations and an apparent increasing trend in recent years. Green turtle nesting has been fluctuating widely from about 10 to over 100 nests per year, but with no apparent trend (Broderick et al., 2002).

- ***Chrysochou Bay***: There are six main beaches on which loggerhead nesting occurs (with the occasional green turtle nest). Nesting occurs on about 12 km of beach (10 km of which are in a Natura 2000 site). All beaches are monitored and all nests are protected. Loggerhead turtle nest numbers range from 200 to 300 nests per year, with significant annual fluctuations (Broderick et al., 2002).

- ***South Coast:*** Sparse nesting also takes place on a number of other beaches on the south coast. Practically all the nesting on these beaches is by loggerhead turtles. Nesting has been recorded from the southeast coast with the very occasional nest, to more regular but still very sparse nesting in Ayia Napa, Larnaca Bay, and on the beaches between the Larnaca airport and Cape Kiti, stretching west to Mazotos and Alaminos. No nesting has been recorded in Limassol Bay (with the exception of the very occasional nest). There is some minor nesting on the beach at Pissouri (0 to 9 nests per annum) and on the beaches at Mandria and Timi. There is more regular though minor nesting on the beach by Paphos Airport, mainly by green turtles and regular nesting of loggerheads on two to three beaches east of Chrysochou Bay. Some nesting also occurs on the beaches in the British SBAs, mostly at Akrotiri, and sparse nesting elsewhere in the bases.

There is very significant nesting of green turtles as well as loggerhead turtles in the occupied areas of the island, mostly at Alakati, on the north coast, and in the Karpas Peninsula (mostly green turtles), with some nesting at the northern end of Morphou Bay (Ayia Irini).

Nesting starts at the end of May for loggerhead turtles and in mid-June for green turtles. It continues until about the end of July and mid-August, respectively.

4.2.6.2 Migrations

Regular migrations take place between the nesting sites and the feeding sites; there is evidence that turtles imprint on both, which means that they will come back to their natal beaches to nest. Loggerhead turtles migrate as far as the western Mediterranean for feeding, while green turtles are restricted to the East Mediterranean. Migration patterns (key migration routes and passages) are only very sketchily known from a small number of turtles, and more results are needed on which to base conclusions.

4.2.6.3 Feeding

Green turtles feed mostly on seagrasses. In the waters around Cyprus, they feed on *Posidonia oceanica* in the *Posidonia* beds and on *Cymodocea nodosa* mostly found on sandy or sandy mud habitats adjacent to the *Posidonia* beds (Demetropoulos and Hadjichristophorou, 1995). There are foraging grounds for green turtles in a number of places around the island. One such foraging ground is the marine area of the Polis-Yialia Natura 2000 site, which is to be managed accordingly. Other feeding sites have tentatively been identified. Both adult and juvenile green turtles can be found in these areas throughout the year. For the first years of life, green turtles are pelagic, feeding on jellyfish and other animals. They appear in the coastal habitats of Cyprus when they reach about 30-cm carapace length, at which stage they start feeding on the sea bed on seagrasses.

Loggerhead turtles are carnivorous, feeding on a variety of benthic organisms. After hatching, the hatchlings drift mainly west with the currents. Like green turtles, they are pelagic during the first years of life, feeding also on jellyfish and other pelagic animals. After a few years they settle in the coastal zone and start feeding on the sea bed. The main known feeding grounds in the Mediterranean are in the central and western basins (Gulf of Gabes and the North Adriatic) and the Nile Delta and the Gulf of Iskenderun (Margaritoulis et al., , 2003), but much remains to be known on their feeding areas. Juveniles and adults are not very common in Cyprus waters, and loggerheads mainly come to the island as adults to breed, appearing in April/May and leaving the island in August/September. However, more information is needed.

4.2.6.4 Protective Legislation

Species Conservation

Turtles and their eggs have been protected under the Fisheries Legislation since 1971 (CAP 135 and Regulations). The killing, pursuing, catching, buying, selling, or possessing of a turtle or attempting to do any of these is prohibited, as is the buying or selling or possession of any turtle egg, turtle part, or derivative.

Habitat Conservation

1. ***West Coast:*** In 1989, the west coast nesting area (10 km of coastline), from the coastal area out to the 20-m isobath (about 1.5 km from the coast), was declared as a turtle reserve (the Lara/Toxeftra Turtle Reserve). This protected area includes the five main green turtle nesting beaches. Management regulations are described in the Law. The public is not allowed to:

    - Stay on the beaches or coastal area at night;
    - Drive any vehicle on a beach or tolerate such action;
    - Place any umbrella, caravan, tent etc., in the Protected Area;
    - Use or anchor a boat or tolerate such action (to the 20-m isobath); and
    - Fish, except with a rod and line (to the 20-m isobath).

2. ***Chrysochou Bay:*** In 2002, the Polis/Limni declared "Shore for Ecological Protection" (Town and Country Planning legislation), which includes restrictions for adjacent areas regarding lights, no permits for commercial use of beach, and no breakwaters or marinas.

In 2005, the Polis/Limni/Yialia area was proposed as a "Natura 2000" site and has been submitted as such to the executive branch of the EU on the basis of the Habitat Directive. The site includes an 11-km coastline and the adjoining sea area down to the 50-m isobath. This has since been accepted by the EC and is now a Site of Community Importance (SCI). Management regulations are pending.

Enforcement

The above legislation is implemented by the DFMR and its Inspectorate Service, which are based in all coastal towns.

4.2.6.5 Conventions and Supranational and National Legislation

Additional Laws and Conventions related to the conservation of marine turtles and their habitats to which Cyprus is a Party include the following:

- Habitats Directive: Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. Both *Caretta Caretta* and *Chelonia mydas* are priority species and included in Annex II of the Habitats Directive - Law 153(I) 2003. Both *Caretta caretta* and *Chelonia mydas* as well as *Dermochelys coriacea* (Dermochelyidae) are included in Annex IV of the Habitats Directive - Law 153(I) 2003 (Annex IV: Animal and plant species of community interest in need of strict protection). Law 153(I)/2003 for the Conservation of Management of Nature and Wildlife has provisions for the conservation of species and habitats listed in the annexes. This law has transposed the provisions of the Habitats Directive into national legislation. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31992L0043:EN:HTML

- Barcelona Convention (R - 1979): Amendments (Acc. 2001) SPA Protocol (R – 1988).

- Protocol on Specially Protected Areas and Biological Diversity of Barcelona Convention (Ratification law N. 20 [III/2001]). http://www.rac-spa.org/dl/protocol_eng.pdf

- All three species of marine turtles are also protected by the Barcelona Convention (Protocol on Specially Protected Areas and Marine Biodiversity 1995).

- Bern Convention (R – 1988). http://europa.eu/scadplus/leg/en/lvb/l28050.htm

- CITES (R – 1974) - Convention on International Trade in Endangered Species. (http://www.cites.org/eng/disc/what.shtml)

- Convention on Biological Diversity (Biodiversity Convention) (R – 1996). http://www.cbd.int/convention/

- Fisheries Law (CAP 135) and Fisheries Regulations (1990-2005) - Fisheries Regulations (Consolidation) of 1990: Regulation 13 and 14. http://www.moa.gov.cy/moa/dfmr/dfmr.nsf/All/F9A65B65765001A6C2257125004B46AF/$file/Κ.Δ.Π.273%20.90.pdf?OpenElement

4.2.7 Protected Marine Species and Habitats

4.2.7.1 Marine Species

Cyprus marine species of interest (EU, Barcelona Convention, and Bern Convention) are summarised in **Tables 4.13** through **4.15**. Macrophyta (mainly habitat-forming species), invertebrates, and marine fishes are presented separately in **Tables 4.13**, **4.14**, and **4.15**, respectively.

Table 4.13. Marine macrophytes of special interest that have been observed in Cyprus. Legend: (MRB) Mediterranean "Red Book" UNEP/IUCN/GIS (1990); (EU) Habitat Directive European Union (1992); (BaC) Barcelona Convention (1995); (BeC) Bern Convention (1996-98). I – V refer to the Annexes of the Conventions/Directive.

Macrophyta	MRB	EU	BaC	BeC
Magnoliophyta				
Cymodocea nodosa				I
Posidonia oceanica	+	I	II	I
Zostera noltii			II	I
Fucophyta				
Cystoseira amentacea	+		II	I
Cystoseira spinosa	+		II	I
Cystoseira zosteroides C. Agardh	+		II	I
Rhodophyta				
Lithophyllum trochanter (=Goniolithon byssoides)	+		II	I
Lithothamnion corallioides		V		
Phymatolithon calcareum (Pallas)		V		
Ptilophora mediterranea	+		II	I

Table 4.14. Marine invertebrates of special interest that have been observed in Cyprus. Legend: (EU) Habitats Directive European Union (1992); (BaC) Barcelona Convention (1995); (BeC) Bern Convention (1996-98). I – V refer to the Annexes of the Conventions/Directive.

Invertebrata	EU	BaC	BeC
Porifera			
Axinella cannabina		II	
Axinella polypoides		II	II
Hippospongia communis		III	III
Spongia agaricina		III	III
Spongia officinalis		III	III
Spongia zimoca			
Mollusca			
Charonia lampas		II	II
Charonia tritonis		II	II
Dendropoma petraeum		II	II
Erosaria spurca		II	II
Lithophaga lithophaga	IV	II	II
Luria lurida		II	II
Pholas dactylus		II	II
Pinna nobilis	IV	II	
Pinna rudis (= P. pernula)		II	II
Tonna galea		II	II

Table 4.14. (continued).

Invertebrata	EU	BaC	BeC
Crustacea			
Maia squinado		III	III
Ocypode cursor		II	II
Palinurus elephas		III	III
Scyllarides latus	V	III	III
Scyllarus arctus		III	III
Bryozoa			
Hornera lichenoides		II	
Echinodermata			
Centrostephanus longispinus	IV	II	II
Ophidiaster ophidianus		II	II
Paracentrotus lividus		III	III

Table 4.15. Marine fishes of special interest that have been observed in Cyprus. Legend: (BaC) Barcelona Convention (1995); (BeC) Bern Convention (1996-98).

Marine Fish	BaC	BeC
Epinephelus marginatus	III	III
Hippocampus hippocampus	II	II
Hippocampus ramulosus	II	II
Sciaena umbra	III	III
Umbrina cirrosa	III	III

Source: MedMPA report (UNEP-MAP RAC/SPA, 2007).

4.2.8 Marine Habitats of Interest

Protected marine habitats of interest in Cyprus include the vulnerable/sensitive Mediterranean habitats listed in **Table 4.16**, according to the following:

- Mediterranean Red Book of the thread marine vegetation, associations, and seascapes of the Mediterranean Sea (UNEP/IUCN/GIS POSIDONIE, 1990).
- The EU Habitat Directive (1992) with Annexes:
  - I (priority habitats);
  - IV (strictly protected species); and
  - V (species whose exploitation is regulated).
- The Barcelona Convention (1995) related to the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean, with Annexes.
  - II (endangered or threatened species); and
  - III (species whose exploitation is regulated).
- The Alghero Convention (1995) on coastal and marine biodiversity in the Mediterranean.
- The Bern Convention (1996) with Annexes:
  - I (strictly protected flora species);

- II (strictly protected fauna species); and
- III (protected fauna species).

Table 4.16. Mediterranean sensitive habitats observed in Cyprus. Legend: (MRB) Mediterranean Red Book UNEP/IUCN/GIS (1990); (EU) Habitat Directive - European Union (1992); (BaC) Barcelona Convention (1995); (AC) Alghero Convention (1995); (BeC) Bern Convention (1996).

Marine Habitats	MRB	EU	BaC	AC	BeC
Littoral organogenic concretions					
Spongites notarisii+Dedropoma petraeum (platforms, cushions)	+		+	+	+
Goniolithon byssoides (cushions)	+		+	+	+
Fucophyceae Forests					
Cystoseira spp. exposed rock *(C.amentacea, C. mediterranea)*	+	+	+	+	+
Cystoseira spp. sheltered rock *(C.humilis, C. spinosa var. tenuior,)*	+			+	
Cystoseira spp. deep forests (*C. spinosa, C. zosteroides*)	+		+		+
Maërl beds (rhodolithes)	+			+	+
Circalittoral organogenic formations (coralligenous community)	+			+	+
Submarine caves		+	+	+	+
Seagrass meadows					+
Posidonia* beds* *(Posidonia oceanica)	+	+	+	+	+
Sandbanks that are slightly covered by sea water all the time (*Cymodocea nodosa*, etc.)		+			

The marine/coastal habitats for the various protected species have been previously discussed in relation to the species. Most have been included in the Natura 2000 network or their submission is pending, as in the case of Akamas.

Of particular importance in the marine habitats listed in the Habitats Directive of the EU are the *Posidonia* beds, which are a Priority Habitat. *Posidonia* is present in a number of sites of the Natura network already; Cape Greco, Moulia, Polis-Yialia, and in the pending Akamas site. *Posidonia* is fairly widespread around the island, with the exception of Episkopi Bay, from depths ranging from about 5 m to over 40 m. *Posidonia* beds are very important for many species as feeding and breeding grounds. Green turtles feed in this area on *Posidonia* itself and also on the often adjacent sand banks where juveniles in particular feed on *Cymodocea nodosa* (Demetropoulos and Hadjichristophorou, 1995).

4.2.9 Areas of Special Concern

4.2.9.1 Fish Habitats

The study area region is characterised by two major fish habitats of concern: pelagic fish habitats and benthic fish habitats.

Pelagic Fish Habitats

Pelagic waters of the exploitation region constitute the habitat of major commercially important pelagic fishes, especially the Atlantic bluefin tuna, *Thunnus thynnus*, and swordfish, *Xiphias gladius*. Information about the health of populations in this ultra-oligotrophic habitat can be gleaned from pelagic capture fisheries statistics. The study area region belongs to Sub-area 37.3 (Eastern Mediterranean), Division 37.3.2 (Levant) of the Food and Agriculture Organization (FAO) Statistical Area system. Unfortunately, the publicly available data sets on fisheries statistics through the FAO system do not list individual statistics for Subarea 37.3 for the indicative species mentioned above. However, the International Commission on the Conservation of Atlantic Tunas (ICCAT) publishes capture statistics in 5º by 5º blocks (**Figure 4.35**).

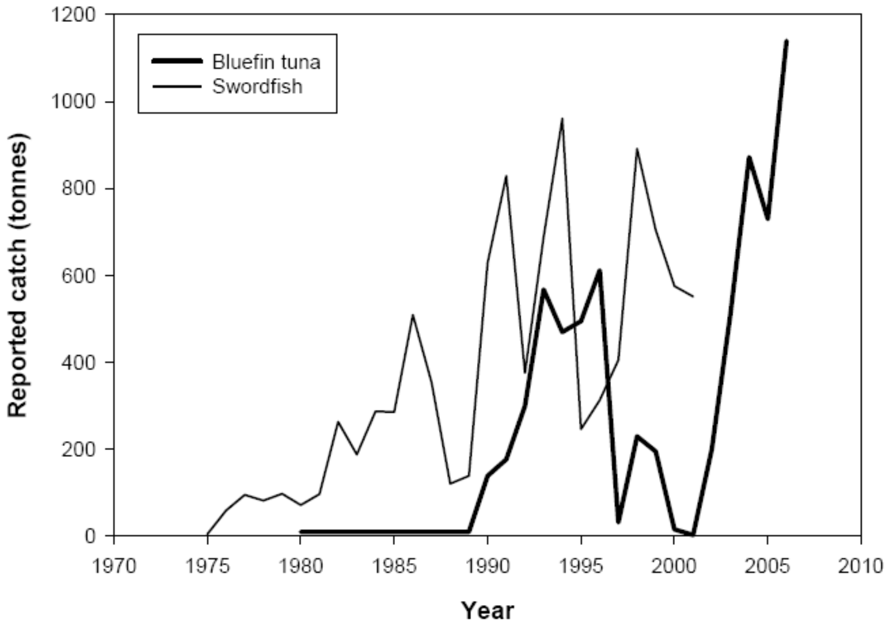


Figure 4.35. Catches of Atlantic bluefin tuna, *Thunnus thynnus*, and swordfish, *Xiphias gladius*, for the 5-degree by 5-degree block east of 30^{o}E and north of 30^{o}N, which includes the study area region (From: http://www.iccat.int/accesingdb.htm).

Relatively rapid increases in catches have led to lean production years, as well as concerns that the populations of these exploited species may be under severe pressure, which may prove to be fatal considering the ultra-oligotrophic nature of this habitat. Monitoring of these fisheries has led ICCAT to declare Mediterranean bluefin tuna stocks as overexploited (2006) and to launch a 15-year recovery plan, starting in 2007. The EU has also been adjusting national quotas for bluefin tuna fishing on an annual basis. Further, prompted by illegal overfishing, the EU introduced a total ban on bluefin tuna fishing in the Mediterranean, starting on 1 July 2008, for the remainder of the year.

Benthic Fish Habitats

The major benthic fish habitat in the study area region is the Eratosthenes Seamount (**Section 4.2.2.3**). The Eratosthenes Seamount, which covers parts of exploitation Blocks 7 and 8, is likely a focus of high productivity relative to the surrounding sea floor, as is the case with other seamounts (Cartes et al., 2004).

During its sixth session in 2005, the Sub-committee on Marine Environment and Ecosystems (SCMEE) of the GFCM Scientific Advisory Committee recommended that demersal fishing be banned in the region defining the Eratosthenes Seamount (SCMEE, 2005). The recommendation was justified by the documented presence of deep-sea coral communities on the seamount, as well as the collection of commercially important shrimp (Galil and Zibrowius, 1998). The recommendation was endorsed by the GFCM Scientific Advisory Committee later that year (FAO GFCM, 2006).

In addition to this ban recommendation, the EU Council proposed a regulation protecting vulnerable habitats (such as reefs, seamounts, deepwater corals, hydrothermal vents, and sponge beds) from bottom trawling (European Council, 2007). This regulation was adopted by the European Parliament in 2008. Considering that commercially important demersal species are present on the seamount along with deepwater corals and sponge beds (Galil and Zibrowius, 1998; **Section 4.2.2.3**), political statements such as this regulation are expected to curb or prevent the destruction of demersal fish habitats. Such destruction may already be taking place in the study area region. According to mass media sources, bottom trawling for shrimp by the Italian fleet has taken place on the banks south of Larnaca and Limassol districts (partially included in exploitation Blocks 1 and 2). However, nothing concrete is known of the fishing activity by trawlers either on these banks or on the Eratosthenes Seamount, leaving a significant gap in our knowledge of the state of and threats on benthic fish habitats in the study area.

4.2.9.2 Marine Protected Areas

Currently, there is only one marine sanctuary in Cyprus waters, the Lara/Toxeftra Protected Area along a section of the coastline of the Paphos District (DFMR, 2005; **Section 4.2.6**). This protected area was established for protection of two species of marine turtles that nest on the island (the green turtle, *Chelonia mydas*, and the loggerhead turtle, *Caretta caretta*), the preservation of major nesting beaches, and the protection of the nests as well as public outreach.

There are currently another five proposed marine protected areas (MPAs) in Cyprus waters under the EU Habitats Directive (European Council, 1992); these MPAs are referred to as Sites of Community Importance (SCIs). An EU Decision in 2006 adopted these SCIs, updated the list of SCIs in 2008, and mandated their designation as Special Areas of Conservation (SACs [i.e., full-fledged MPAs]) by 2014 (European Commission, 2008a). All five marine SCIs concern marine coastal areas (with a significant adjacent part of each SCI being terrestrial) and are therefore within the territorial waters of Cyprus and outside of the exploitation block region (**Section 4.2.8**).

It should be noted that the habitats and species identified in the Annexes of the EU Habitats Directive cover almost exclusively terrestrial and coastal regions. This suggests that the propositioning of MPAs beyond the territorial waters of Cyprus (and within the exploitation block region) is at present unlikely within the framework of the Habitats Directive. The protection of vulnerable habitats within the study area will be considered in reference to recent declarations by the EU (see **Section 4.2.8**).

4.2.9.3 Seamounts

The exploitation block region includes a major Mediterranean seamount, the Eratosthenes Seamount. This seamount includes habitats for commercially important fishes and crustaceans, as well as vulnerable deep-sea coral and sponge communities (**Sections 4.2.2.3** and **4.2.9.1**). Consequently, the Eratosthenes Seamount is a site of intense pressures to simultaneously exploit and protect. While the European Council (2007) has developed a regulation that protects vulnerable habitats such as this seamount from bottom trawling, this regulation is aimed specifically at “the high seas” and therefore does not include the Cyprus EEZ. However, the GFCM (FAO GFCM, 2006) does specifically recommend that demersal fishing be banned in the region defining the Eratosthenes Seamount. The GFCM recommendation also noted that fishing activity in this area was probably limited, hinting at a relatively pristine condition, though this has not yet been independently verified (**Section 4.2.9.1**). Seamounts are known to be areas of rich biodiversity. The EU Marine Strategy Directive (MSD 2008/56/EC) requires periodic assessments of the marine environment, including assessments on biodiversity and pressure (anthropogenic), with the aim of achieving a good environmental status for the marine environment.

4.2.9.4 Chemosynthetic Communities

Chemosynthetic benthic communities driven by the biological oxidation of sedimentary methane (e.g., cold seeps) are documented at an increasing number of sites around the eastern Mediterranean from the Mediterranean Ridge in Italy to the Nile submarine fan (Cartes et al., 2004). It is quite likely that hydrocarbon-rich sediments in unexplored regions of the Levantine Basin will support chemosynthetic communities exploiting sedimentary methane resources. To date, such communities have not been documented in the study area. However, reports from the HERMES project map chemosynthetic habitats in proximity to the westernmost block (Block 4; Weaver et al., 2004). Additionally, recent acoustic data collection surveys have documented the widespread distribution of mud volcanoes and related mud flows, fluid seeps, and brines along the Cyprus Arc (Huguen et al., 2005). These aforementioned seafloor features are indicative of conditions that support chemosynthetic communities. Given the high probability of the existence of chemosynthetic communities in the exploitation block region, there is a clear need to assess their presence and extent.

4.3 SOCIOECONOMIC ENVIRONMENT

This section provides an overview of the main socioeconomic features relevant to the Cyprus coastal area that would be affected by the hydrocarbon activities offshore Cyprus. Special attention was given to the area of Vasilikos Bay where the Energy Centre of Cyprus is proposed to be built along with the onshore facilities to support offshore activities during both exploration and exploitation. It should be noted that both the development of hydrocarbons activities and the energy centre are the main goals of the Cyprus Energy Policy (M.W. Kellogg Ltd. et al., 2006).

4.3.1 Fisheries

Cyprus is the third largest island in the Mediterranean, with a coastline 735 km long. Because Cyprus is an island, its fisheries have always been economically important. Even though the economics of the fisheries sector show negative growth, fish still remains a main dish in Cypriot cuisine, and large quantities are consumed by both the local population and tourists. It is estimated that, on average, 13 kg of fish are consumed per person per year (DFMR, 2007).

Some types of the fishing activities presented in the Environmental Report may not occur in the licence area but are conducted in close proximity.

4.3.1.1 Commercial and Recreational Fisheries

The Cyprus capture fishery consists of the inshore fishery, the trawl fishery, the polyvalent (or multipurpose) fishery, and the sport fishery. There is also one purse seiner operating in the waters of Cyprus.

The Inshore Fishery

The inshore fishery is practiced with small wooden boats 6 to 12 m in length that mainly fish with bottom set nets and long-lines (passive gears). In 2003, 677 persons were occupied as full-time fishermen in 500 licensed boats (DFMR, 2007; Fisheries Statistics, 2007).

The Trawl Fishery

The trawl fishery (mobile gears) consists of 12 trawlers measuring 21.4 to 26.8 m in length with 220 to 750 horsepower diesel engines. These are all stern trawlers with steel or wooden hulls. Four trawlers are licensed to operate in the waters of Cyprus, whereas the others operate exclusively in international waters in the Mediterranean. In 2007, 198 fishermen were fully occupied on these 12 trawlers.

The Polyvalent (Multipurpose) Fishery

The polyvalent fishery (polyvalent gears) is practiced with boats about 16 m long equipped with long-lines in the waters of Cyprus and international waters in the east Mediterranean. In 2007, 101 fishermen were fully occupied on 25 boats licensed for multipurpose fishing.

The Sport Fishery

There are approximately 2000 individual licensed sport fishermen in Cyprus. Many others fish with rod and line for pleasure, without the need of license.

Categories of sport fishing that require a license are

- long-lining; and
- spear-gun fishing.

The sport fishery captures about 15% of the total catch of Cyprus. In 2007, 1888 recreational fishing licenses were issued.

Fisheries Production

The total commercial fisheries production in Cyprus for 2007 was 2440 tones, with an estimated value of approximately € 13.82 million (**Table 4.17**). The production in inshore fisheries was 1054 tones with a value of € 8.45 millions, and production from trawlers was 322 tones with a value of € 2.35 million from national waters and 282 tones with a value of € 2.05 million from international waters. Finally, production from pelagic fishing, mainly for tunas and swordfish, was 782 tones, with a value of € 1.97 million.

Table 4.17. Fisheries production by capture location.

Location	Tones	Percentage %	Value (million €)
Inshore	1054	43.2	8.45
National waters–trawlers	322	13.2	2.35
International waters–trawlers	282	11.6	2.05
Pelagic fishing (tunas and swordfish)	782	32	1.97
Total	**2440**	**100**	**13.82**

There was a small increase in fish caught in 2007 compared to the last 4 years, but catch still remains small compared to catches recorded since 1983. Daily production in 2007 decreased compared to 2006 at approximately 10.3 kg/day, and there was an increase in the number of working days. This decrease in catch is due to overfishing of most species of commercial value (e.g., red and striped mullets). It is estimated that approximately 1 120 people are employed in the fisheries sector and about 800 more in related professions.

Fisheries at Vasilikos Bay

A number of fisheries companies currently use some of the old houses that belonged to the Cement Works for work purposes, employee restrooms, and ice machines. In addition, they have constructed a store space for equipment and fish feed. Approximately 35 coastal fishermen, mainly from Zygi, fish with trammel, gill nets, and long-lines in the area of the proposed Energy Centre facility.

The marine site around the area is frequently used by coastal fishermen throughout the year. Fishermen set nets and long-lines from shallow waters down to depths of 100 m. **Table 4.18** presents the inshore fishery data (2002-2004) for the area between Cape Greco and Cape Zevgari, which includes Vasilikos Bay (DFMR, 2007).

Table 4.18. Inshore fishery data, 2002-2004 (Source: DFMR, 2007).

		Greater Vasilikos area from Cape Greco - Cape Zevgari	Total for Cyprus	% of total from the greater Vasilikos area
2002	No of Boats	324	500	64.8
	Catch (kg)	591,630	1,026,480	57.6
	Average Catch/Day/Boat	10.80	12.2	88.5
	Total No of W.Days	54,861	84,109	65.2
2003	No of Boats	313	500	62.6
	Catch (kg)	512,860	922,690	55.5
	Average Catch/Day/Boat	10.7	12.76	83.8
	Total No of W.Days	47,834	72,292	66.1
2004	No of Boats	313	499	62.7
	Catch (kg)	419,773	639,380	65.6
	Average Catch/Day/Boat	10.1	38.96	25.9
	Total No of W.Days	41,578	64,237	64.7

Bottom trawlers are found in Vasilikos Bay from the start of fishing season (7 November) to the last day of trawling (the last day of May). Bottom trawling techniques involve dredging the seabed between the 50- and 100-m isopaths.

The number of recreational fishermen using the Vasilikos area for fishing has increased in the last 10 years. Licensed recreational fishermen may use a variety of fishing methods, including trammel nets, fishing traps, long-line, and spear gun.

Future Developments

The construction of a fishing shelter and an additional five breakwaters in Zygi started in December 2007 and is expected to be completed in 30 months. This shelter will have a capacity of 220 vessels and will be located at the old harbor of Zygi. The construction of the shelter is expected to significantly help with providing safe mooring for fishing vessels and should contribute to the socioeconomic development of the area as well as increase domestic and international tourism. The DFMR also will construct another fishing shelter at Pissouri Bay to accommodate the needs of fishermen between Lemesos and Pafos.

4.3.1.2 Aquaculture

Aquaculture has grown significantly over the last years, and further development of the sector is promoted by the DFMR in recognition of its potential. Total aquaculture production for 2007 for both marine and fresh water was 3260 tones of market-size fish and 15 million marine fish fry, with a total value of € 28.5 million (DFMR, 2007).

In 2007, aquaculture production of market-size fish cultured in open sea cages reached 2200 tons of seabass and seabream and 1000 tons of bluefin tuna. The total production of market-size trout from the private sector reached 60 tons, valued at € 410.000. Additionally, 150.000 ornamental fish were produced by the private sector, valued at € 256.300. The total production of marine hatcheries reached 15 million fry, mainly seabass and seabream, valued at € 2.56 million. Approximately 4.5 million fry were exported to Greece and Israel. The total value of the exported aquaculture products was approximately € 18.8 million, almost half of which is from the export of bluefin tuna.

As of 2007, three marine fish hatcheries and one land-based shrimp hatchery/farm were in operation, as well as six private offshore cage farms culturing mainly seabass and seabream and three offshore cage farms culturing/fattening bluefin tuna. Additionally, six small trout farms culturing mainly rainbow trout and two farms culturing ornamental fish were in operation. It is estimated that there are approximately 160 employees working in aquaculture and a significantly higher number of people employed in related professions.

In addition, a total of 20 fishery products processing companies employ more than 120 workers, the majority of them full-time. It is estimated that the value of processed fish products has significantly increased to a value of more than € 25.6 million.

Fish Farms Offshore of Vasilikos Bay

Vasilikos Bay hosts most of the marine fish farms in Cyprus, and currently there are seven aquaculture companies in operation between Vasilikos port and west of Cape Dolos to the Moni Power Station. Five of these operations culture gilthead seabream (*Sparus aurata*) and European seabass (*Dicentrarchus labrax*), while the other two farm bluefin tuna (*Thunnus thynnus*). All of the fish farm facilities are marked with buoys and deflectors to warn any oncoming sea traffic. Locations of marine fish farms in the wider area are shown in **Figure 4.36**.

Companies that are operating fish farms in the area are as follows:

- Blue Island Holdings Ltd., located approximately 4.5 km west of Vasilikos Port offshore in Cape Dolos. The company has been operational since the early 1990's farming seabream and seabass and currently employs 35 people on a full-time basis. The company has cages moored at 20- and 35-m depths and has a license to produce 900 tons/yr.
- Seawave Fisheries Ltd., located approximately 1.7 km from the shore. The company has been operational since 1993 producing seabream and seabass and employs 11 people on a full-time basis. The company has cages moored at 30- and 35-m depths and has a license to produce 450 tons/yr.
- East Mediterranean Aqua Technique Ltd., located approximately 3.8 km west of Cape Dolos. The company has been operational since the mid-1990's producing seabream and seabass and employs three people on a full-time basis. The company has cages moored at 33- and 35-m depths at a distance approximately 1 km from the closest shore. It has a license to produce 100 tons/yr.
- Alkioni Fisheries, located approximately 1.1 km offshore at the Moni area, produces seabream and seabass. The company has cages moored on the seabed at 28- to 40-m depths and a license to produce 300 tons/yr.
- Kitiana Fisheries Ltd., a new fish farm for fattening bluefin tuna (*Thunnus thynnus*), which started operation in June 2006. It has a license to produce 1000 tons/yr and is located 4 km offshore, moored at a depth of 60 m.
- Telia Aqua Marine Public Ltd., a new fish farm in the area for producing gilthead seabream and European seabass, started operating in the summer of 2006. It has a license to produce 500 tons/yr.
- Telia Tuna Ltd., a new fish farm in the area for fattening bluefin tuna, started operation in June 2006. It has a license to produce 1000 tons/year and is located 4 km offshore, moored at a depth of 70 m.

Figure 4.36. Location of marine fish farms offshore Vasilikos Bay.

4.3.2 Shipping and Marine Operations

The administration, operation, and development of Cypriot ports is handled by the Cyprus Port Authority (CPA). Under its jurisdiction are the commercial ports of Lemesos and Pafos, the industrial port of Vasilikos, the old port of Lemesos, the port of Pafos, the fishing harbor at Lachi, and the oil terminals at Larnaca, Moni, Vasiliko, and Dekeleia (**Figure 4.37**).

Figure 4.37. Cyprus port and oil terminal locations.

4.3.2.1 Shipping Activity

During the period from 2000 to 2006, an average of 4726 ships/year docked at Cypriot ports (**Table 4.19**). During 2006, 65 shipping lines included Cyprus in their itineraries, an increase of 6.6% from the previous year. The main categories of ships that called at Cyprus ports during 2006 were conventional ships (21%), container ships (17%), tankers (19%), ro-ro type ships (14%), and passenger ships (10%).

Table 4.19. Number of ships docked in Cyprus, 2000 to 2006 (Statistical Service of the Republic of Cyprus, 2008a).

Year	2000	2001	2002	2003	2004	2005	2006
Number of Ships	5289	5246	4698	4375	4297	4649	4534

4.3.2.2 Cargo Traffic

Cyprus trade is mainly carried out through its multipurpose ports of Lemesos and Larnaca, the port of Vasilikos (the main handler of bulk cargo of industrial origin, animal feed, and dirty cargo in general to and from Cyprus), and the oil terminals that handle oil products. Cargo by sea to and from Cyprus amounted to 8.5 million metric tons, an increase of 6.8% from the previous year.

The two multipurpose ports of Lemesos and Larnaca handle approximately the 61% of the total container sea traffic. During the period from 2000 to 2006, an average of 5.7 million metric tons of goods per year were delivered at the ports of Cyprus (**Table 4.20**), while an average of 1.6 million metric tons of goods per year were shipped from Cyprus (**Table 4.21**).

Table 4.20. Goods delivered at Cypriot ports, 2000 to 2006 (Statistical Service of the Republic of Cyprus, 2008a).

Year	2000	2001	2002	2003	2004	2005	2006
Delivered Goods (Metric Tons)	5 270 010	5 237 485	5 252 689	5 682 924	5 756544	6 134 977	6 460 638

Table 4.21. Goods shipped from Cypriot ports, 2000 to 2006 (Statistical Service of the Republic of Cyprus, 2008a).

Year	2000	2001	2002	2003	2004	2005	2006
Shipped Goods (Metric Tons)	1 631 078	1 406 046	1 276 728	1 565 406	1 402 422	1 901 891	2 060 335

For Vasiliko Port, cargo traffic for 2006 totalled about 1.5 million metric tones, an increase of 25% compared to 2005. This largely consisted of export of cement and clinker and import of coal, petroleum products, and raw materials.

4.3.2.3 Oil Terminals

The movement of cargoes in the country's oil terminals during 2006 amounted to 1.85 million metric tons, a decrease of 4.8% from the previous year. Imports through the Larnaca Port remained at the same levels, 1.23 million metric tons for 2006 and 1223 million metric tons for 2005, while imports through the oil terminals at Moni and Dekeleia, for use in the respective power stations, were down to 621 000 metric tons from 724 000 in 2005 (Cyprus Port Authority, 2006).

4.3.2.4 Passenger Traffic

Cyprus has long established itself as one of the most important cruise centres in the Eastern Mediterranean and is included in the itineraries of most cruise ships sailing in the area. During 2006, 39 international cruise ships included Cyprus in their tours, calling on the island 222 times and handling about 454 000 cruise passengers, an increase of 23% from 2005.

Furthermore, Cyprus is a permanent base for a large cruise fleet carrying excursions in the region on a regular basis. In 2006, 307 short cruises to Syria, Lebanon, Egypt, and the Greek islands carried more than 217.000 passengers, an increase of 8.2% from 2005 (Cyprus Port Authority, 2006).

There was also a considerable increase of arrivals and departures from Cyprus ports in 2006, an 18.1% increase compared to 2005. During the 2000 to 2006 period, an average of 319 560 people arrived to Cyprus by sea, while during the same period an average of 312 210 people left by sea (**Tables 4.22** and **4.23**).

Table 4.22. Arrivals to the ports of Cyprus, 2000 to 2006 (Statistical Service of the Republic of Cyprus, 2008a).

Year	2000	2001	2002	2003	2004	2005	2006
No. of Arrivals	518 048	350 499	234 883	241 200	249 502	281 129	361 664

Table 4.23. Departures from the ports of Cyprus, 2000 to 2006 (Statistical Service of the Republic of Cyprus, 2008a).

Year	2000	2001	2002	2003	2004	2005	2006
No. of Departures	516 572	347 463	235 397	239 891	248 627	281 658	315 860

4.3.2.5 Port Services

Port services, the handling of cargo on a ship, are carried out by Port Workers and Tally Clerks. In Lemesos Port there are 90 Port Workers and 8 Tally Clerks, while at Larnaca there are 50 Port Workers and 6 Tally Clerks.

Licensed Porters are engaged in the horizontal transport work and the movement of cargo along the quays and in storage areas (stacking/delivery). For 2006, there were 63 Licensed Porters in the port of Lemesos and 42 in the port of Larnaca. A further 68 individuals were employed by the Licensed Porters as a permanent labour force and technicians.

At Lemesos Port, the task of transportation of passenger luggage is carried out by a company employing seven individuals on a permanent basis and two more as required. At Larnaca, luggage handling is the responsibility of the Licensed Porters (Cyprus Port Authority, 2006).

4.3.2.6 Ships Registered

In 2006, there were 1828 ships registered under the Cypriot flag, a small increase from 2005. However, there has been a continuous decline in the Cyprus fleet (31.5%) since 2000 (**Table 4.24**).

Table 4.24. Number of ships registered under the Cyprus flag, 2000 to 2006 (Statistical Service of the Republic of Cyprus, 2008a).

Year	2000	2001	2002	2003	2004	2005	2006
No. of Registered Ships	2669	2239	2153	2031	1913	1802	1828

4.3.3 Telecommunications

An extensive submarine fiber optic cable network has been developed in the Eastern Mediterranean Basin by Cyprus and neighboring countries in order to connect them with other international networks (**Figure 4.38**). This state-of-the-art network is continuously developing in order to connect with other fiber optic networks around the world. The company responsible for the network in Cyprus is CytaGlobal, which has three landing stations in Cyprus, at Ayia Napa, Pentaskhinos, and Yeroskipos (**Figure 4.39**) (CytaGlobal, 2008).

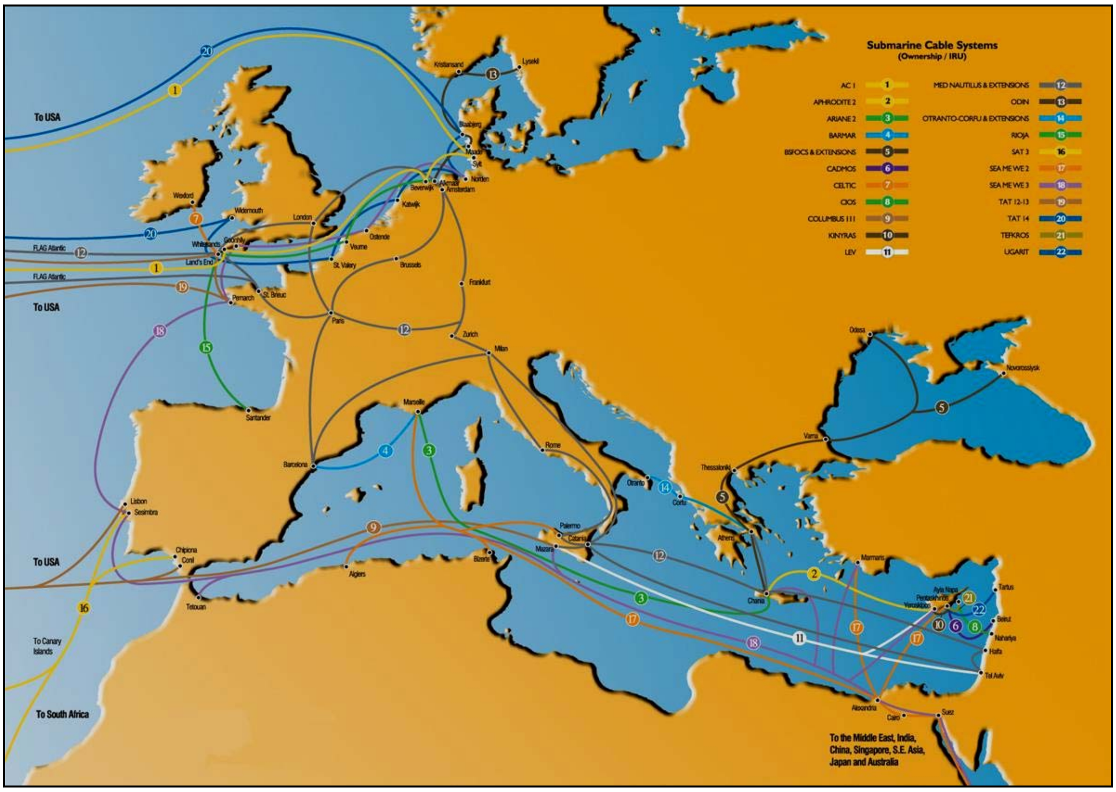


Figure 4.38. Eastern Mediterranean Basin submarine cable system.

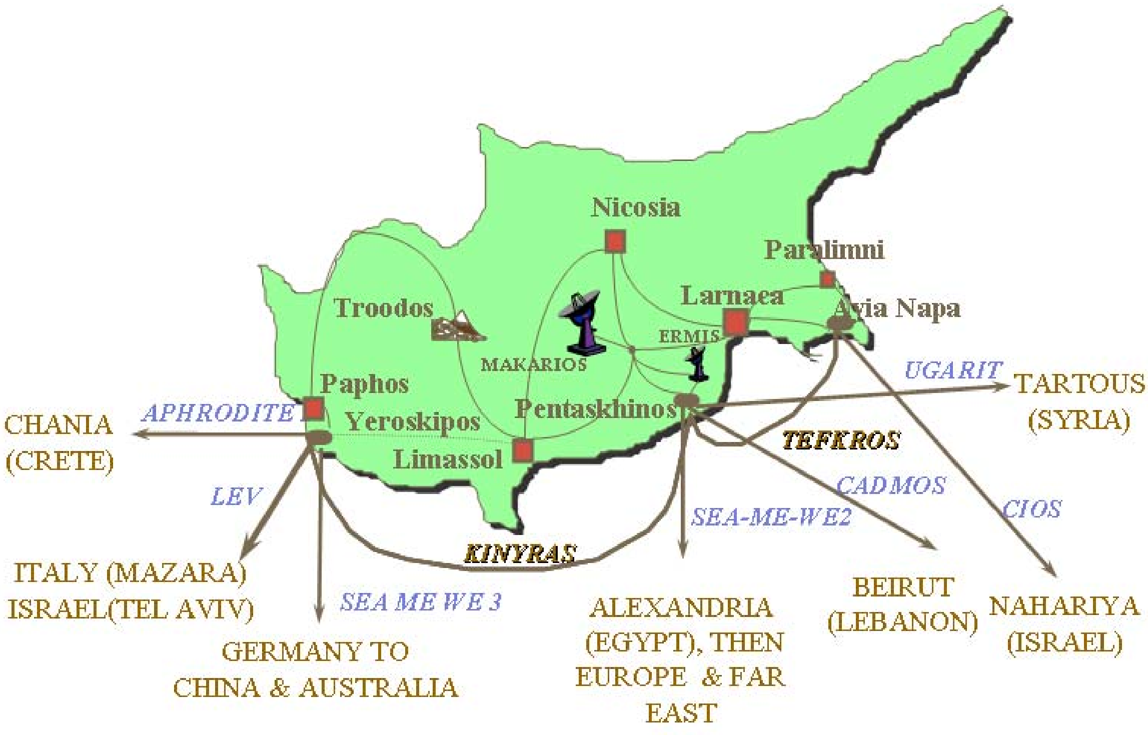


Figure 4.39. Submarine and land cable connections of Cyprus**.**

The following submarine fiber-optic cable systems are currently in service:

1. APHRODITE 2 – westwards to Greece and thereafter via ARIANE 2 cable system to Europe and beyond. This cable interconnects with ARIANE 2, of which CytaGlobal is a major co-owner, and stretches from Crete in Greece to Marseilles, France. It provides plesiochronous digital hierarchy (PDH) digital backbone facilities connecting Cyprus to Europe, the U.S., and the rest of the world.

2. CIOS – eastwards to Israel. This is a repeaterless cable system of synchronous digital hierarchy (SDH) technology connecting Cyprus directly with Israel.

3. CADMOS – eastwards to Lebanon. This is a repeaterless cable system of SDH technology connecting Cyprus directly with two separate landing stations in Lebanon.

4. UGARIT – eastwards to Syria. This is a repeaterless SDH cable system connecting Cyprus directly with Syria and thereafter providing terrestrial extensions to Jordan.

   CADMOS and UGARIT cable systems are currently being upgraded to 2.5 Gbit/s. These two cable systems, along with the BERYTAR (Beirut – Tartous) cable system, will form a self-healing ring interconnecting Cyprus with Lebanon and Syria.

5. SEA ME WE 3 – southwards via Egypt, to the Middle East and the Indian subcontinent, Southeast Asia, China, and Australia and westwards to Europe, traversing the Mediterranean and North Sea, all the way to Germany. This is a 20 Gbit/s submarine fiber-optic cable network noted for its huge traffic-carrying capacity, linking the Pacific Rim, Southeast Asia, the Middle East, and Western Europe through a multitude of landing stations. Its total length of about 40,000 km makes it the longest submarine fiber-optic cable network in the world.

6. LEV – eastwards to Israel, and westwards to Italy. This is a state-of-the-art cable system connecting Cyprus with Israel and Italy and thereafter via MED NAUTILUS cable system to Greece, Europe, and beyond.

7. MINERVA – an independent cable subsystem forming a direct self-healing ring between Cyprus and Italy, and through Telecom Italia Sparkle Pan-European network to the rest of Europe, the U.S., and beyond.

Two high-capacity coastal links – TEFKROS and KINYRAS – interconnect all landing points in Cyprus (Ayia Napa, Pentaskhinos, and Yeroskipos), thereby securing all wet routes for regional and international traffic. The two coastal links are further protected with terrestrial SDH self-healing rings.

CytaGlobal is continuously evaluating the connection of Cyprus to other planned fiber optic networks the world over. By co-owning, buying, or leasing capacity, CytaGlobal is participating in many major regional and global submarine cable systems such as AC 1, ARIANE 2, BSFOCS, CELTIC, COLUMBUS III, MED NAUTILUS, SAT3, TAT 12-13, TAT 14, and OTRANTO-CORFU (CytaGlobal, 2008).

4.3.4 Archaeological Resources, Antiquities, and Cultural Heritage

Cyprus, as well as most Eastern Mediterranean countries, has an important cultural heritage. Cypriot heritage is important for several reasons, including:

- Historical and archaeological significance. Information gathered from heritage sites is of great importance to scholars, both in Cyprus and internationally. It provides a basis for interpretation of vital stages in the development of modern civilisation, particularly during prehistoric, Greek, and Roman periods.

- National pride. In view of their international importance noted above, heritage sites are a focus for Cypriot national pride, and they are an indication of the long involvement that Cyprus has had in Western civilisations.

- Tourism potential. Heritage sites can be an important tourist resource if appropriate measures are taken to protect damaged structures and artifacts, and if visitor facilities are adequate. Heritage sites can be attractive tourist venues both for Cypriots interested in their country's history and for the important overseas visitor market.

Most of the significant archaeological sites of Cyprus (**Figure 4.40**) are located on the south coast. These sites are as follows:

- Kition – Located in the Larnaca district, this site contains the remains of the ancient city of Kition.

- Amathous – The ancient town of Amathous is situated on the south coast of Cyprus, about 7 km east of the town of Lemesos.

- Kourion – The mount of Kourion, on which the ancient city-kingdom developed, occupies a dominant position on the coast 4 km southwest of the village of Episkopi in the Lemesos district.

- Nea Pafos – Situated on a small promontory on the southwest coast of the island.

- Tombs of the Kings – The splendid necropolis that is located just outside the walls to the north and east of Pafos town.

- Maa-Paliokastro (Palaeokastro) – This archaeological site is situated on a small peninsula north of the town of Pafos.

- Agios Yeorgios, Pegeia – Agios Yeorgios (St. George) at Pegeia is a well known pilgrimage site on Cape Drepanon in the Pafos district in the west of Cyprus.

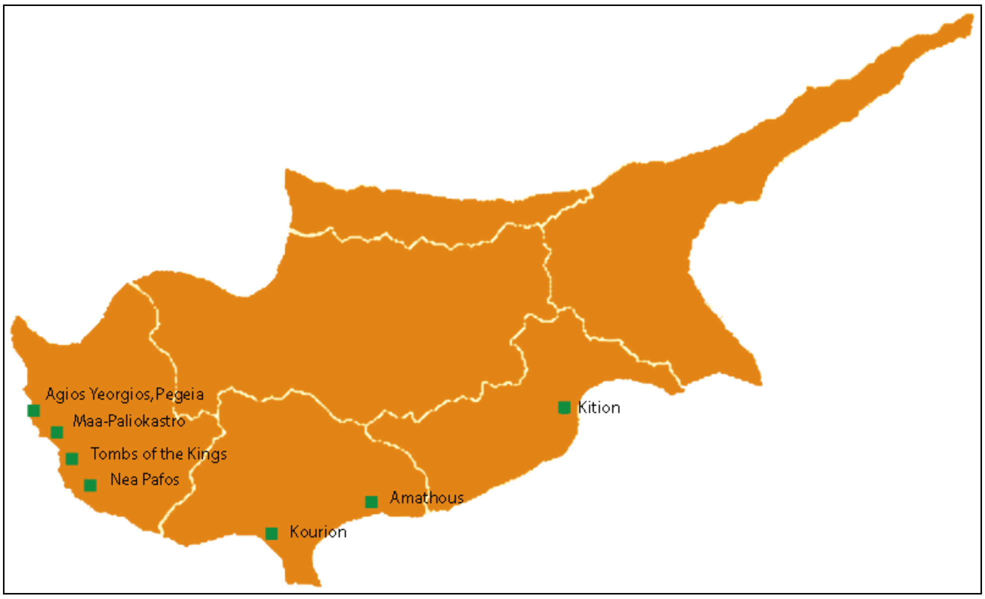


Figure 4.40. Significant archaeological sites of Cyprus (Department of Antiquities, 2008).

The three most culturally or economically significant shipwrecks in the Cyprus region are described below. Two of these are in shallow water, and the other is west of Cyprus and therefore probably not within the licence area.

1. The Phoenician trade vessel of Melkarth – VI Century BC. The Phoenecian vessel found off Melkarth was an ancient trade vessel carrying a cargo of amphorae, possibly sunk during the VI century B.C. The hull was discovered and explored by means of a remotely operated vehicle (ROV) (an unmanned submarine) and lies in very deep waters west of Cyprus;

2. The Greek vessel of Kyrenia – 306 B.C. The ancient ship of Kyrenia was a small Greek trade vessel carrying a cargo of wine in Rhodian amphorae and sunk north of Kyrenia around 306 B.C. The hull was about 15 m long and was protected from fouling by a lead cover. The wreck lies on a sandy bottom at a depth of 30 m; a large part of the hull has been well preserved by sediments, together with the complete cargo, including almonds and several hundreds of amphorae; and

3. The *ZENOBIA* cargo in Larnaka Bay – 1980. The *ZENOBIA* was a Swedish cargo ship loaded with trucks sunk in Larnaka Bay during 1980: the local divemasters say it was *ZENOBIA*'s maiden voyage, but this is a legend. The wreck is about 200 m long, and it is almost intact, still preserving its original cargo, including articulated trucks with their goods inside. The hull lies in navigation trim on a sandy bottom about 43 m deep. The upper structures are at a depth of 17 m, and the dive is easy even for beginners. The *ZENOBIA* is very popular among scuba divers because it is an imposing wreck, but the dive is interesting also for the beautiful, colorful environment, and particularly for large schools of Mediterranean barracuda *(Sphyrena sphyrena).*

4.3.5 Recreation and Tourism

4.3.5.1 Tourism

Tourism is central to the Cypriot economy. Approximately 2.5 million tourists visited the country in 2007, with the resulting revenue reaching € 1858 million (**Table 4.25**). Peak monthly arrivals and resulting revenues are recorded in July and August, and for 2007 almost 700 000 tourists arrived, generating € 600 million in revenue, an increase of 12.2 % when compared to the corresponding months of the previous year (Statistical Service of the Republic of Cyprus, 2008b).

Table 4.25. Tourist arrivals, 2000 to 2007 (Statistical Service of the Republic of Cyprus, 2008c).

	2000	2001	2002	2003	2004	2005	2006	2007
Tourist Arrivals (thousands)	2686.2	2696.7	2418.2	2303.2	2349.0	2470.1	2400.9	2416.1
Change (%)	10.3	0.4	-10.3	-4.8	2.0	5.2	-2.8	0.6

The majority of tourists (95%) come from European countries, and their preferred locations are the seaside resorts in Pafos (33%) and Agia Napa – Paralimni (32%), with only 10% staying inland (**Table 4.26**). The U.K. remained the most important source of tourism to the island with a 56.5% share of the total tourist traffic, followed by Russia (6.4%), Greece (6.1%), Germany (6%), and Sweden (5.3%). The gross income from tourism in 2007 was € 1858.1 million, in comparison to €1755.2 million in 2006, an increase of 5.8%.

Table 4.26. Preferred tourist locations, 2001 to 2007 (Statistical Service of the Republic of Cyprus, 2008d).

Location (%)	2001	2002	2003	2004	2005	2006	2007
Pafos and Polis	29.5	30.6	34.6	34.5	34.8	35.3	33.6
Paralimni	14.8	19.1	18.1	16.3	14.7	14.7	14.9
Agia Napa	21.0	18.1	16.4	15.7	16.5	17.0	17.0
Lemesos	17.5	16.7	15.9	16.3	16.1	14.2	13.8
Larnaca	9.4	8.6	8.2	9.3	9.2	9.0	9.8
Nicosia	4.7	2.8	3.2	3.6	3.4	4.6	5.3
Elsewhere	3.1	4.1	3.6	4.3	5.3	5.2	5.5

During 2006, the hotels and restaurants sector has improved in performance compared to 2005. Value added in real terms increased by 2.7% compared to the 1.6% realised in 2005. At current market prices, value added in 2006 increased by 5.1% to € 919.4 million compared to € 874.8 million in 2005, but its contribution to the Gross Domestic Product (GDP) declined in 2006 to 7.1% from 7.3% in 2005. The GDP output increased by 7.6% to € 1643.4 million from € 1527.9 million in 2005.

Of the total value added, 39.2% was generated through the activity of hotels, 10.9% by hotel apartments, 23% by restaurants and taverns, 7.3% by cafeterias and coffee shops, 4.3% by night clubs and cabarets, 4.1% by fast food outlets and take away restaurants. and 11.2% by other eating and drinking establishments (**Figure 4.41**) (Hotels and Restaurants, Statistical Service of the Republic of Cyprus, 2006a).

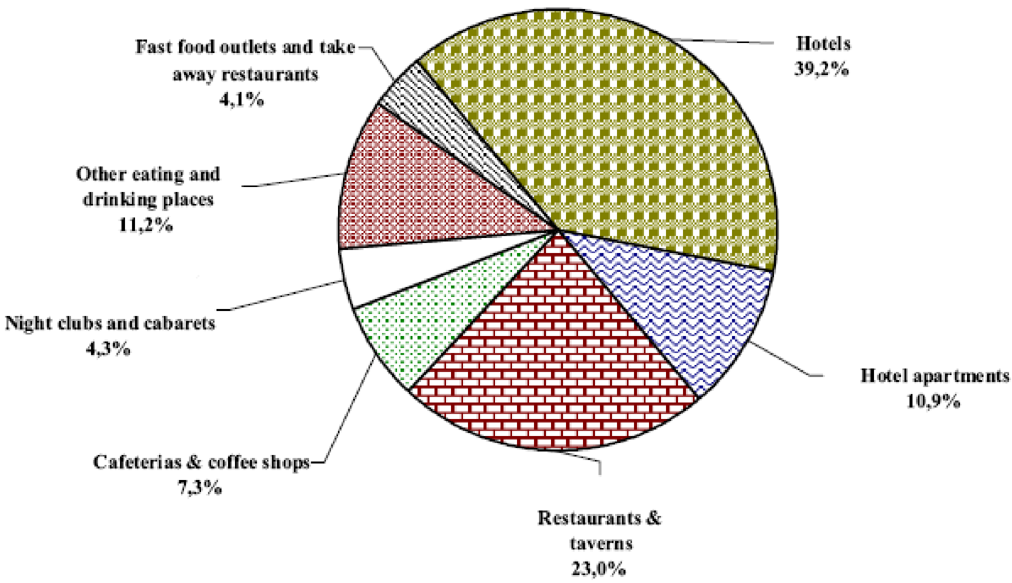


Figure 4.41. Value added by economic activity in Cyprus.

4.3.5.2 Employment and Investments

Employment in restaurants and hotels increased by 5.9% in 2006 compared to the previous year and reached 35 955 persons, accounting for 9.4% of the total economically active population and 10% of the total gainfully employed population. Gross fixed capital formation in 2006 increased by 5.1% to €94.9 million from €90.3 million in 2005. Investment in new buildings (hotels, hotel apartments, restaurants, etc.) accounted for €50.6 million, in machinery and other equipment € 21.4 million, in furniture and fixtures € 21.5 million, and in transport equipment € 1.4 million.

The Government of Cyprus and the Cypriot Tourism Organisation (CTO) are currently implementing a sustainable tourism strategy to encourage appropriate tourism development to safeguard and nurture the quality of the tourist experience, the beauty of the natural environment, and the quality of the life of inhabitants by making the best use of resources available without over-stretching or exhausting them. In the framework of this policy, the CTO has set the following targets with respect to the tourist development in the island:

1. Arrivals: 3.5 million tourists by 2010 is considered as the maximum limit, since it is acknowledged that an increase in revenues fuelled by increased arrivals depletes available resources and undermines the sustainability of the destination; and

2. Basic Infrastructure: Extension and upgrade of airports that will lead to an increase in their capacity and the supply of top quality facilities and high service levels is a matter of great priority (Hotels and Restaurants, Statistical Service of the Republic of Cyprus, 2006a).

4.3.6 Politics and Administration

Cyprus became an independent republic on 16 August 1960. The 1960 Constitution of the Republic of Cyprus proved unworkable in many of its provisions, which made its smooth implementation impossible. In 1963, the President of the Republic proposed amendments to facilitate the functioning of the State, and the Turkish Cypriot community responded with rebellion. The Turkish Cypriot Ministers withdrew from the Cabinet, and Turkish Cypriot civil servants ceased to attend their offices while Turkey threatened to invade Cyprus. Using the coup of July 1974 (which was instigated against the Cyprus Government by the military Junta, then in power in Athens) as a pretext, Turkey invaded Cyprus on 20 July 1974. As a result, approximately 37% of the island is occupied. In an effort to consolidate the *de facto* situation, the "Turkish Republic of Northern Cyprus" was unilaterally declared in 1983 in the occupied area; it is recognised only by Turkey and entirely dependent on it. Illegal settlers have been brought from Turkey to colonise the occupied area, thus changing the demography of the island. As of the present time, Turkey refuses to withdraw from Cyprus and maintains the island's division by the force of arms. The Government of the Republic of Cyprus is the internationally recognised authority (Cyprus Government Portal, 2008).

Cyprus is an independent, sovereign Republic with a presidential system of government. Under the 1960 Constitution, executive power is vested in the President of the Republic, elected by universal suffrage for a 5-year term of office. The President exercises executive power through a Council of Ministers, which includes the following Ministries: Interior, Labour and Social Insurance, Justice and Public Order, Foreign Affairs, Communications and Works, Defence, Finance, Education and Culture, Health, Agriculture, Natural Resources and the Environment, and Commerce, Industry and Tourism.

The Legislative power in the Republic of Cyprus is exercised by the House of Representatives. Out of a total of 80 seats in the House of Representatives, 56 are filled by Greek Cypriot successful candidates belonging to single parties and/or party coalitions or combinations, as well as by independent candidates, all of whom are elected by universal, direct, secret, and compulsory vote for a 5-year term of office. Initially, there were 50 seats in total, of which 35 (70%) went to Greek Cypriots and 15 (30%) to Turkish Cypriots. The same ratio was maintained after their increase to 80, through a House decision to that effect in 1985. Twenty-four of these seats belong to the Turkish Cypriots and remain vacant due to the Turkish Cypriot members' withdrawal in 1963, after intercommunal strife had broken out, and continuing to this day, as a result of the Turkish invasion of 1974. The Maronite, Armenian, and Latin minorities also elect representatives who attend meetings, though generally without a right of participation in the deliberations.

The Republic of Cyprus joined the EU on 1 May 2004. Every Cypriot carrying a Cyprus passport now has the status of a European citizen.

As shown in **Figure 4.42**, Cyprus is divided into six administrative districts. Each district is headed by a District Officer, a senior civil servant appointed by the Government responsible for the coordination of all Ministries in its district and accountable to the Ministry of Interior.

Figure 4.42. The six administrative districts of Cyprus.

At the local administrational level, areas around major urban (and tourism-based) residential populations fall under the jurisdiction of Municipalities, with smaller rural villages and settlements managed through Local Authorities (until recently termed "Village Boards" or "Improvement Boards"). Local policy is devised by the Municipal council, led by a Mayor (both elected by the citizens for a 5-year term).

The municipality is responsible for a range of activities including construction and maintenance of buildings, parks and public gardens, street lighting, sanitation and the protection of public health, waste collection and disposal, and the protection of the environment. Where budget permits, municipalities are also responsible for promoting their area through the development of tourism, arts, and sports. Their finances are derived from municipal taxes, fees, and duties as well as state subsidies. Municipal Law means that the municipality has jurisdiction over Streets and Buildings Regulation Law, Town Planning Law, and the Sewerage Systems Law, amongst others.

Communities (or Local Authorities) are broadly equivalent in terms of function to municipalities, although structurally different. The Local Authority is made up of the elected members of the Village Commission (including a President, Deputy President, and three others), and the District Officer or a representative of his office is Chairman of the Board. The District Officer is appointed by the government as its local representative in each District and acts as chief coordinator and liaison for the activities of all Ministries in Districts, accountable to the Ministry of Interior. With the exception of some of the wealthier Local Authorities, the central government provides administrative and technical assistance to most Local Authorities through civil servants employed in the District Office. All members of the Village Commission are elected by the residents of the village for a 5-year period.

The responsibilities of Local Authorities cover public health; construction and maintenance of roads; collection and disposal of waste; cleaning, lighting, and naming of roads; and regulation of trade and business, as well as the promotion of the area. Local Authorities issue bylaws, which are subject to central government approval. The revenue of the boards consists of state subsidies as well as taxes and fees collected from the residents of their area. The Village Commission has basic duties, while the District Office provides all the necessary services for the Community.

Local Authorities exist today in almost all villages of the island. Any community may become a municipality by local referendum (subject to approval) provided it has a population of over 5,000, or has the economic resources to function as a municipality. A community may receive financial, administrative, and technical support from the District Office or from the central government.

4.3.7 Economic Overview

Cyprus continued its economic expansion through the year 2007 at a higher pace as compared with the previous year. The GDP growth rate is provisionally anticipated to be on the order of 4.4% for 2007, compared to 4.0% in 2006 (**Table 4.27**). The GDP for 2006 was € 14 286.8 million, compared to € 13 432.3 million in 2005.

Table 4.27. Gross Domestic Product by economic activity in € million (Statistical Service of the Republic of Cyprus, 2007).

Economic Activity NACE REV.1	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Agriculture, hunting and forestry	316,8	295,7	274,1	310,6	315,8	310,6	348,0	355,3	346,4	315,2	311,1	307,9	309,5
Fishing	14,2	17,5	18,3	17,8	20,6	19,0	18,9	19,4	16,7	27,4	26,5	28,7	29,0
Mining and quarrying	18,6	18,9	18,1	23,3	24,6	27,5	25,5	29,5	34,7	41,0	43,7	45,4	50,2
Manufacturing	771,0	787,1	802,5	838,4	869,5	904,4	929,2	949,5	976,4	1.050,7	1.068,6	1.080,8	1.115,4
Electricity, gas and water supply	136,8	142,9	146,1	158,5	157,0	188,4	201,9	213,5	238,7	248,3	252,5	262,6	275,6
Construction	542,1	572,3	574,6	600,2	611,6	624,3	675,9	737,7	809,9	908,6	992,2	1.075,9	1.162,2
Wholesale and retail trade	880,8	900,5	935,9	1.029,8	1.065,0	1.159,4	1.222,6	1.265,6	1.266,8	1.432,4	1.515,6	1.618,3	1.744,4
Hotels and restaurants	601,4	587,5	635,0	692,8	778,1	873,2	946,5	871,3	838,4	856,1	881,4	911,8	960,6
Transport, storage and communication	525,9	557,0	591,4	660,1	737,2	817,8	886,9	858,0	859,7	933,6	983,1	1.011,2	1.028,7
Financial intermediation	352,2	399,2	453,8	508,6	648,1	702,7	696,6	635,1	657,0	758,0	839,7	934,8	1.074,2
Real estate, renting and business activities	1.018,0	1.100,5	1.179,1	1.287,1	1.370,6	1.477,3	1.648,0	1.770,6	1.894,7	2.030,0	2.214,6	2.463,5	2.715,2
Public administration and defence	578,7	612,9	663,6	696,3	764,3	833,5	863,5	930,5	1.139,3	1.179,6	1.252,1	1.325,9	1.370,5
Education	309,0	335,9	373,8	416,5	438,8	478,3	518,2	556,1	639,8	663,5	702,3	746,4	783,2
Health and social work	217,2	238,8	257,8	279,9	299,1	323,1	346,5	373,4	418,1	437,6	465,3	493,8	519,3
Other community, social and personal services	227,0	249,6	281,9	312,3	324,6	360,8	393,3	405,1	427,2	445,0	461,5	483,3	512,2
Private households with employed persons	24,4	30,6	33,7	37,2	41,0	47,0	56,7	64,8	75,2	87,5	96,7	102,0	104,9
Total Gross Value Added	**6.534,2**	**6.847,0**	**7.239,7**	**7.869,5**	**8.465,9**	**9.147,3**	**9.778,2**	**10.035,3**	**10.638,8**	**11.414,5**	**12.106,9**	**12.892,2**	**13.755,1**
Plus: Custom duties & Taxes on Imports	288,2	264,0	217,8	190,0	193,2	229,1	260,7	254,4	228,6	201,1	156,3	148,8	165,1
Plus: Value added tax (net)	327,9	338,3	352,7	385,8	403,4	506,8	589,0	689,9	893,8	1.038,0	1.199,0	1.352,5	1.570,0
Gross Domestic Product at market prices	7.150,4	7.449,3	7.810,2	8.445,3	9.062,6	9.883,1	10.627,9	10.979,7	11.761,2	12.653,6	13.462,3	14.393,6	15.490,2

The main stimulus to growth in 2007 was provided by the tertiary sector (mainly Financial Intermediation, Real Estate, Renting and Business Activities, and Wholesale and Retail Trade) expanding by 4.7% in real terms in 2007, compared to 4.6% in 2006. The secondary sector exhibited a real growth of 3.8% (mainly Construction) in 2007 compared to 3.0% in 2006. On the contrary, the primary sector recorded a negative growth rate of -2.2% in 2007, compared to -3.6% in 2006 (Statistical Service of the Republic of Cyprus, 2007).

For the fifth consecutive year, the sector of Agriculture, Hunting and Forestry is exhibiting a negative growth rate (-2.3% in its value added, compared to -4.5% in 2006). The Manufacturing sector is recording a higher growth rate of 2.1% in comparison to the 0.7% growth rate of 2006. Moreover, the Electricity, Gas, and Water Supply sector continues its expansion in 2007, registering a 3.1% growth rate compared to 2.4% in 2006. Construction continues its expansion with high growth rates since 2001, recording a growth rate of 5.7% in 2007, compared to the 6.0% in 2006. The Hotels and Restaurants sector is exhibiting, for a third consecutive year, positive expansion after 3 years of negative growth rates, reflecting the gradual improvement of tourism activity over the last 3 years. The Hotels and Restaurants sector, in particular, shows 2.8% growth in comparison to 2.7% in 2006. The Wholesale and Retail Trade sector registers a high growth rate of 5.5% in 2007 as compared to 5.2% in 2006. Transport, Storage, and Communication, which recorded exceptionally high growth rates in 2004 and 2005 of 13.3% and 8.5%, respectively, records a slowdown in 2006 and 2007 with real growth rates of 1.7% and 2.5%, respectively. Furthermore, Financial Intermediation continues its expansion with high growth rates, recording a growth of 11.0% compared to 8.1% in 2006. The Real Estate, Renting, and Business Activities continues its expansion with high growth rates, recording a marginally reduced 6.8% growth rate compared to 6.9% in 2006, while the growth rate of other Community, Social, and Personal Services increased to 4.8% in 2007 from 3.0% in 2006.

4.3.8 Population and Demographics

The Republic of Cyprus has a population of approximately 867.700 with an estimated annual growth rate of 1.6% (Statistical Service of the Republic of Cyprus, 2006b). Total population figures do not include illegal settlers from Turkey, which probably number somewhere in the range of 150 000 to 160 000, estimated on information of significant arrivals of Turks in the occupied area.

The estimated composition of the population by community for the Republic of Cyprus at the end of 2006 was:

- Greek Cypriot community – 660 600 (76.1%).
- Turkish Cypriot community – 88 900 (10.2%).
- Foreign residents – 118 100 (13.7%).

The religious groups that belong to the Greek Cypriot community totalled:

- Armenians – 2700 (0.3% of the Greek Cypriot community and 0.4% of the total population).
- Maronites – 4800 (0.7% of the Greek Cypriot community and 0.6% of the total population).
- Latins – 900 (0.1% of the Greek Cypriot community and 0.1% of the total population).

The population of the Government-controlled area was estimated to be 778 700 at the end of 2006, compared to 766 400 at the end of 2005, an increase of 1.6%.

The population of the Districts of Nicosia was 307 100, Limassol was 223 600, Larnaca was 130 100, Pafos was 74 900, and Famagusta was 43 000. The main cities of the south coast of Cyprus are Lemesos with a population of 180 100, Larnaca with a population of 80 400, and Pafos with a population of 54 000. There were 542 900 people living in urban areas and 235 800 in rural areas.

In 2006, the proportion of children below the age of 15 decreased to 18.0% while the proportion of senior adults age 65 and over increased to 12.3% compared to 25.4% and 11.0%, respectively, in 1992 and 25.0% and 10.8%, respectively, in 1982. There was a gradual increase in the proportion of senior adults and a decrease in the proportion of children, demonstrating the aging process. The proportion of persons aged 45 to 64 also increased to 24.1%, up from 19.4% in 1992 and 17.6% in 1982, indicating an aging of the working age population as well.

The population of Cyprus accounts for 0.2% of the total population of the 25 EU countries. Cyprus has the third smallest population ranking behind Malta and Luxembourg. Cyprus has the highest rate of population growth among the 25 EU countries, which is explained by its particularly significant positive net migration balance. The rate of natural increase is also high, the second largest behind Ireland. The age composition of the population portrays a somewhat younger age-structure than the European average. The proportion of senior adults 65 and over is among the lowest, while at the same time the proportion of children below the age of 15 is among the highest.

4.3.9 Land Use

4.3.9.1 Coastal Policy Framework in Cyprus

In Cyprus, as in many other countries, there is no Coastal Zone Management Policy as a separate and self-contained document. Policies for the coastal zone are included in various sectoral policies that apply to different administration areas (Loizidou, 2003). The main policies are the following:

- ***Land Use Policy***: Land use planning policy in Cyprus is under the responsibility of the Town Planning and Housing Department, Ministry of Interior and is controlled mainly by the Town and Country Planning Law, which came into force in 1991. Development in the main urban areas is controlled by the Local Plans and in the rural areas through the Policy Statement for the Countryside. Land uses and development zones are defined through these two planning tools, which are revised approximately every 4 years.

- ***Tourism Policy***: The Cyprus Tourism Organisation (CTO), a semi-Governmental Organisation under the Ministry of Commerce Industry and Tourism, is the authority responsible for Tourism Policy. Several policies and measures for the regulation of tourism development and tourism establishments are in force on the basis of CTO legislation. As previously mentioned, in 2000 a Strategy for Tourism was prepared by the CTO containing the main strategic goals for Cyprus tourism for the decade 2000 – 2010, aiming for a 40% increase of the number of tourists.

- ***Environmental Policy***: The responsibility for the Environmental Policy lies mainly with the Environment Service of the Ministry of Agriculture, Natural Resources and Environment. At the present time, environmental policy in Cyprus is focused on harmonization with the EU Acquis and the incorporation of EU Directives into the legislation of Cyprus. Environmental policy is expressed in sectoral policies of various natural resources (water, air, forests, etc.). Except from the Environment Service, more than 10 governmental departments and authorities from different Ministries are involved in Environment policies, creating a rather complex system.

4.3.9.2 Coastal Development in Cyprus – Land Uses

The dominant trends for development in Cyprus are as follows:

- Sub-urbanisation, i.e., rapid population growth and urban development in suburbs located at the edges of the main urban areas; and
- Coastal development, i.e., rapid coastal tourism development.

A major characteristic of the coastal development of the last two decades is that formerly agricultural and natural zones at the coastline are converted to tourist development zones after each revision of land-use planning zones every 4 years. The status of the land-use planning zones along the coastline after the last revision is as follows:

- Tourist zones cover 105 km (37% of the coastline [in length]).
- Open areas/protected natural or archaeological areas cover 125 km (43% of the coastline).
- Agricultural zones cover 36 km (12% of the coastline).
- Residential zones cover 17 km (6% of the coastline).
- Industrial zones cover 9 km (3% of the coastline).

The Tourism Development Plan for Cyprus shows the entire coastline stretching from the Akrotiri Sovereign base west of Limassol to the Dhekelia Sovereign base east of Larnaca as a CTO Controlled Zone. The designation of a CTO Controlled Zone presumably does not preclude heavy industrial development within appropriate selected areas of the zone, as Cyprus' two cement works and two of its largest oil-fired power stations all fall within this zone.

4.3.10 Existing Infrastructure

4.3.10.1 Highways

Cyprus has a total of 12 246 km of roads. Of these, 7845 km (including 276 km of expressways) are paved and 4301 km are unpaved (Statistical Service of the Republic of Cyprus, 2008a) (**Figure 4.43**).

The main highways of Cyprus are the following:

- A1 connecting Nicosia with Lemesos;
- A2 connecting Nicosia with Larnaca;
- A3 connecting Larnaca with Agia Napa;
- A5 connecting Larnaca with Lemesos; and
- A6 connecting Lemesos with Pafos.

Figure 4.43. Road map of Cyprus.

At the end of 2007, there were approximately 600 000 vehicles, of which 411 000 were private vehicles, taxis, and rental cars, 117 500 were light and heavy trucks, and 41 000 were motorcycles.

4.3.10.2 Airports

Cyprus has two international airports, one in Larnaca and one in Pafos, handling approximately 7 million passengers annually. In 2006, 3.29 million passengers arrived and 3.34 million departed, while 19 500 metric tons of goods arrived and 25 400 metric tons were shipped from the two airports (**Figure 4.44**).

Figure 4.44. International airports of Cyprus.

Chapter 5
Impact Assessment

5.1 INTRODUCTION

This chapter focuses on potentially significant impacts associated with the offshore hydrocarbon licensing programme for the Republic of Cyprus.

5.1.1 Affected Resources

Based on **Chapter 4** (Compilation of Environmental Information), the following resources were considered for the impact analysis:

- Air quality
- Water quality
- Sediments/geology
- Plankton
- Fishes
- Deepwater corals
- Chemosynthetic communities
- Soft bottom benthos
- Marine mammals
- Sea turtles
- Marine and coastal birds
- Coastal habitats
- Protected areas
- Fishing activities
- Shipping activities
- Telecommunications cables
- Shipwrecks
- Recreation and tourism
- Coastal communities

5.1.2 Significance Criteria

Directive 2001/42/EC requires that the determination of impact significance take into account the magnitude and spatial extent of effects and the value and vulnerability of the area likely to be affected. In this Environmental Report, an impact is considered significant if it is likely to result in one or more of the following:

- Violation of air or water quality standards, effluent limits, or emission limits;
- Persistent contamination of water or sediments resulting in harm to aquatic life, human health, or beneficial uses of the environment;
- Damage to, or contamination of, sensitive or protected habitats, fishery resources, or recreational resources such as beaches or parks;
- Damage to marine or coastal habitats to the extent that ecosystem function and ecological relationships would be altered;
- Death, injury, disruption of critical activities (e.g., breeding, nesting, nursing), or damage to critical habitat of a species listed by the IUCN as endangered, critically endangered, or vulnerable;
- Frequent or continual interference with other marine uses such as fishing, shipping, recreation and tourism, or telecommunications;
- Damage to or contamination of important cultural, historical, or religious sites on land or in the sea (e.g., shipwrecks, submerged archaeological sites); and/or
- A threat to public health or public safety.

5.1.3 Phases of Hydrocarbon Activities

For this assessment, three phases of offshore hydrocarbon activities are recognised:

- **Prospecting** – activities to locate hydrocarbons and/or evaluate hydrocarbon potential by methods other than drilling. Prospecting includes seismic surveys, geological and geochemical sampling, electromagnetic surveys, and remote sensing.

- **Exploration** – the process of drilling one or more exploratory wells in a block to determine whether commercially exploitable hydrocarbons are present.

- **Exploitation (development and production)** – the process of exploiting commercial quantities of hydrocarbons. Key activities include drilling of development wells, installation of production facilities, installation of export facilities such as pipelines, routine operation of these systems, and eventual decommissioning.

The rest of this chapter discusses potential impacts during Prospecting (**Section 5.2**), Exploration (**Section 5.3**), and Exploitation (**Section 5.4**). Accidents, which can occur during any phase, are discussed separately in **Section 5.5**. Cumulative impacts are addressed in **Section 5.6,** and transboundary impacts are evaluated in **Section 5.7**, followed by a summary of potentially significant impacts in **Section 5.8**.

5.2 PROSPECTING

5.2.1 Description of Activities

Prospecting for hydrocarbon resources in the marine environment encompasses a variety of techniques, including seismic surveys, geological and geochemical sampling, electromagnetic surveys, and remote sensing surveys (Continental Shelf Associates, Inc., 2004). In general, seismic surveys are the activities of most interest with respect to environmental impacts. The other techniques typically have little or no environmental impact.

Table 5.1 summarises the characteristics of potential prospecting survey activities that may occur offshore the Republic of Cyprus. Several of these methods may also be used during other phases of offshore oil and gas activity (e.g., during exploration and/or exploitation).

Some prospecting activities have already been conducted in the licence area. A two-dimensional (2D) seismic survey was conducted in the licence area by Petroleum Geo-Services (PGS) in 2006. The survey covered an area of approximately 51 000 km^2 within the EEZ. A three-dimensional (3D) seismic survey was conducted in Block 3 in 2007.

The level of future prospecting activities associated with the licensing programme is unknown. For this analysis, it is assumed that:

- One or more additional 2D and/or 3D survey(s) will be conducted to provide coverage of certain or all licensing blocks.

- Geological or geochemical sampling is likely to occur in all blocks that are licensed for exploratory drilling.

- Ocean bottom cable surveys are unlikely to be conducted in the licence area due to the water depths (248 to 2866 m).

Table 5.1. Characteristics of prospecting activities (Adapted from: Continental Shelf Associates, Inc., 2004).

Activity	Purpose	Description	Survey Platform	High Energy Sound Source	Sea Floor Activities
Seismic Surveys					
2D streamer surveys	Delineate oil and gas reservoirs	Receivers on streamer cables	Vessel	Single array of airguns	None
3D streamer surveys	Delineate/monitor oil and gas reservoirs	Receivers on streamer cables	Vessel	Dual array of airguns	None
High-resolution site surveys	Locate shallow hazards, archaeological resources, sensitive benthic habitats	Receivers on streamer cables	Vessel	Single or multiple airguns	None
Ocean bottom cable surveys	Delineate/monitor oil and gas reservoirs	Receivers on cables deployed on sea floor	Multiple vessels	Dual array of airguns	Cables placed temporarily on sea floor
Vertical cable surveys	Delineate/monitor oil and gas reservoirs	Receivers on vertical cables anchored to sea floor	Two vessels	Dual array of airguns	Vertical cables anchored temporarily on sea floor
Vertical seismic profile	Correlate geological data to seismic data	Receivers on vertical cables lowered into borehole	Suspended (e.g., by crane) from drilling rig or workboat	Single or multiple airguns	Receivers inserted into borehole
Geological and Geochemical Sampling					
Bottom sampling	Obtain physical and chemical data on surficial sediments	Samples collected with a gravity or piston corer, grab, or dredge	Vessel	None	Removal of a sediment sample
Shallow coring	Obtain physical and chemical data on surficial sediments	Conventional rotary drilling from a boat or barge	Vessel	None	Removal of a sediment sample
Electromagnetic Surveys					
Magneto-telluric surveys	Delineate potential oil and gas reservoirs	Receivers placed on sea floor to detect natural electrical and magnetic fields	Vessel	None	Receivers placed temporarily on sea floor
Bi-pole surveys	Delineate potential oil and gas reservoirs	Receivers detect electrical signals sent into sea floor	Vessel	None	Receivers placed temporarily on sea floor
Remote Sensing					
Radar imaging	Delineate potential oil and gas reservoirs	Radar detects oil slicks indicating possible seep locations	Satellite	None	None
Aeromagnetic surveys	Delineate potential oil and gas reservoirs	Magnetometer measures earth's magnetic field and/or its vertical gradient	Aircraft (fixed wing)	None	None
Gravity surveys	Delineate potential oil and gas reservoirs	Gravity meter measures earth's gravitational field	Vessel (or rarely, helicopter)	None	None
Gravity gradiometry	Delineate potential oil and gas reservoirs	Instrument measures earth's gravity gradient	Vessel	None	None
Marine magnetic surveys	Delineate potential oil and gas reservoirs	Magnetometer measures earth's magnetic field and/or its vertical gradient	Vessel	None	None

5.2.1.1 Seismic Surveys

Seismic surveys are used to help define the subsurface geology of a region or area of interest. The common feature of most marine seismic surveys is the use of "airguns" (a compressed air sound source that is usually towed behind a survey vessel) to generate sound waves to penetrate the earth's crust. Geophysicists use the resulting data to identify subsurface features that are favourable for oil and gas accumulation. Seismic data are used to help select well locations for exploratory drilling.

Seismic surveys can broadly be categorised as exploration-related or production-enhancing (International Association of Oil and Gas Producers [OGP] and International Association of Geophysical Contractors [IAGC], 2004). Examples of exploration-related surveys include 2D and 3D streamer surveys, which are often conducted by geophysical contractors across large areas prior to licensing of blocks for exploration. The seismic surveys that have already been conducted in the Cyprus EEZ are in this category and include one 2D survey and one 3D survey. Other seismic surveys such as high-resolution site surveys, ocean bottom cable surveys, vertical cable surveys, and vertical seismic profiles typically are more limited in scope and are conducted after a block is licenced, either during the exploration or exploitation phase.

2D and 3D Streamer Surveys

2D and 3D streamer surveys are the most common types of seismic survey that are likely to be conducted in the licence area. A 2D survey consists of a group of widely spaced survey lines (e.g., 2 km between survey lines), whereas a 3D survey consists of multiple, closely spaced lines (e.g., 300 to 600 m between lines). A 3D survey can produce more highly detailed subsurface maps than 2D survey data, which often require interpolation between lines.

A typical seismic survey array is shown in **Figure 5.1**. Sound waves from airguns towed by a seismic survey vessel are directed downward into the sea floor and subsurface geologic structures. The sound waves are then reflected back to the surface where they are detected by underwater hydrophones in the streamer(s) towed behind the vessel (**Figure 5.2**).

Seismic exploration survey equipment typically includes:

- A seismic survey vessel equipped with adequate accommodations and storage to operate continuously (24 hours per day; 7 days per week) for weeks or months at a time;
- Single or multiple airguns – a compressed air source to generate sound waves to penetrate the earth's crust;
- Single or multiple streamers – cables of variable length (e.g., 1 to 2 km long or longer) that contain a series of hydrophones that serve as receivers of the seismic sound;
- A data recording system and related equipment to place the seismic source and hydrophones in their appropriate positions and monitor them once in position; and
- A tail buoy equipped with a radar reflector and flashing light, which is attached to the end of the streamer for navigational purposes and to warn passing vessels of its presence.

There are variations on this typical arrangement, dictated by water depth or the presence of other structures within the area of interest.

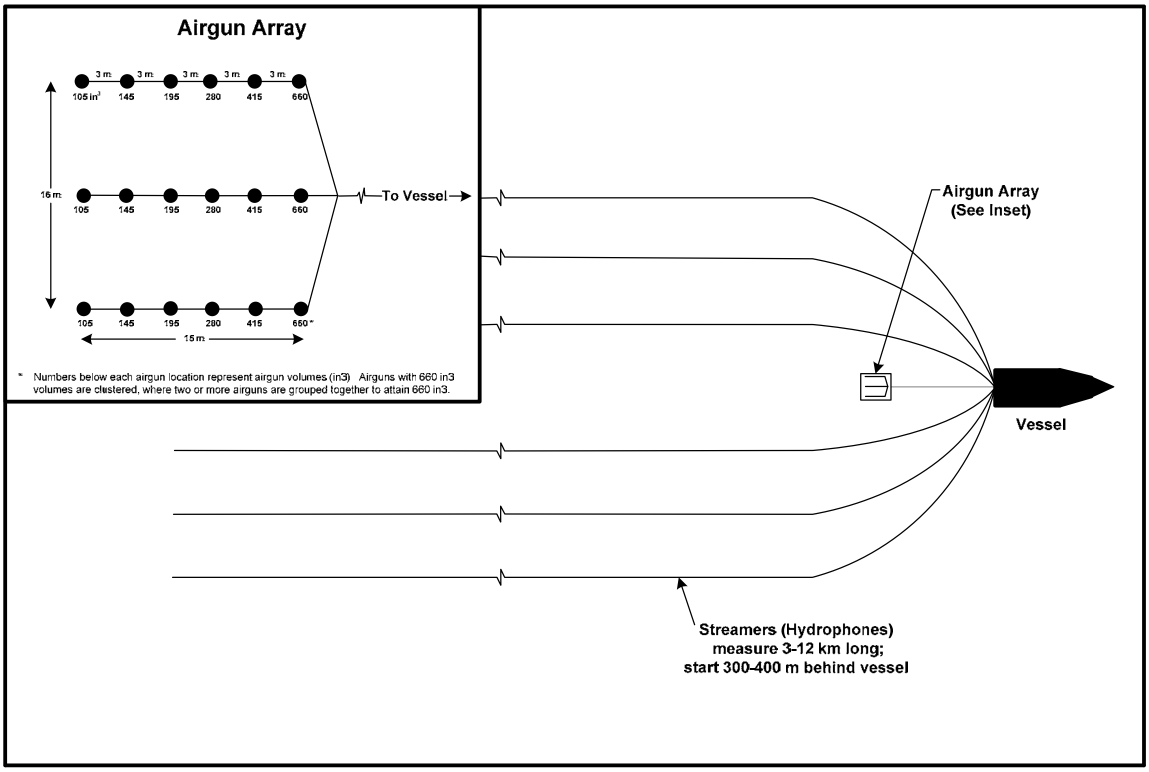


Figure 5.1. Typical configuration of a seismic survey array (From: Continental Shelf Associates, Inc., 2004).

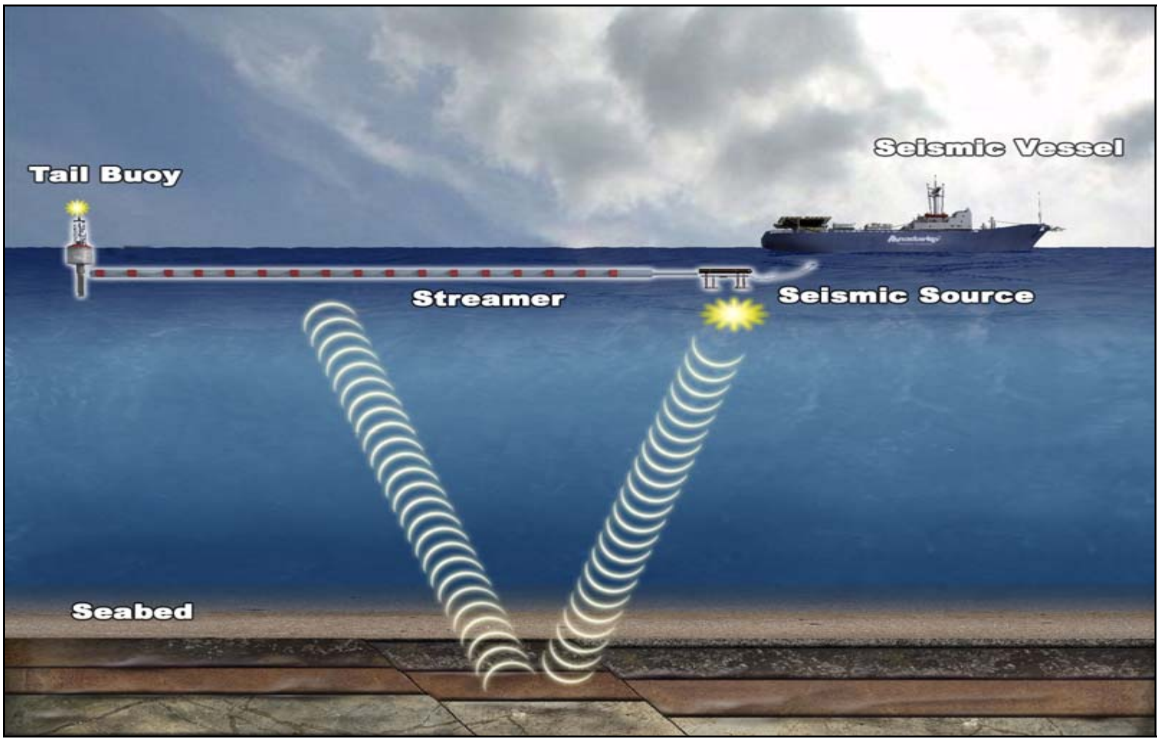


Figure 5.2. Illustration of a survey vessel towing a seismic source (airgun array) and streamers (with underwater hydrophones). Equipment may extend 3 to 12 km behind the vessel.

Vessels conducting 2D surveys are generally 60 to 90 m long and tow a seismic source array at a distance of 100 to 200 m behind the vessel. The source array typically consists of three subarrays with six or seven airguns each; each source array is about 12 to 18 m long and 16 to 36 m wide (**Figure 5.1**). Following behind the source array another 100 to 200 m is a single streamer on the order of 8 to 12 km long. The vessel tows this apparatus at a speed of about 8.3 km/h (4.5 kn). About every 16 sec (i.e., a distance of 37 m for a vessel travelling at 8.3 km/h), the airgun array is fired; the actual time between firings varies depending on vessel speed. Typically, a survey vessel motors along a track line for 12 to 20 h, covering 100 to 166 km, and then takes 2 to 3 h to turn around and start down another track. The spacing between tracks is usually on the order of 2 km, but can be greater; for example, survey lines for the 2D survey conducted by PGS in 2006 were about 20 km apart (**Figure 5.3**). A survey can continue day and night for days, weeks, or months depending upon the size of the survey area.

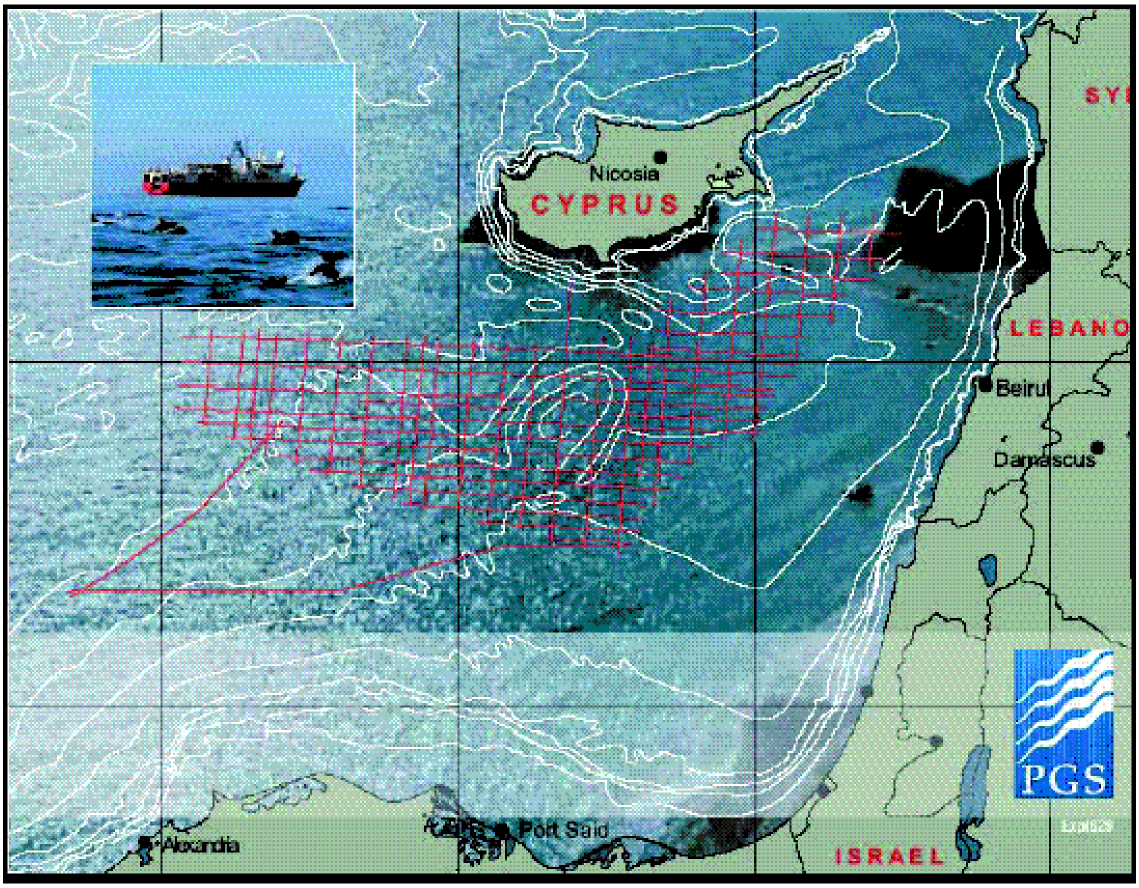


Figure 5.3. 2D seismic survey lines completed in 2006 offshore Cyprus (From: Jones, 2007).

3D surveys typically use slightly larger vessels (e.g., 80 to 90 m long) than 2D surveys do because the vessel must tow more equipment. The vessel tows two source arrays, aligned in parallel with one another, 100 to 200 m behind the vessel. The source arrays are the same as those used in the 2D surveys. Following another 100 to 200 m behind the dual source arrays are 6 to 12 streamer cables measuring 3 to 12 km long and spread out over a breadth of about 600 to 1500 m. Survey vessels tow their arrays and streamers at a speed of 4.5 kn (8.3 km/h). About every 16 seconds, one of the airgun arrays is fired, and then 16 seconds later, the other array is fired.

High-Resolution Site Surveys

High-resolution site surveys are conducted to investigate the shallow subsurface for geohazards and soil conditions, as well as to identify potential benthic communities (or habitats) and archaeological resources present within an area of interest. Information from high-resolution surveys can be recovered at much greater water depths, so they may be additionally utilised for exploration purposes. These surveys typically focus on a limited area such as a block or portion of a block where exploratory drilling or other activities are being considered by an operator.

A typical high resolution site survey operation consists of a vessel towing an airgun about 25 m behind the vessel and a 600-m streamer cable with a tail buoy (Continental Shelf Associates, Inc., 2004). A typical grid is 300 x 900 m, although narrower spacing may be used where submerged archaeological resources (e.g., shipwrecks) are suspected. The vessel travels at 3 to 3.5 kn (5.6 to 6.5 km/h), and the airgun is fired every 7 to 8 s (or about every 12.5 m). Typically, the ship motors in one direction along a track line for about an hour, then turns around (about 20 to 30 minutes) and surveys the next track.

Recently, 3D high-resolution site surveys with ships towing multiple streamer cables have become available as a prospecting seismic tool (Continental Shelf Associates, Inc., 2004). These surveys use slightly larger vessels (47 m vs. 37 m) than conventional high-resolution site surveys. Up to six streamers 100 to 200 m long are used with a tri-cluster of airguns.

Ocean Bottom Cable Surveys

Ocean bottom cable surveys are similar to conventional streamer surveys, except that the receivers are located in cables deployed on the sea floor. Such systems were originally introduced to enable surveying in areas of obstructions (such as production platforms) or shallow water inaccessible to ships towing streamers. These surveys can be effective in obtaining information about the fluids and rock characteristics in the subsurface geological structures.

Although newer technology has allowed ocean bottom cable surveys to be conducted at water depths of 2500 m or more, the depth limit of most surveys is typically less than 200 m (Ugbor, 2007). Therefore, this technique is not likely to be used in the licence area.

A typical ocean bottom cable survey consists of four to six vessels, including a source boat, a recording boat, one or two cable boats, and two smaller utility boats (Continental Shelf Associates, Inc., 2004; Ugbor, 2007). Cables are deployed from the back deck of the cable boat by a hydraulic device while the vessel traverses the pre-planned line. Groups of hydrophones or geophones are attached to the cable at intervals of 25 to 50 m. Multiple cables are laid parallel to each other using this layout method with a 50-m interval between cables. When the cable is in place on bottom, a ship towing a dual airgun array passes between the cables, firing about every 25 m. After a source line is shot, the source ship takes about 10 to 15 minutes to turn around and pass down between the next two cables. When a cable is no longer needed to record seismic data, it is retrieved by the cable pickup ship and moved to the next recording position. A particular cable can lay on the bottom anywhere from 2 h to several days. In some cases, cables may be left on the bottom for future time-lapse surveys.

Vertical Cable Surveys

Vertical cable surveys are similar to ocean bottom cable surveys in that the receivers are deployed and then shot into by a source boat (Continental Shelf Associates, Inc., 2004). However, in this case, the receivers are located on vertical cables anchored to the ocean bottom. These surveys are normally conducted at water depths up to 1700 m; however, when specially constructed hydrophones are used, surveys can be conducted in water depths up to 2500 m. The surveys use two identically configured boats to initially place the cables. During the survey, one boat is used as a source boat and the other to recover and redeploy the cables. Vertical cables are deployed every 2 km on two overlapping grids. Normally, 28 or 32 vertical cables are deployed at any one time. At the bottom of each vertical cable is an anchor, and at the top are buoyant floats to keep the cable as vertical as possible. Once the cables are in place, the source boat begins shooting in such a way that each vertical cable receives shots at a distance of 5 km in all directions. This is accomplished by motoring down lines parallel to the grid of vertical cables. Once the source boat shoots a line 1 km beyond the first row of vertical cables, that row is recovered and redeployed. Cables may be left in place for hours or days, depending upon the size of the survey and operating conditions. Vessel speed is normally 4.5 kn. The dual airgun array is the same as normally used in 3D streamer surveys.

Vertical Seismic Profile Surveys

In vertical seismic profile (VSP) surveys, seismic data are recorded from sensors placed in a borehole (i.e., a hole vertical to the ocean surface or sea floor) with seismic sources deployed in various geometries around the vertical array of sensors (Continental Shelf Associates, Inc., 2004). As such, VSP surveys typically occur during exploration or development drilling activities.

In all VSP surveys, sensors are lowered down a borehole before production tubing is placed in the well bore or the well is abandoned. After the sensor string is lowered to the lowest portion of the borehole to be surveyed, the sensors are temporarily clamped to the side of the well bore and seismic signals recorded. Subsequently, the sensors are repositioned and the next set of seismic signals recorded. Seismic sources used in VSP surveys are the same as those used in conventional seismic surveys. “Zero offset” surveys are conducted using a small, single airgun suspended by a crane on the deck of the drilling rig. “Walk-away” surveys use a work boat with four to eight airguns. 3D VSP surveys use the same airgun arrays as used for conventional 2D and 3D surveys.

5.2.1.2 Geological and Geochemical Sampling

Geological and geochemical sampling is conducted to obtain sediments for physical and/or chemical analyses. Physical analyses are used in engineering studies for placement of structures such as platforms and pipelines. Chemical analyses (surface geochemical prospecting) are based on the premise that upward migrated petroleum from deep source rocks and reservoirs can be detected in near-surface sediments and are used to evaluate exploration potential. Usually, a programme of bottom sampling and shallow coring is simultaneously conducted from a small marine drilling vessel (Continental Shelf Associates, Inc., 2004).

Bottom Sampling

Bottom sampling is done with devices that penetrate only a few centimetres to several metres below the sea floor. Samples of surficial sediments are typically obtained by dropping a piston core or gravity core (“dart”) to the ocean floor and recovering it with an attached wire line. Samples also can be obtained using a grab or dredge. The typical piston core is a 6-m long, 7.5-cm diameter pipe with a 910-kg core weight. In gravity coring, penetration into the bottom is limited by the sediment type, friction of the sediment on the outside and inside walls of the core barrel, and the resistance of the water exiting the top of the core barrel. In contrast, a piston corer uses a “free fall” of the coring rig to achieve a greater initial force on impact, and a sliding piston inside the core barrel to reduce inside wall friction with the sediment and to assist in the evacuation of displaced water from the top of the corer.

Shallow Coring

Shallow coring is conducted via conventional rotary drilling equipment from a drilling barge or boat. Penetration is usually limited to the recovery of several metres of consolidated rock.

5.2.1.3 Electromagnetic Surveys

Magneto-telluric and bi-pole surveys occur during the prospecting phase, cover one or more blocks, and are designed to delineate potential oil and gas reservoirs (Continental Shelf Associates, Inc., 2004).

Magneto-Telluric Surveys

For magneto-telluric surveys, vessels are used to deploy and retrieve specialised recording devices on the sea floor (Continental Shelf Associates, Inc., 2004). The devices are about 1.5 m high by 1 m on a side and attached to a concrete anchor about 60 cm on a side, 15 cm high, and weighing about 130 kg. Also attached to the recording device are four arms extending out from each side of the box with an electrode on each end. These arms are about 20 m long and made of 5-cm plastic polyvinyl chloride (PVC) pipe. No electrical currents are induced into the earth, but the receiver device detects the natural electrical and magnetic fields present in the earth. The recording device contains a magnetometer and a long-term recorder that allows the box to remain on the sea floor for days at a time. Recording devices are retrieved by using an acoustic pinger that releases a float that ascends to the ocean surface, where float, line, and recording device can be retrieved.

Bi-pole Surveys

Bi-pole surveys involve the use of two cables (joined together, with the second cable a few hundred feet longer than the first) that are towed by a vessel (Continental Shelf Associates, Inc., 2004). Attached to the end of each cable is a metal cylinder about 3 m long and 0.3 m in diameter. At regular intervals, the vessel stops, the cables sink to the bottom, and an electrical signal is input through the cables and into the sea floor. These electrical signals are detected by previously deployed receivers 2 to 10 km away from the source and arranged in a line or profile. The receiver boxes are attached to concrete blocks similar to those used for the magneto-telluric surveys. Inside the receiver boxes are devices that allow for recording for a few days. When the recording is finished, an acoustic pinger releases the recording box from the anchor, and the recording box floats to the surface for retrieval.

In both techniques, minor sea floor disturbance will occur. Each recording device occupies an area of about 1 m^2, while electrode-containing arms may affect another 4 m^2, for a total of 5 m^2 of sea floor disturbed for each recording device deployed. In a bi-pole survey, retrievable metal cylinders will also contact the sea floor, with a footprint of approximately 1 m^2 each time the device is set on the sea floor (Continental Shelf Associates, Inc., 2004).

5.2.1.4 Remote Sensing Methods

Remote sensing surveys may be conducted from a vessel, fixed-wing aircraft, or satellite. These methods are used to help delineate potential oil and gas reservoirs across large areas and involve little or no environmental impact (Continental Shelf Associates, Inc., 2004).

Radar Imaging

Satellite imagery can be used to detect oil slicks on the sea surface (Continental Shelf Associates, Inc., 2004). This is possible because when the oil molecules reach the sea surface, they form a thin layer that dampens the ocean surface capillary waves. The detection of oil slicks requires quiet water conditions and consequently is limited by sea state as well as by satellite position and frequency of coverage. For example, InfoTerra has constructed a global seeps database by screening offshore basins to a depth of approximately 3000 m using Synthetic Aperture Radar (SAR) satellite data to identify potential oil seeps. This type of survey uses existing satellite imagery and does not produce any environmental impacts in the project area.

Aeromagnetic Surveys

Aeromagnetic surveys are conducted to look for deep crustal structure, salt related structure, and intrasedimentary anomalies (Continental Shelf Associates, Inc., 2004). Surveys are flown by fixed-wing aircraft with flight lines on the order of 400 km long at a height of 75 to 150 m above the sea surface at speeds of about 220 km/h. Flight line spacing ranges from 500 to 800 m apart with cross lines every 2000 to 3000 m. Acquisition rates are on the order of 1000 to 2000 km of data per day. The earth's magnetic field is measured by either a proton precision or cesium vapor magnetometer mounted in a "stinger" projection from the tail of the aircraft. On occasion, two magnetometers are used to measure not only the total magnetic field but also the vertical gradient of the field. Magnetometers also can be towed behind a vessel, usually in conjunction with a seismic survey or as a separate survey effort.

Gravity Surveys

Gravity data are collected with instruments placed on the sea floor, in boreholes, in vessels, or in helicopters (Continental Shelf Associates, Inc., 2004). The predominant survey platform for gravity surveys are vessels. While gravity data can be acquired concurrently during seismic survey operations, the preferred method has been to use dedicated ships in order to acquire more precise data. Data grids for gravity surveys range from 1.6 km x 8 km to 9.7 km x 32 km.

Gravity Gradiometry Surveys

In gravity gradiometry, the earth's gravity gradient is measured by a survey vessel. A typical grid size is 0.25-km by 1-km in shallow water and 1-km by 2-km in deeper water (Continental Shelf Associates, Inc., 2004).

Marine Magnetic Surveys

Marine magnetic surveys measure the earth's magnetic field for the purpose of determining structure and sedimentary properties of subsurface horizons (Continental Shelf Associates, Inc., 2004). These surveys are usually conducted in conjunction with a seismic survey, allowing the navigation information to be used for both surveys. The sensor is housed in a cylindrical package measuring approximately 1 m long and 15 to 20 cm in diameter and weighing about 14 kg. The sensor is towed behind one of the sub-arrays of the seismic source array at a distance of about 100 m. The sensor is towed at a depth of 3 m and makes use of depth devices mounted on the cable to maintain a constant depth.

5.2.2 Impact Factors

In accordance with Directive 2001/42/EC, the SEA focuses on "likely significant" environmental effects. Based on a preliminary evaluation, the following prospecting activities are expected to produce negligible or minor environmental impacts, and therefore are not analyzed further:

- **Geological and geochemical sampling** – Bottom sampling and shallow coring could affect a small area of sea floor, resulting in surficial sediment disturbance, resuspension, and creation of minor surficial features (e.g., gouges, holes, depressions, etc.). The total sea floor area disturbed during these activities in each block would be a few square metres, and the impact would be similar to collecting sediment samples for scientific research. Impacts on sediments/geology and benthic communities would be negligible.

- **Electromagnetic surveys** – In addition to small amounts of ship traffic (with associated discharges and emissions), these surveys involve only minor disturbance to the sea floor (temporary placement of receiver boxes on the bottom). Impacts on sediments/geology and benthic communities would be negligible.

- **Remote sensing surveys** – These involve only a small amount of vessel and/or aircraft traffic (with associated discharges and emissions) and have little or no impact on any resource.

Therefore, seismic surveys are the only prospecting activity that is analyzed in detail. Five impact factors (i.e., causes or sources) were identified: (1) airgun noise; (2) vessel traffic and towed streamers; (3) effluent discharges; (4) air pollutant emissions; and (5) sea floor disturbance. Relevant resources that may be affected by each impact factor are identified in **Table 5.2**.

Table 5.2. Impact factors and potentially affected resources for seismic surveys. Potentially significant impacts (X) are highlighted in yellow.

Resource	Airgun Noise	Vessel Traffic and Towed Streamers	Effluent Discharges	Air Pollutant Emissions	Sea floor Disturbance
Air quality	---	---	---	o	---
Water quality	---	---	o	---	---
Sediments/geology	---	---	---	---	o
Plankton	---	---	---	---	---
Fishes	o	---	---	---	---
Deepwater corals	---	---	---	---	o
Chemosynthetic communities	---	---	---	---	o
Soft bottom benthos	---	---	---	---	o
Marine mammals	X	o	---	---	---
Sea turtles	X	o	---	---	---
Marine and coastal birds	---	---	---	---	---
Coastal habitats	---	---	---	---	---
Protected areas	---	---	---	---	---
Fishing activities	o	X	---	---	---
Shipping activities	---	X	---	---	---
Telecommunications cables	---	---	---	---	o
Shipwrecks	---	---	---	---	o
Recreation and tourism	---	---	---	---	---
Coastal communities	---	---	---	---	---

X = potentially significant impact with mitigation recommended; o = minor or negligible impact, no additional mitigation recommended; -- = no impact.

5.2.3 Effects of Airgun Noise

Airgun noise has the potential to adversely affect marine biota. The resources of concern with respect to significant impacts are marine mammals, sea turtles, and fishes. Although plankton, invertebrate nekton, benthic fauna, and other biota could be affected, those impacts are not likely to be significant and are not discussed here.

5.2.3.1 Effects on Marine Mammals

The Mediterranean Sea supports a diverse marine mammal fauna, including several species listed by the IUCN as endangered (e.g., fin whale) or vulnerable (e.g., sperm whale). Common species are likely to include the bottlenose dolphin, common dolphin, Risso's dolphin, and striped dolphin (see **Section 4.2.5**). The rare, critically endangered Mediterranean monk seal may be present in nearshore Cyprus waters (Dendrinos and Demetropoulos, 1999) but is unlikely to be found in offshore waters of the licence area due to the depth and distance from shore.

Potential impacts of seismic surveys on marine mammals have been reviewed extensively (Richardson et al., 1995; Davis et al., 1998; Gordon et al., 1998; Stone, 2003; Continental Shelf Associates, Inc., 2004). The key findings are as follows:

- There is a risk of temporary or permanent auditory trauma within a range of a several hundred metres of a typical airgun array. The range depends on a variety of factors including the size and configuration of the array, water depth, and the density structure of the water column.

- Behavioural responses such as avoidance have been observed in many instances. The biological importance of such behavioural responses has not been determined (Ocean Studies Board, 2003) but likely depends on the context.

While the risk of auditory trauma depends on proximity to the airgun array (and how long an animal remains nearby), behavioural responses may occur at distances of many kilometres and are not necessarily predictable from the loudness of the sound source. Behavioural responses may vary depending on factors such as the age and status of the animal, the type of activity it is engaged in, and the social context (McCauley et al., 2000).

Mysticetes (e.g., fin whales) are believed to have good hearing in the low-frequency range that is produced by airguns, that is, the noise would seem loud to them. Toothed whales and dolphins generally are thought to be less sensitive to low-frequency noise. However, behavioural responses to seismic survey noise have been observed in both groups. In addition, some odontocetes (e.g., sperm whales, beaked whales) may be at greater risk because of factors such as their deep-diving behaviour and the difficulty of detection during pre-survey monitoring.

Auditory Effects

In humans and terrestrial mammals, exposure to high levels of sound can cause a temporary elevation of the hearing threshold, known as temporary threshold shift (TTS) (Richardson et al., 1995). Prolonged or repeated exposure to sound levels sufficient to induce TTS without recovery time eventually leads to permanent threshold shift (PTS) or permanent hearing loss.

There is limited information about TTS in marine mammals. Finneran et al. (2002) conducted TTS experiments with one dolphin and one white whale exposed to sounds generated from a seismic airgun. TTS was observed in the white whale after exposure to single impulses with peak pressure of 224 dB re 1 μPa. The white whale's hearing returned to normal within 4 minutes of exposure. No TTS was observed in the dolphin at a peak pressure of 226 dB re 1 μPa. These experiments involved single pulses; animals exposed to multiple pulses would be expected to experience TTS at lower peak sound pressure levels, but this has not been quantified. Some experts have expressed concerns about peak sound pressure levels above 180 dB re 1 μPa (High Energy Seismic Survey Team [HESS], 1999), and this same level was used in an Environmental Assessment by the U.S. Minerals Management Service (MMS) (Continental Shelf Associates, Inc., 2004). A marine animal could be exposed to this sound pressure level within a few hundred metres laterally from an airgun array (and primarily beneath it). For example, Continental Shelf Associates, Inc. (2004) estimated that for a typical seismic array, a sound pressure level of 180 dB re 1 μPa would extend approximately 300 m laterally from the array.

Mysticetes (baleen whales) are probably at greater risk for auditory trauma than odontocetes (toothed whales and dolphins). This conclusion is based on the high hearing threshold (i.e., poor hearing) of odontocetes in the frequency range less than 200 Hz, where most of the energy from seismic pulses is concentrated (Goold, 1996).

Another potential auditory impact is masking. Auditory masking occurs when sound signals that are important to animal (such as sounds associated with echolocation, communication, and environmental cues) are blocked or interfered with (Richardson et al., 1995). In the case of seismic surveys, the potential masking noise consists of a pulsed form with a low cycle rate (approximately 10%, or a 1-second disturbance in every 10 seconds of ambient noise). Davis et al. (1998) considered the effect of masking resulting from marine seismic operations to be of little consequence, due to the low cycle rate of seismic pulses relative to continuous sounds such as ship noise.

Behavioural Effects

A number of studies have documented behavioural effects of marine mammals in response to seismic surveys (Malme et al., 1984; Richardson et al., 1995; McCauley et al., 2000; Stone, 2003; Holst et al., 2006; Miller et al., 2006). However, it is unclear how the behavioural changes may affect long-term health (Ocean Studies Board, 2003).

Stone (2003) reported that during seismic surveys in U.K. waters, several dolphin species were seen less frequently when airguns were firing than when they were not firing. In addition, baleen whales, killer whales, and all of the small odontocetes were farther from large airgun arrays during periods when airguns were firing than when the airguns were silent. In general, small odontocetes showed the strongest avoidance response to seismic activity, with baleen whales and killer whales showing some localised avoidance, pilot whales showing few effects, and sperm whales showing no observed effects from these data. Different groups of cetaceans may adopt different strategies for responding to acoustic disturbance from seismic surveys (Stone, 2003).

Baleen whales are believed to hear well in the low frequency range and have been observed to increase their distance from the source, change their orientation, and sometimes remain nearer the surface in response to airguns. Behavioural reactions (avoidance) have been noted in gray whales and bowhead whales (Malme et al., 1984; Richardson et al., 1995). McCauley et al. (2000) reported that humpback whales began avoidance maneuvers at 5 to 8 km from an operating airgun array and maintained a standoff range of 3 to 4 km. McCauley et al. (2000) interpreted this as suggesting localised avoidance of the operating seismic vessels. Similar results have been reported for other baleen whales (Richardson et al., 1995).

McCauley et al. (2000) reported instances of percussive behaviour such as tail slapping in response to airgun firing. Percussive behaviour is typically shown by breeding males competing for females, and can produce very high sound levels. It has been suggested that males may perceive the loud sounds that airguns produce as competing males (McCauley et al., 2000).

Mother/calf behaviours such as suckling may be more susceptible to acoustic disturbance. McCauley et al. (2000) suggest potential avoidance ranges of 7 to 12 km by nursing animals (based on results of single airgun trials scaled to 3D array measurements), but noted that these might differ in different sound propagation conditions. There are no known nursery areas for marine mammals in the licence area.

→ **Conclusion**: There is a risk of temporary or permanent auditory trauma to marine mammals within a range of a several hundred metres of a typical airgun array, particularly if they swim beneath the array. Mysticetes (e.g., fin whales) and deep-diving odontocetes (e.g., sperm whales and beaked whales) are probably at greater risk than small odontocetes. Behavioural responses such as avoidance may occur at ranges of several kilometres from an airgun array.

→ **Existing Control Measures**: No existing control measures were identified. Some petroleum companies and seismic survey operators voluntarily implement measures such as a "soft start" and visual monitoring for marine mammals and sea turtles.

→ **Recommended Mitigation:** See **Section 5.2.3.4**.

5.2.3.2 Effects on Sea Turtles

Three sea turtles species occur in the Mediterranean Sea: green (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), and loggerhead (*Caretta caretta*). The green and loggerhead turtles are listed by the IUCN as endangered, and the leatherback turtle is listed as critically endangered. Both green and loggerhead sea turtles nest on Cyprus beaches.

Auditory Effects

In contrast to marine mammals, relatively little is known about sea turtle hearing ability or their dependency on sound, passive or active, for survival cues. The anatomy of the sea turtle ear does not lend itself to aerial conduction but rather is structured for sound conduction through two media: bone and water (Békésy, 1948; Lenhardt, 1982; Lenhardt and Harkins, 1983). Auditory testing and behavioural studies show that turtles can detect low-frequency sounds (Ridgway et al., 1969; Bartol et al., 1999). Most common sound frequencies produced by seismic airguns overlap with the frequency range where turtle hearing is most sensitive (100 to 700 Hz). Therefore, it is likely that sea turtles would be able to hear seismic activities for a considerable distance from the source of the shots and possibly experience some disturbance.

All sea turtle species are assumed to be at some risk for auditory trauma, although hearing data are available only for loggerhead and green turtles. Hatchling sea turtles are probably at minimal risk for noise impacts. These animals inhabit *Sargassum* mats and debris floating on the sea surface. Due to the attenuation pattern of airgun arrays, seismic noise levels would be lowest in near-surface waters.

Because sea turtles remain submerged much of the time (Eckert et al., 1986, 1989; Keinath and Musick, 1993), they may be passed over by seismic arrays and therefore exposed to the highest sound levels, which are directed downward. Although the sound levels produced by an airgun are not likely to kill a sea turtle even at close range, they could result in auditory trauma.

Sublethal impacts of acoustic impulses on the hearing system of sea turtles have been examined in only one study (Moein et al., 1995). The turtles in this study were used to test the efficacy of seismic airguns to repel sea turtles from the path of hopper dredges. Turtles were tested for stress levels and hearing thresholds before and after the airgun trials. A temporary alteration of blood chemistry values after exposure to the airguns indicated that the turtles might have been affected by exposure to repeated acoustic stimuli. Values indicated both an increase in the stress level of the animal as well as damage to tissues. However, the magnitude of the changes did not indicate serious injury to the turtles' organs, and blood chemistry levels returned to normal in approximately 2 weeks. Thus, this exposure to sound stimuli did cause minor, but reversible, changes to the turtles' tissues (Moein et al., 1995). Hearing thresholds also were examined by Moein et al. (1995). Half of turtles tested exhibited a shift in the latency of their auditory evoked potentials collected within 24 hours of exposure. This shift was indicative of a change in the hearing physiology. However, in all five cases, hearing capabilities of each turtle returned to normal by the end of 2 weeks, and the effect was always temporary.

Behavioural Effects

Two studies have examined the behavioural response of juvenile loggerheads to sound in their natural environment (O'Hara and Wilcox, 1990; Moein et al., 1995). Both studies used airguns as an acoustic repelling device for sea turtles. Trial exposures of sea turtles to seismic sounds have also been done.

O'Hara and Wilcox (1990) attempted to create a sound barrier for loggerhead turtles at the end of a canal using seismic airguns. The test results indicated that the airguns were effective as a deterrent for a distance of about 30 m. However, this study did not account for the reflection of sound by the canal walls. Consequently, the stimulus frequency and intensity levels are ambiguous (O'Hara and Wilcox, 1990). Moein et al. (1995) investigated the use of airguns to repel juvenile loggerhead sea turtles from hopper dredges. Avoidance of the airguns was observed upon first exposure for the juvenile loggerheads. However, these animals also appeared to habituate to the sound stimuli. After three separate exposures to the airguns, the turtles no longer avoided the stimuli (Moein et al., 1995).

McCauley et al. (2000) exposed sea turtles to airgun pulses and found that they began to noticeably increase their swimming activity, and at higher exposure levels began to show more erratic swimming patterns, possibly indicative of them being in an agitated state. They suggest that sea turtles displayed a general "alarm" response at an estimated 2-km range from an operating seismic vessel, and behaviour indicative of avoidance occurred at an estimated 1-km range.

Holst et al. (2006) reported on the results of turtle observations during seismic surveys at various locations. Sea turtles showed localised avoidance during large and small-source surveys. The mean closest point of approach for turtles was smaller during non-seismic than seismic periods (139 m versus 228 m for large-source surveys, 120 m versus 285 m for small-source surveys).

Nesting Disturbance

Due to the distance from shore, seismic surveys in the licensing area would not be expected to affect turtle nesting on Cyprus beaches. Minimum distances to shore from individual licence blocks range from 11.4 to 178 km.

→ **Conclusion**: Less is known of sea turtle hearing than that of marine mammals. However, it is assumed there is a risk of temporary or permanent auditory trauma to sea turtles within a range of a several hundred metres of a typical airgun array, particularly if they swim beneath the array. Any of the three species occurring in the region could be affected. Hatchling turtles tend to be found in surface waters and are much less likely to be harmed. Nesting activities are not likely to be affected due to the distance from shore.

→ **Existing Control Measures**: No existing control measures were identified. Some petroleum companies and seismic survey operators voluntarily implement measures such as a "soft start" and visual monitoring for marine mammals and sea turtles.

→ **Recommended Mitigation:** See **Section 5.2.3.4**.

5.2.3.3 Effects on Fishes and Fishing Activities

All fish species can hear, with varying degrees of sensitivity, within the frequency range of sound produced by seismic airguns (Hawkins, 1973; Popper and Fay, 1973; Tavolga et al., 1981; Fay, 1988; Popper and Fay, 1993; Fay, 2000). Seismic pulses may produce temporary or permanent hearing impairment in some fishes, but, as in the case of marine mammals, would be unlikely to cause serious injury except at very close range. Because of wide differences in hearing capability and morphologies among fish species, behavioural responses and the susceptibility of fishes to auditory trauma vary greatly.

There is no evidence of fish mortality resulting from seismic shots, and there are no data available on the noise intensity that would result in mortality or other pathological effects. Except at close range, the effects of airguns on fishes are thought to be transitory, mainly evoking a startle response (i.e., movement away from the source of the noise) and changes in schooling behaviour. Habituation of fishes to the noise is suggested by the fact that behavioural changes are observed to cease during the exposure period, sometimes within minutes of commencement of surveying.

Noise from marine seismic surveys also may have the potential to cause masking of the sounds normally used by fishes in their usual acoustic behaviours (Popper and Clarke, 1976; Ha, 1985). These behavioural effects also may result in decreased catchability even though no direct mortality may result (Dalen and Knutsen, 1986; Pearson et al., 1992; Engås et al., 1993; Løkkeberg and Soldal, 1993). Fishes with specialised hearing abilities (such as those species with swimbladders and especially those species with bladders mechanically linked to the ear) will be more likely to exhibit behavioural responses to distant seismic survey operations than will fishes with relatively poor hearing (McCauley, 1994).

McCauley et al. (2000) conducted trials with captive fishes that showed a common fish "alarm" response of swimming faster, swimming to the bottom, tightening school structure, or all three, at an estimated 2 to 5 km from a seismic source. Captive fishes exposed to short-range airgun pulses were seen to have some damaged hearing structures but showed no evidence of increased stress. Ears of fishes exposed to an operating airgun sustained extensive damage to the sensory epithelia, which was apparent as ablated hair cells. The regionally severe damage showed no evidence of repair or replacement of damaged sensory cells up to 58 days after airgun exposure. The study suggests that exposure to seismic airguns can cause significant damage to the ears of fishes (McCauley et al., 2003).

Studies of the effects of seismic surveys on fish catch have shown mixed results (Davis et al., 1998). Some studies have shown little or no effect (Turnpenny et al., 1994). Others have shown effects during airgun operations and for a certain period afterward. There have been a number of field studies investigating the effects of seismic airguns on cod and herring distributions and catch success (Chapman and Hawkins, 1969; Matousek et al., 1988; Løkkeberg, 1991; Skalski et al., 1992; Engås et al., 1993; Løkkeberg and Soldal, 1993). Løkkeberg (1991) and Engås et al. (1993) both reported that the cod catch (by trawl) was reduced (80% to 50% reduction) during and following seismic surveys in the North Sea off the coast of Norway. The calculated sound pressure levels received by the fish were 191 and 160 dB, respectively. Engås et al. (1993) found that the reduced catch lasted for at least 5 days within a 33-km radius of the airguns. Davis et al. (1998) noted that this contrasts with most other studies, which show a more localised and short-term effect. Similarly, a review by Gausland (2003) concluded that many studies find that the maximum distance from seismic surveys that causes behavioural impact on fishes is limited to less than 2 km.

In California waters, Pearson et al. (1992) investigated the effects of airgun sounds on rockfish behaviour, and Skalski et al. (1992) concurrently studied effects on catch-per-unit-effort. At levels of 180 dB re 1 μPa, animals appeared to be alarmed, and either aggregated more tightly, descended, or ascended in the water column. The lowest level causing any observed behavioural change was 161 dB. A return to pre-exposure behaviours was noted within 20 to 60 minutes. Skalski et al. (1992) found that catch rate declined by an average of 52% when the airgun was operating. Although catch rate was not monitored after airgun firing stopped, the authors speculated that the catch would quickly return to pre-exposure levels since fish behaviour returned to normal within minutes.

→ **Conclusion**: Seismic surveys may produce temporary or permanent hearing impairment in some fishes, but would be unlikely to cause serious injury except at very close range. Also, by disturbing fishes, airgun operations may indirectly cause a temporary reduction in fish catch near survey vessels. Literature and data are insufficient to conclusively determine whether such effects will occur and if so, their areal extent and duration.

→ **Existing Control Measures**: No existing control measures were identified. Some petroleum companies and seismic survey operators voluntarily implement measures such as a "soft start" that may reduce impacts on fishes.

→ **Recommended Mitigation:** See **Section 5.2.3.4**.

5.2.3.4 Mitigation for Effects of Airgun Noise

Cyprus has no regulations or guidelines for mitigation during seismic surveys. Such mitigation measures have only come into common use within about the last decade, and there are many uncertainties about their effectiveness (Continental Shelf Associates, Inc., 2004; Holst et al., 2006; Miller et al., 2006; Weir et al., 2006). **Table 5.3** summarises the main characteristics of mitigation measures used in several other countries (U.K., U.S., and Australia) as well as those recommended by the International Finance Corporation (IFC).

Key differences among the various mitigation protocols include the size of the safety zone, whether a shutdown of the airgun array is required when a marine mammal enters the safety zone, and whether airgun array can be operated at night. These topics are discussed below.

Safety Zone. The Joint Nature Conservation Committee (JNCC), MMS, and IFC guidelines all specify a 500-m radius safety zone, whereas the Australian guidelines specify a 3000-m radius. The purpose of establishing a safety zone is to ensure that marine mammals (and/or turtles) are not exposed to sound levels that could cause temporary or permanent auditory trauma. It is not feasible for the safety zone to be based on behavioural responses, since such responses have been noted at distances of many kilometres and are not necessarily predictable based on the received sound level (e.g., responses could depend on what the animal is doing and its previous auditory experience). The available information indicates that the 500-m safety zone specified by the JNCC, MMS, and IFC guidelines is sufficient to avoid the likelihood of most auditory trauma. Therefore, a safety zone radius of at least 500 m is recommended.

Dolphins swimming near a seismic survey vessel (From: Jones, 2007).

Shutdowns. The JNCC guidelines do not require sound sources to be shut down if a marine mammal enters the safety zone after the array is powered up. However, U.S. MMS and Australian guidelines do require a shutdown if a whale (or turtle, under the MMS guidelines) enters the safety zone. This is a reasonable precaution to reduce the likelihood of auditory trauma in the event that a whale or turtle does not (or cannot) avoid the area near the seismic array. Shutdown should also be required for monk seals, in the unlikely event that one was seen in the survey area. The likelihood of auditory trauma for small odontocetes (e.g., dolphins) is considered low, and shutdown would not be required if they entered the safety zone during a survey.

Night-Time Operations. Ideally, if monitoring of a safety zone for marine mammals and turtles is required during the daytime, then a similar procedure should be used at night, or surveys should be limited to daylight hours only. However, there is a trade-off between allowing continual 24-hr surveying versus restricting operations to daylight only and having a longer survey duration (Weir et al., 2006).

Table 5.3. Comparison of seismic survey mitigation measures from the U.K. Joint Nature Conservation Committee (JNCC), U.S. Minerals Management Service (MMS), Environment Australia (EA), and International Finance Corporation (IFC).

Topic	JNCC (2008)	MMS (2007a)	EA (2001)	IFC (2007)
Marine mammals	• Includes all marine mammals	• Includes whales only, not dolphins or porpoises	• Includes whales only, not dolphins or porpoises	• Includes all marine mammals
Turtles	• Not included	• Included (same protection as whales)	• Not included	• Not included
Scheduling	• Recommends scheduling surveys to reduce likelihood of encounters with marine mammals during breeding/calving seasons	• Not specified	• Not specified	• Plan surveys to avoid sensitive times of year; or, in fishing areas, less productive times of year, where possible
Observers	• Training course required. Experienced observers required in sensitive areas • Two observers required when there are more than 12 daylight hr/d	• Two qualified observers required. Must complete a training course • Individual observers limited to no more than 12 hr/d total and 4 consecutive hr, with 2-hr breaks between watches	• Wherever practicable; use trained, independent observers	• Experienced observers should be used where significant impacts to sensitive species are anticipated
Power levels, etc.	• Use the lowest practicable power levels during survey • Seek methods to reduce and/or baffle unnecessary high-frequency noise produced by airguns or other acoustic energy sources • Minimise airgun firing that is not part of a survey line	• Not specified	• Not specified	• Use the lowest practicable power levels during surveys • Use methods to reduce and/or baffle unnecessary high-frequency noise produced by airguns or other acoustic energy sources, where possible • Reduce operation times, where possible
Safety zone	• 500-m radius	• 500-m radius	• 3000-m radius	• 500-m radius
Timing of observations	• Begin 30 min prior to startup. Wait 20 min after last sighting	• Begin 30 min prior to startup. Wait 30 min after last sighting	• Begin 90 min prior to startup. Wait 30 min after last sighting	• Begin time not specified. Wait 20 min after last sighting
Soft start	• Start with smallest airgun in array and build up slowly over 20 to 40 min. Repeat if operations stop for >5 min	• Start with smallest airgun in array and build up slowly over 20 to 40 min. Repeat if operations stop for >20 min	• Gradual increase in number of airguns over a 20-min period	• Gradual increase in sound pressure to full operational levels should be used in areas of known marine mammal activity
Stop if animal enters safety zone after startup?	• No	• Yes	• Yes	• Not specified
Night-time startups	• Operators encouraged to start up only during daylight; passive acoustic monitoring encouraged during darkness	• Night-time startups prohibited unless passive acoustic monitoring is used in place of visual observers	• Night-vision binoculars can be used to meet the visual monitoring requirement	• Not specified

Although the JNCC guidelines "encourage" daylight operations, they do not prohibit night-time startups or operations. Instead, the guidelines encourage the use of passive acoustic monitoring (specifically, the PAMGUARD system) to allow night-time detection of marine mammals. Both the Australian and MMS guidelines do specify limits on night-time operations. The Australian guidelines allow surveying operations to continue at night with visual monitoring via infrared/night vision binoculars, despite an effective range of only around 100 m (Weir et al., 2006). MMS guidelines specify that a soft start cannot begin during night-time unless passive acoustic monitoring is used in place of visual observations. MMS (2007a) guidelines identify passive acoustic monitoring as an "experimental" technique and clearly indicate that the requirement is intended as a means to gather data on the effectiveness of the technique. The use of passive acoustic monitoring creates significant logistical difficulties, and there are problems obtaining accurate range and bearing information on vocalising animals (C. Weir, personal communication, 2007).

Based on the available information, no specific requirements for night-time surveys are recommended. Visual monitoring at night (i.e., night-vision binoculars) has a very limited range and is likely to detect only animals very near the survey vessel (e.g., bow-riding dolphins). Use of passive acoustic monitoring would significantly complicate the logistics while providing uncertain benefit. Some protection is already in place at night because, under the recommended guidelines, a soft start is required for any shutdown (day or night). The soft start offers protection from sudden exposure to damaging noise levels.

→ **Recommended Mitigation.** During seismic surveys, licensees should be required to implement a protocol to reduce the risk of auditory trauma to marine mammals and sea turtles. The protocol should include at a minimum the following provisions:

- **Soft start** – Every time the use of the seismic array is initiated, "soft-start" procedures should be used to allow time for marine mammals and turtles to move away from the survey area before an airgun array reaches full power. The process should begin with the smallest source in an array and build up slowly over 20 to 40 minutes.

- **Visual monitoring** – Beginning at least 30 minutes before startup during daylight hours, visual observers should monitor a safety (exclusion) zone of 500 m radius around the source vessel. Startup of the array cannot begin until the safety zone is clear of marine mammals and turtles for at least 20 minutes.

- **Shutdown of the array** – Visual monitoring of the sea surface should continue while the seismic array is operating during daylight hours, and the array should be shut down if a whale, monk seal, or sea turtle enters the safety zone during visual monitoring. A whale is defined as a cetacean other than Family Delphinidae (i.e., including any baleen, sperm, or beaked whale species).

No specific mitigation is recommended for fishes. However, the use of "soft-start" procedures for marine mammals and turtles provides an opportunity for fishes to leave the area before an airgun array reaches full power.

5.2.4 Effects of Vessel Traffic and Towed Streamers

During 2D and 3D streamer surveys, an exclusion zone or safety zone is maintained around the seismic vessel and streamer arrays. The zone is necessary to prevent fishing vessels or other ships from crossing the streamer arrays. This helps to avoid damaging the seismic array and fishing gear.

Figure 5.4 shows an example of a typical exclusion zone for a streamer survey. In this example, the zone is 20 km long and 12 km wide. The zone moves with the survey vessel at about 4.5 knots (8.3 km/hr) and would take approximately 2.5 hours to pass any particular point. Typically, one or more escort vessels or "chase boats" travel well in front of the seismic vessel to detect and notify other boats to move out of the area. Vessels are notified by appropriate signals in accordance with International Maritime Law including via radio, lights, and flags.

An exclusion zone as shown in **Figure 5.4** would occupy an area of 240 km^2. This represents 0.5 percent of the total licence area (approximately 51 000 km^2).

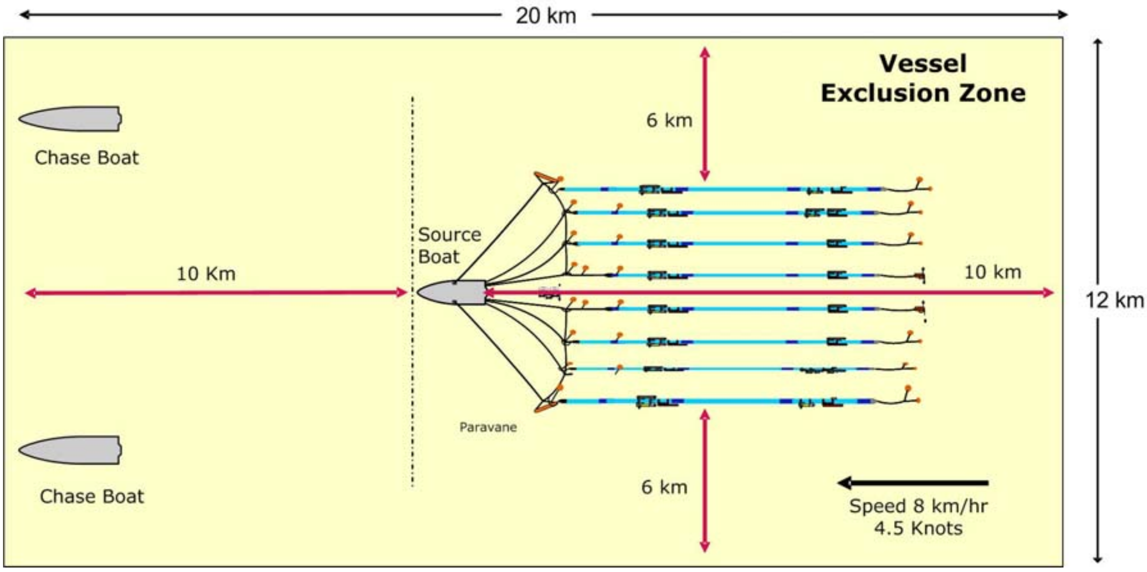


Figure 5.4. Example of an exclusion zone around a seismic vessel towing a streamer array. Actual dimensions may vary.

Fishing activities in the licence area include bottom trawling and long-lining (see **Section 4.3.1**). The exclusion zones around seismic survey vessels could result in temporary exclusion of fishing boats from certain areas. During the surveys, some fishing boats might need to detour around the array. There is also the possibility of entanglement with long-line sets.

Considerable ship traffic also passes through the licence area enroute to Cypriot ports including Limassol and Larnaca. During the period from 2000 through 2006, an average of 4726 ships per year docked at Cypriot ports (see **Section 4.3.2**). The exclusion zones could require some ships to detour around the seismic survey vessels and their towed arrays.

Other than the exclusion zones, the impacts of vessel traffic are expected to be negligible. Survey vessels move slowly and operate in accordance with international maritime conventions. The activity is similar to other maritime traffic in the region, except for the slow speed. The chance of a seismic survey vessel striking a marine mammal or turtle is considered negligible, because the vessels would be moving very slowly and trained observers would be scouting the sea surface before and during surveys (see **Section 5.2.3.4**).

→ **Conclusions** – Movements of fishing vessels and other ships may be temporarily interrupted during streamer surveys due to the extent of the moving safety zone around the streamers. There is also the potential for towed streamer arrays to become entangled with long-line sets.

→ **Existing Control Measures** – No specific control measures for this activity were identified. However, the Hydrocarbons Regulations of 2007 require licensees to ensure that operations are conducted in an environmentally acceptable and safe manner, consistent with the applicable environmental legislation and good international industry practice. It is assumed that licensees would be required to notify the relevant Cyprus maritime authorities of the planned survey location and schedule. Also, it is assumed that survey vessels would use appropriate signals in accordance with International Maritime Law (including communications via radio, lights, and flags) to warn other vessels of the exclusion zone.

→ **Recommended Mitigation** – Licensees should be required to consult with stakeholders prior to conducting streamer surveys to ensure that conflicts with fishing and shipping activities are minimised.

5.2.5 Effects of Effluent Discharges

Effluent discharges from survey vessels will include treated sanitary waste, domestic waste, deck drainage, and bilge and ballast water. Impacts will be similar to those of effluent discharges from other ships in the region. For example, effluents may affect concentrations of suspended solids, nutrients, and chlorine, as well as generating biochemical oxygen demand (BOD). These discharges are expected to be diluted rapidly in the open ocean. Impacts would likely be undetectable beyond tens of metres from the source and are considered to be negligible.

→ **Conclusions** – Effluent discharges from survey vessels will be similar to those from other vessels in the region and are expected to have negligible impacts on offshore water quality.

→ **Existing Control Measures** – Survey vessels must comply with MARPOL requirements including provisions concerning sewage, food waste, oily waste, and garbage.

→ **Recommended Mitigation** – No additional mitigation is recommended.

5.2.6 Effects of Air Pollutant Emissions

Engines of seismic survey vessels (including the source boat and chase boats) will emit air pollutants including carbon monoxide (CO), nitrogen oxides (NO_x), sulphur oxides (SO_x), particulate matter (PM), and volatile organic compounds (VOCs), as well as greenhouse gases such as carbon dioxide (CO_2) and methane (CH_4). Some of these gases are known to degrade to form different compounds, and these degradation products and transformation processes are important in the context of problems such as global warming and acidification. The emissions are indistinguishable from those of existing maritime traffic in the region and are expected to be rapidly diluted and dispersed in the atmosphere. There may be some decrease in air quality within several hundred metres around the vessels during operations. However, no detectable impacts on air quality in Cyprus are expected based on the relatively small quantities of pollutants emitted and the operational distances from shore.

→ **Conclusions** – Air pollutant emissions from seismic survey vessels would be similar to those of existing ship traffic in the region and are expected to have negligible impacts on air quality.

→ **Existing Control Measures** – Survey vessels must comply with MARPOL Annex VI, which sets limits on sulphur oxide and nitrogen oxide emissions from ship exhausts and prohibits deliberate emissions of ozone-depleting substances including halons and chlorofluorocarbons. MARPOL also sets limits on emissions of nitrogen oxides from diesel engines and prohibits the incineration of certain products on board such as contaminated packaging materials and polychlorinated biphenyls. Also, under the Hydrocarbons Regulations of 2007, licensees are required to ensure that all machinery, equipment, and installations used by the licensee and subcontractors comply with generally accepted standards in the international petroleum industry and are of proper construction and kept in good working order.

→ **Recommended Mitigation** – No additional mitigation is recommended.

5.2.7 Effects of Sea Floor Disturbance

Some types of seismic surveys involve a small amount of sea floor disturbance (see **Section 5.2.1**). The extent of sea floor disturbance would be minimal, and in most cases impacts would be negligible. However, resources that could be significantly affected include (1) deepwater coral communities, (2) chemosynthetic communities, (3) telecommunications cables, and (4) shipwrecks and other submerged archaeological resources.

As noted in **Section 5.2.1**, ocean bottom cable surveys are not likely to be conducted in the licence area because the depth limit of most surveys is typically less than 200 m (Ugbor, 2007). The other two relevant survey techniques are as follows:

- **Vertical cable surveys** – Receivers are located on vertical cables anchored to the ocean bottom. Vertical cables are deployed every 2 km on two overlapping grids. Normally, 28 or 32 vertical cables are deployed at any one time. At the bottom of each vertical cable is an anchor, and at the top are buoyant floats to keep the cable as vertical as possible. Although this technique may be used in the area, the amount of sea floor disturbance is minimal.

- **Vertical seismic profiles** – In VSP surveys, seismic data are recorded from sensors placed in a borehole (i.e., a hole vertical to the ocean surface or sea floor) with seismic sources deployed in various geometries around the vertical array of sensors. Although this technique may be used in the area, the amount of sea floor disturbance is minimal.

Most of the sea floor in the licence area is expected to consist of soft-bottom benthic habitat. Deepwater benthic communities of the Mediterranean Sea are characterised as impoverished, with low density and low diversity (see **Section 4.2.2**). The main concern with regard to potential impacts is the placement of cables or other equipment on the sea floor in areas such as deepwater coral communities (e.g., on the Eratosthenes Seamount) or chemosynthetic communities. These areas are associated with elevated densities of epifauna and fishes, and are considered relatively rare and ecologically important. However, due to the small area and limited amount of sea floor disturbance during these seismic surveys, the likelihood of significant impacts is negligible.

There are several submarine telecommunications cables passing through the licence area (see **Section 4.3.3**). These features are susceptible to physical damage from sea floor-disturbing activities. However, licensees routinely map and avoid these cables during detailed project planning, and it is assumed that impacts would be avoided.

The licence area is in a region where historical shipwrecks and other submerged archaeological resources are likely to be present (see **Section 4.3.4**). These features are susceptible to physical damage from sea floor-disturbing activities. However, due to the minimal sea floor disturbance during these seismic surveys, no significant impacts are expected.

→ **Conclusions** – Ocean bottom cable surveys (if any), vertical cable surveys, and VSP surveys may disturb small areas of the sea floor. There is a slight possibility of impacts to deepwater corals, chemosynthetic communities, shipwrecks, or other submerged archaeological resources if they are present at the survey location. However, due to the minimal amount of sea floor disturbance during these surveys, no significant impacts are expected.

→ **Existing Control Measures** – No existing control measures were identified.

→ **Recommended Mitigation** – No additional mitigation is recommended.

5.3 EXPLORATION

5.3.1 Description of Activities

During the Exploration phase, one or more exploratory wells would be drilled in a block to determine whether commercially exploitable hydrocarbons are present. An operator may also conduct additional seismic surveys and/or other prospecting surveys to help select drilling locations and identify geohazards. These have been previously characterised under **Section 5.2** and are not repeated here.

Drilling an exploratory well in the deepwater environment typically takes 70 to 90 days (Regg et al., 2000). However, the duration may range from 40 to 120 days, depending on the target well depth and any problems encountered during drilling. Typically, a self-contained, mobile drilling rig would be brought into the area to drill a well. Based on water depths in the licensing area (248 to 2866 m), the most likely type of drilling rigs would be semi-submersibles or drillships. Each well would be drilled to a predetermined depth and either temporarily suspended or abandoned in accordance with industry standards. During drilling, the rig would discharge drilling fluids and cuttings and other effluents in accordance with the effluent limits summarised in **Section 3.4**.

If a hydrocarbon formation is discovered during exploratory drilling, a well test may be conducted. A well test is a procedure to determine the productive capacity, pressure, permeability, and/or extent of a hydrocarbon reservoir, and it may involve burning a small quantity of oil or gas. If a well is deemed productive, it may be suspended by installing cement or mechanical plugs to isolate the hydrocarbon intervals and fitting a well suspension cap to allow reentry of the well at a later date (for completion and production).

If no commercially exploitable reservoir is found during exploratory drilling, a well would be permanently plugged with cement or mechanical plugs and abandoned. A site clearance survey would be conducted to ensure that any debris from drilling activities is removed from the sea floor around each drillsite.

5.3.1.1 Types of Drilling Units

Several types of mobile offshore drilling units are used for exploratory drilling, including jack-up rigs, semi-submersibles, and drillships (**Figure 5.5**). Because conventional jack-up rigs are limited to water depths of 110 to 120 m or less (Bennett, 2008), they are not expected to be used in the licence area. The other two rig types are characterised as follows (from MMS, 2008):

- **Semi-submersible** – a floating vessel that is supported primarily on large pontoon-like structures submerged below the sea surface. Most semi-submersibles are not self-propelled and must be towed to a drillsite by assisting vessels. Operating decks are elevated about 30 m or more above the pontoons on large steel columns. Semi-submersibles can operate in a wide range of water depths, including deep water. Conventionally moored semi-submersibles are held in place by 6 to 12 anchors placed radially around the rig and extending to distances of 3 km or more. Dynamically positioned semi-submersibles use a computer-controlled system that allows the rig to maintain position using thrusters and propellers, thereby avoiding the need for anchoring.

- **Drillship** – a vessel modified to include a drilling rig and special station-keeping equipment. Drillships are self-propelled, capable of operating in deep water and ultra-deep water, and typically carry larger payloads than semi-submersible rigs. They typically use dynamic positioning rather than conventional moorings. A "moon pool" in the centre of the drillship provides access for a derrick from the deck surface through the centre of the vessel to the water column.

a)

b)

Figure 5.5. Examples of mobile offshore drilling units that may be used in the licence area: (a) semi-submersible and (b) drillship.

Operators select the type of drilling rig based on the characteristics of the physical environment (including water depth), expected drilling depth, and the mobility required based on expected weather and sea state conditions. Maximum water depth is a function of the length of the rig's riser – the bundled utility tubes through which drilling fluids and other material are conducted, enclosed in an outer tube, suspended from the semi-submersible to the sea floor. Semi-submersibles can usually operate in rougher seas than a drillship (Canadian Association of Petroleum Producers [CAPP], 2006).

While there are differences between semi-submersibles and drillships with respect to capabilities, treatment facilities, and effluent discharge depths, the characteristic volumes and types of wastes streams generated during drilling operations are similar. Also, all offshore drilling rigs, regardless of type, contain well drilling equipment, working and living quarters, crew and supply transfer capabilities (e.g., moorings/landing platforms for supply vessels, helidecks for helicopter landing and departure), and fire and rescue equipment.

5.3.1.2 Drilling Discharges

From an impact perspective, one of the key activities during exploratory drilling is the discharge of drilling fluids and cuttings. These discharges would occur in accordance with the effluent limits summarised in **Section 3.4**.

Cuttings are rock fragments that are displaced as the drill bit moves through geological formations. They are discharged more or less continuously during drilling.

Drilling fluids (also known as drilling muds) are special fluids that are pumped down into the well through nozzles on the drill bit. They are a complex mixture of clays, chemical additives, freshwater, and/or seawater used to lubricate and cool the drill bit, flush out cuttings, control formation pressures, seal permeable formations, and maintain well bore stability. Drilling fluids also help to minimise damage to reservoirs, prevent the formation of gas hydrates, assist in the transition of hydraulic energy to drill tools, assist in formation evaluation via logging equipment, control corrosion, and facilitate casing cementing (CAPP, 2005). Drilling fluids are composed of several main ingredients (primarily water, barite, and clay minerals) and numerous special purpose additives (National Research Council, 1983; Neff, 1987).

There are two major types of drilling fluids: water-based fluids (WBFs) and nonaqueous base fluids (NABFs). WBFs consist of freshwater or saltwater, barite, clay, caustic soda, lignite, lignosulfonates, and/or water-soluble polymers. NABFs (also known as organic-phase fluids) are emulsions – a base fluid consisting of a liquid hydrocarbon or other water-insoluble organic chemical forms the continuous external phase, while calcium chloride brine forms the discontinuous internal phase (Neff et al., 2000). In the past, NABFs have contained diesel or conventional mineral oil as the primary component (Group I fluids). However, the industry has moved to NABFs with low-toxicity mineral oil (Group II fluids) and, more recently, enhanced mineral oils and synthetics (Group III fluids), also known as synthetic-based fluids (SBFs). SBF base fluids include linear-α-olefins, poly-α-olefins, internal olefins, linear alkyl benzenes, ethers, esters, or acetals (Neff et al., 2000). According to OGP (2007), 90% of the NABF cuttings discharged in 2006 contained SBFs.

It is expected that both WBFs and SBFs would be used during drilling in the licence area. SBFs are typically used for drilling, directional drilling, and in deep waters where hole stability and integrity are critical. No diesel oil-based fluids would be used.

During the initial stage of drilling, a large diameter surface hole is "jetted" a few hundred metres into the sea floor. At this stage, the cuttings and seawater used as drilling fluid are discharged onto the sea floor. A continuous steel pipe known as a surface casing is lowered into the hole and cemented in place. A blowout preventer (BOP) is installed on the top of the surface casing to prevent water or hydrocarbons from escaping into the environment. Once the BOP is fully pressure tested, the next section of the well is drilled.

The marine riser is a pipe with special fittings that establishes a seal between the top of the wellbore and the drilling rig. After it is set, all drilling fluid and cuttings are returned to the drilling rig and passed through a solids control system designed to remove cuttings and silt so that the drilling fluids may be recirculated downhole. The drill cuttings, typically sand or gravel-sized with any residual drilling mud attached, are then discharged via the shale chute. Drilling fluid properties eventually become degraded, and the used fluids are periodically discharged in bulk (WBFs) or returned to the supplier for recycling (SBFs).

During well intervals when WBF systems are used, cuttings and adsorbed WBF solids are discharged to the ocean at a rate of 0.2 to 2.0 m^3/hr (Neff, 1987, 2005). When SBF systems are used, the percentage of SBF retention on cuttings is typically subject to regulatory limits (Neff et al., 2000). Under the Barcelona Convention offshore protocol, the SBF retention limit is 10% by weight.

5.3.2 Impact Factors

Based on a preliminary evaluation, exploratory drilling was identified as an activity with the potential for significant environmental effects, which are analyzed in detail in this section. Eight impact factors were identified: (1) drilling rig installation and removal; (2) drilling rig presence; (3) drilling discharges; (4) other effluent discharges; (5) marine debris; (6) air pollutant emissions; (7) well testing; and (8) support activities. **Table 5.4** summarises the environmental resources potentially affected by each impact factor.

Table 5.4. Impact factors and potentially affected resources for exploratory drilling. Potentially significant impacts (X) are highlighted in yellow.

Resource	Drilling Rig Installation/ Removal	Drilling Rig Presence	Drilling Discharges	Other Effluent Discharges	Marine Debris	Air Pollutant Emissions	Well Testing	Support Activities
Air quality	---	---	---	---	---	o	o	---
Water quality	---	---	o	o	o	---	X	---
Sediments/geology	o	---	o	---	o	---	---	---
Plankton	---	o	o	---	---	---	---	---
Fishes	---	X	o	---	---	---	---	---
Deepwater corals	X	---	X	---	o	---	---	---
Chemosynthetic communities	X	---	X	---	o	---	---	---
Soft bottom benthos	o	---	o	---	o	---	---	---
Marine mammals	---	o	---	---	o	---	---	o
Sea turtles	---	o	---	---	o	---	---	o
Marine and coastal birds	---	o	---	---	o	---	---	X
Coastal habitats	---	---	---	---	---	---	---	---
Protected areas	---	---	---	---	---	---	---	---
Fishing activities	---	---	---	---	---	---	---	o
Shipping activities	---	---	---	---	---	---	---	o
Telecommunications cables	o	---	o	---	---	---	---	---
Shipwrecks	X	---	o	---	---	---	---	---
Recreation and tourism	---	---	---	---	---	---	---	---
Coastal communities	---	---	---	---	---	---	---	---

X = potentially significant impact with mitigation recommended; o = minor or negligible impact, no additional mitigation recommended; -- = no impact.

5.3.3 Effects of Drilling Rig Installation and Removal

Depending on the type of drilling rig used, sea floor sediments could be disturbed during installation and removal of drilling rigs. Conventionally moored semi-submersibles typically are held on location by radially deployed anchors, and the setting and dragging of anchors and chains disturbs sea floor sediments (**Figure 5.6**). The length or "scope" of each mooring line may be five to seven times the water depth. According to MMS (2007b), the disturbed sea-bottom footprint for a conventionally-moored semi-submersible varies depending on the mooring configuration but is generally 2 to 3 ha. This represents 0.001% or less of the area of a licence block.

After a drilling rig is removed, anchor scars will likely remain on the bottom for months to years (EG&G Environmental Consultants, 1982; Shinn et al., 1990, 1993; Dustan et al., 1991). In a recent study of drillsites in the Gulf of Mexico at depths of about 1000 m, Continental Shelf Associates, Inc. (2006) detected anchor scars up to 14 years after drilling was completed. Individual anchor scars ranged from less than 100 m to over 3 km in length. The anchor scars will eventually disappear as sediments are redistributed by currents and benthic organisms.

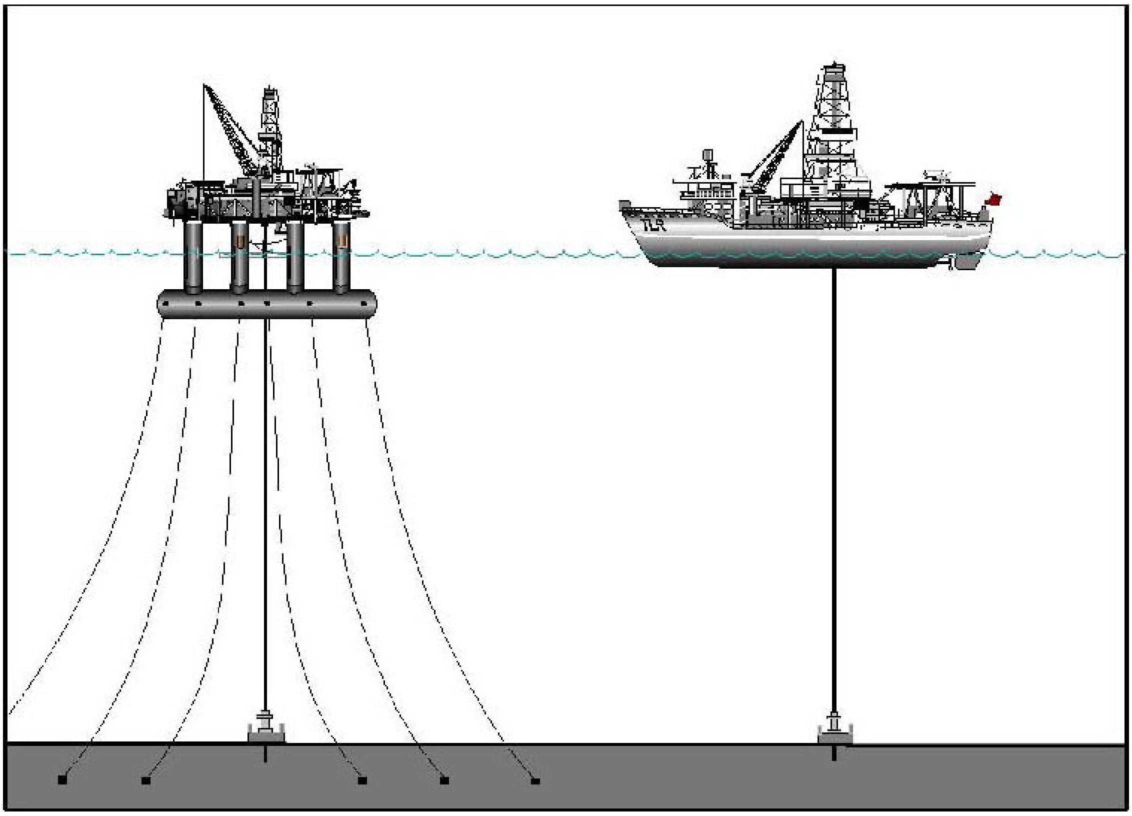


Figure 5.6. Diagram of sea floor disturbance by a conventionally moored semi-submersible (left) and a dynamically positioned drillship (right) (From: Regg et al., 2000).

Most of the sea floor in the licence area is expected to consist of soft-bottom benthic habitat. Deepwater benthic communities of the Mediterranean Sea are characterised as impoverished, with low density and low diversity (see **Section 4.2.2**). The main concern with regard to potential impacts is the placement of anchors in areas such as deepwater coral communities (e.g., on the Eratosthenes Seamount) or chemosynthetic communities. These areas are associated with elevated densities of epifauna and fishes, and are considered relatively rare and ecologically important. Mitigation is recommended so as to avoid impacts.

There are several submarine telecommunications cables passing through the licence area (see **Section 4.3.3**). These features are susceptible to physical damage from sea floor-disturbing activities such as anchoring and placement of structures on the sea floor. However, because the locations of these cables are known, licensees routinely map and avoid them during detailed project planning, and it is assumed that impacts would be avoided.

The licence area is in a region where historical shipwrecks are likely to be present (see **Section 4.3.4**). These features are susceptible to physical damage from sea floor-disturbing activities such as anchoring and placement of drilling rigs on the sea floor. Mitigation is recommended so as to avoid impacts.

→ **Conclusion**: Where conventionally moored semi-submersibles are used, approximately 2 to 3 ha of sea floor sediments and benthic communities will be physically disturbed by anchors and cables. The impacts are likely to persist for several years. Where dynamically positioned semi-submersibles or drillships are used, there will be no anchoring impacts. Impacts of anchoring in soft bottom areas are considered negligible due to low density and low diversity of the deepwater benthic communities. However, placement of anchors on deepwater coral communities or chemosynthetic communities would represent a significant impact and should be avoided. Potential damage to shipwrecks or other submerged archaeological resources could be significant and should be avoided.

→ **Existing Control Measures**: No existing control measures were identified.

→ **Recommended Mitigation**: Before conducting any sea floor disturbing activities within the Eratosthenes Seamount area (defined in **Section 6.0**), licensees should be required to use high-resolution seismic survey (i.e., geohazards) data, three-dimensional (3D) seismic survey data, and any other pertinent information available to identify hard bottom areas that could support deepwater coral communities. If any such areas are identified, licensees should be required to maintain a separation distance of at least 100 m from the location of all proposed sea floor disturbances (including those caused by anchors, anchor chains, and wire ropes).

→ **Recommended Mitigation**: Before conducting any sea floor disturbing activities in the licence area, licensees should be required to evaluate the potential for high-density chemosynthetic communities around each proposed wellsite and, if any such features are identified, maintain a separation distance of at least 100 m from the proposed sea floor disturbances (including those caused by anchors, anchor chains, and wire ropes) within the activity footprint.

→ **Recommended Mitigation:** Before conducting any sea floor disturbing activities in the licence area, licensees should be required to (1) conduct a remote sensing survey of the sea floor to evaluate the potential for shipwrecks and other submerged archaeological resources and (2) submit an archaeological assessment report by a qualified marine archaeologist to include any identified archaeological resources and recommendations for avoidance or further investigation (see **Section 6.0** for details).

5.3.4 Effects of Drilling Rig Presence (including Noise and Lights)

Exploratory drilling rigs typically are on site for approximately 70 to 90 days. During this time, the physical presence of the rig, as well as noise and lights from drilling activities, may affect marine biota including plankton, fishes, marine mammals, sea turtles, and birds. For a single, temporary structure such as a drilling rig, the effects are negligible. The potential impact for permanent structures (e.g., production platforms) is discussed further under Exploitation (see **Section 5.4.5**).

The most obvious effect of drilling rig presence during exploratory drilling would be the attraction of fishes (Gallaway and Lewbel, 1982). Offshore structures typically attract epipelagic fishes such as tunas, dolphin, billfishes, and jacks (e.g., Holland et al., 1990; Higashi, 1994). This "artificial reef effect" is generally considered a beneficial impact.

For most of the licence area, drilling rigs probably would not be visible from shore. Drilling rigs and platforms typically are visible from shore at distances of 5 to 16 km, with small structures (e.g., a single drilling rig) barely visible at 5 km from shore. On a clear night, lights on top of offshore structures could be visible to a distance of approximately 32 km (MMS, 2007b). Minimum distances to shore from individual licence blocks range from 11.4 to 178 km.

→ **Conclusion**: The physical presence of the rig will attract pelagic fishes. Birds may use offshore rigs as stopping places. Noise and lights may cause minor behavioural changes in marine mammals and sea turtles (e.g., attraction or avoidance). Due to the brief duration of exploratory drilling and the small number of drilling rigs that would be present at any time, the impacts are considered negligible. Most drilling rigs are not likely to be visible from shore.

→ **Existing Control Measures**: No existing control measures were identified.

→ **Recommended Mitigation**: No additional measures are recommended.

5.3.5 Effects of Drilling Discharges

The fate and effects of drilling discharges have been reviewed extensively (National Research Council, 1983; Neff, 1987; Hinwood et al., 1994; Neff et al., 2000; OGP, 2003; Neff, 2005). To understand the fate of drilling discharges in the licence area, it is helpful to recognise three types of discharges:

- Sea floor releases of cuttings, seawater, and excess cement slurry during initial jetting of wells. Most of this material settles within tens of metres around the wellsite, producing the thickest accumulations (several centimetres to tens of centimetres);

- Discharges of WBFs and cuttings from the drilling rig. These occur after the marine riser is set, allowing drilling fluids and cuttings to be returned to the drilling rig. The discharged cuttings tend to sink rapidly within a few hundred metres, whereas the drilling fluids may disperse over several kilometres, producing a thin or even undetectable layer (Boothe and Presley, 1989);

- Discharges of SBF cuttings from the drilling rig. When SBF systems are used, the SBF itself is recycled, but cuttings are discharged along with small amounts of adhering drilling fluids. The SBF cuttings tend to clump together and sink rapidly near the wellsite, generally within a few hundred metres (Neff et al., 2000; OGP, 2003) (**Figure 5.7**).

Effects on Water Quality, Plankton, and Fishes

Drilling fluid and cuttings discharges will produce a visible plume that will move with the currents as these materials are diluted and settle to the sea floor. In general, turbid water may extend between a few hundred metres and several kilometres down-current from the discharge point and persist for several hours after each bulk discharge. Studies have demonstrated reductions in water clarity within a few hundred metres to about 2 km of drilling rigs during drilling fluid discharges (Ayers et al., 1980a,b; Ray and Meek, 1980). Dispersion to background levels typically requires several minutes to several hours (Neff, 1987).

During well intervals when SBFs are used, only the cuttings will be discharged, along with a low percentage of adhering drilling fluids. Drilling fluids associated with SBF cuttings typically adhere tightly to cuttings particles and probably would not produce much turbidity as the cuttings sink through the water column (Neff et al., 2000).

Discharges of drilling fluids and cuttings are likely to have little or no impact on plankton or fish due to the low toxicity and rapid dispersion of these discharges (National Research Council, 1983; Neff, 1987; Hinwood et al., 1994). Water-based drilling fluids typically have low toxicity. Therefore, there is little chance of toxic effects on fishes or other water column organisms.

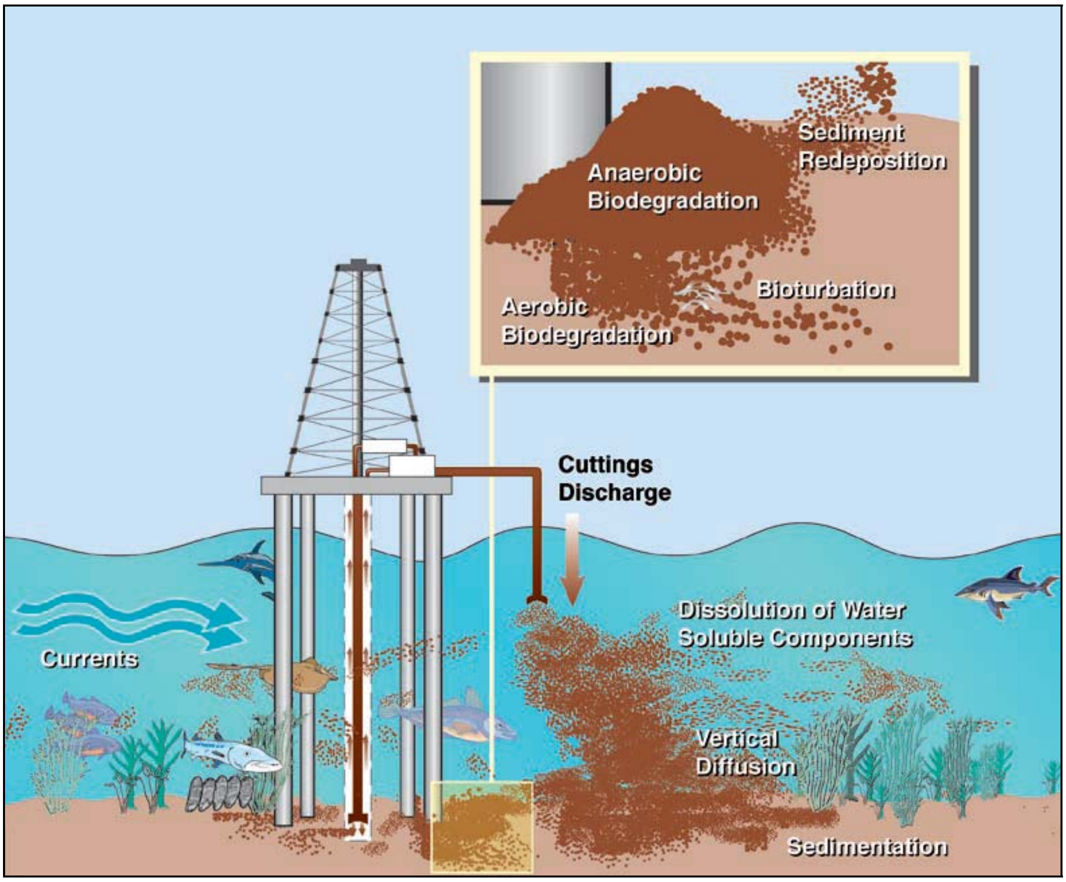


Figure 5.7. Fate of cuttings discharges (From: OGP, 2003).

Effects on Sediments/Geology and Benthic Communities

Drilling fluids and cuttings will accumulate on the sea floor, resulting in changes in bottom contours, grain size, barium concentrations, and perhaps concentrations of other metals (National Research Council, 1983; Boothe and Presley, 1989; Hinwood et al., 1994). These changes occur primarily within a few hundred metres around each wellsite and may persist for several years (Continental Shelf Associates, Inc., 2006).

Benthic community effects of drilling discharges have been reviewed extensively by the National Research Council (1983), Neff (1987), and Hinwood et al. (1994). Due to the low toxicity of most drilling fluids, the main mechanism of impact to benthic communities is increased sedimentation, possibly resulting in burial or smothering. Monitoring programmes have shown that benthic impacts of drilling are minor and localised within a few hundred metres of the wellsite (EG&G Environmental Consultants, 1982; National Research Council, 1983; Neff, 1987; Continental Shelf Associates, Inc., 2006). The water depth is expected to facilitate the dispersion of drilling fluids and cuttings discharged from drilling rigs and should minimise benthic impacts. The thickest accumulations may result from release of cuttings and water-based "spud mud" during the initial well interval before the marine riser is set. These materials will bury and smother benthic organisms around the wellbore.

A study of cuttings impacts was recently completed in the Gulf of Mexico (Continental Shelf Associates, Inc., 2006). The study focused on drillsites in water depths of about 1000 m. Geophysical and chemical measurements indicated that a layer of cuttings and drilling fluids several centimetres thick was deposited around each wellsite. The effects were most evident within 500 m of wellsites, but in some cases traceable amounts were detected as far away as 2 to 3 km. At one exploratory drillsite, the area of geophysically mappable cuttings was 13 ha.

<u>Sea Floor Releases</u>. During the first well interval when the hole is being jetted into the sea floor, cuttings and "spud mud" will be released at the sea floor. These initial discharges will create a mound with a diameter of several metres to tens of metres. Also, during setting of the casing, cement slurry will be pumped into the well to bond the casing to the walls of the hole. Excess cement slurry will emerge from the hole and accumulate on the sea floor, generally within about 10 to 15 m around the wellbore (Shinn et al., 1990). Cement slurry components typically include cement mix and some of the same chemicals used in water-based drilling fluids (Boehm et al., 2001).

The main impacts resulting from the release of these materials will be burial and smothering of benthic organisms within several metres to tens of metres around the wellbore. Soft bottom sediments disturbed by cuttings, drilling muds, and cement slurry will eventually be recolonised through larval settlement and migration from adjacent areas. Recovery may require several years.

<u>Rig Discharges – WBFs and WBF Cuttings</u>. After the initial well interval, the marine riser is set, allowing muds and cuttings to be returned to the drilling rig where they will be processed through solids control equipment. Cuttings will be separated and discharged overboard, whereas muds will be recirculated into the hole until their properties become degraded and they must also be discharged.

Cuttings and WBFs will be released almost continuously from drilling rigs during drilling. Cuttings typically are coarse particles that settle rapidly to the sea floor near the discharge point, primarily with a few hundred metres. A layer of fine particles (primarily drilling muds) will be dispersed and deposited over a much broader area (Boothe and Presley, 1989). Due to the strong currents in the area, it is likely that muds will be widely dispersed and only the coarse cuttings will settle near the drillsites.

Barite (barium sulfate) is a major insoluble component of drilling fluid discharges, and therefore barium concentrations will increase in bottom sediments around the wellsites. Concentrations of other metals in drilling fluids are similar to those in marine sediments, but some metals such as cadmium, copper, lead, mercury, and zinc may be elevated within a few hundred metres of the wellsite (Boothe and Presley, 1989). However, metals in drilling fluids show very low bioavailability to marine animals and do not pose a risk to benthic organisms or their predators (Neff et al., 1989a,b).

Benthic communities within a few hundred metres of each drillsite may be buried or smothered (EG&G Environmental Consultants, 1982; National Research Council, 1983; Neff, 1987; Continental Shelf Associates, Inc., 2006). Soft bottom areas buried by cuttings and drilling fluids will eventually be recolonised through larval settlement and migration from adjacent areas. Recovery may require several years.

Rig Discharges – SBF Cuttings. During intervals when SBF are used, only the cuttings will be discharged, along with small percentages of adhering SBF. The behaviour of SBF cuttings differs somewhat from that of WBF cuttings (Neff et al., 2000; OGP, 2003). In shallow water, cuttings with adhering SBFs tend to clump together and form piles close to the drilling rig. However, the water depth in the project area is a natural mitigating factor that is expected to reduce the chance for thick cuttings piles to accumulate. Use of fluid recovery technology such as a cuttings dryer can reduce the chance of producing discernable SBF cuttings piles around wellsites (Getliff et al., 1997; Hanni et al., 1998).

Where SBF cuttings accumulate in concentrations of about 1000 mg/kg or higher, benthic infaunal communities may be adversely affected (Neff et al., 2000). Continental Shelf Associates, Inc. (2006) reported on a recent study of SBF cuttings impacts around wellsites in the Gulf of Mexico. Areas of SBF cuttings deposition were associated with elevated organic carbon concentrations and anoxic conditions. Areas within about 500 m of drillsites had patchy zones of disturbed benthic communities, including microbial mats, areas lacking visible benthic macroinfauna, zones dominated by pioneering stage assemblages, and areas where surface-dwelling species were selectively lost. Infaunal and meiofaunal densities generally were higher near drilling, although some faunal groups were less abundant near drillsites. Some stations near drilling had lower diversity, lower evenness, and lower richness indices compared with stations away from drilling. Some stations affected by drilling were dominated by high abundances of one or a few deposit-feeding species, including known pollution indicators.

Most of the sea floor in the licence area is expected to consist of soft-bottom benthic habitat. Deepwater benthic communities of the Mediterranean Sea are characterised as impoverished, with low density and low diversity (see **Section 4.2.2**). The main concern with regard to potential impacts is the accumulation of SBF cuttings around wellsites in areas such as deepwater coral communities (e.g., on the Eratosthenes Seamount) or chemosynthetic communities. These areas are associated with elevated densities of epifauna and fishes and are considered relatively rare and ecologically important. Mitigation is recommended so as to avoid impacts.

Several telecommunications cables pass through the licence area, and historical shipwrecks are likely to be present (see **Sections 4.3.3** and **4.3.4**). Drilling discharges are not likely to adversely affect these features, and it is expected that they would be avoided during site selection. Therefore, no significant impacts are anticipated.

→ **Conclusion**: Drilling fluids and cuttings will accumulate on the sea floor, resulting in changes in bottom contours, grain size, barium concentrations, and perhaps concentrations of other metals. These changes occur primarily within about 500 m around each wellsite and may persist for several years. Impacts of these accumulations in soft bottom areas are considered minor or negligible due to low density and low diversity of the associated deepwater benthic communities. However, discharges in areas of deepwater coral communities and chemosynthetic communities could represent a significant impact and should be avoided.

→ **Existing Control Measures**: No existing control measures were identified.

→ **Recommended Mitigation**: Before conducting drilling activities within the Eratosthenes Seamount area (defined in **Section 6.0**), licensees should be required to use high-resolution seismic survey (i.e., geohazards) data, three-dimensional (3D) seismic survey data, and any other pertinent information available to identify hard bottom areas that could support deepwater coral communities. If any such areas are identified, licensees should be required to maintain a separation distance of at least 500 m from any proposed drilling fluid and cuttings discharge location.

→ **Recommended Mitigation**: Before conducting drilling activities in the licence area, licensees should be required to evaluate the potential for high-density chemosynthetic communities around each proposed wellsite and, if any such features are identified, maintain a separation distance of at least 500 m from the location of any proposed drilling fluid and cuttings discharge.

5.3.6 Effects of Other Effluent Discharges

Other routine discharges during exploratory drilling typically include treated sewage and domestic wastes (including food waste), deck drainage, and miscellaneous discharges. These are subject to MARPOL regulations.

Sewage, or sanitary waste, consists of human body wastes from toilets and urinals. Sanitary waste will be treated using a marine sanitation device that produces an effluent with a minimum residual chlorine concentration of 1.0 mg/L and no visible floating solids or oil and grease. Wastewater treatment sludge will be transported to shore for disposal at an approved facility. Domestic waste, or “gray water,” includes water from showers, sinks, laundries, and galleys, safety showers, and eye-wash stations. Gray water does not require treatment before discharge. Service vessels will be equipped with an approved marine sanitation device. Food waste, a type of domestic waste, will be ground prior to discharge, in accordance with MARPOL requirements.

Sanitary and domestic waste from drilling rigs and support vessels may affect concentrations of suspended solids, nutrients, and chlorine, as well as generating BOD. It is assumed that one person generates 100 L/d of sanitary waste and 220 L/d of domestic waste. It is predicted that sanitary wastes have an associated BOD of 240 mg/L. Assuming a typical crew complement of 130 persons, a drilling rig may be expected to generate about 13 000 L of sanitary wastewater (resulting in 3.1 kg of BOD and 28 600 L of domestic wastewater on a daily basis). These discharges are expected to be diluted rapidly in the open ocean (U.S. Environmental Protection Agency [USEPA], 1993; MMS, 2007b). Impacts would likely be undetectable beyond tens of metres from the source.

Deck drainage consists of all waste resulting from rainfall, rig washing, deck washings, tank cleaning operations, and runoff from curbs and gutters, including drip pans and work areas. Drilling rigs are designed to contain runoff and prevent oily drainage from being discharged. The flow is diverted to separation systems depending on the area from which it is collected. There will be no discharge of free oil in deck drainage that would cause a film, sheen, or discoloration of the surface of the water, or a sludge or emulsion to be deposited beneath the surface of the water. Only non-oily water (<15 ppm) will be discharged overboard. If the deck becomes contaminated, oily deck drainage will be contained by absorbents or collected by a pollution pan under the rig floor for recycling and/or disposal. Because of the separation and treatment of water from oily areas prior to discharge, deck drainage is not expected to produce a visible sheen or any other detectable impacts on water quality.

The volume of deck drainage obviously varies with the amount of rainfall. Assuming a typical surface area of about 10 000 m^2 for a drillship and a maximum monthly rainfall of about 100 mm, the monthly average deck drainage would be 1000 m^3. Rig washes may account for approximately another 200 L per month.

Additional miscellaneous discharges typically occur from numerous sources on a drilling rig. Examples include uncontaminated freshwater and seawater used for cooling water and ballast, desalination unit discharges, BOP fluids, and boiler blowdown discharges (USEPA, 1993). These discharges must meet MARPOL requirements and are expected to be diluted rapidly in the open ocean. Impacts on water quality would likely be undetectable beyond tens of metres from the source.

→ **Conclusions** – Discharges of effluents such as treated sewage, domestic wastes, deck drainage, and miscellaneous wastes may affect water quality near drilling rigs. The effluents will be similar to those from other vessels in the region, and effects on offshore water quality are expected to be negligible.

→ **Existing Control Measures** – Drilling rigs and support vessels must comply with MARPOL requirements including provisions concerning sewage, food waste, oily waste, and garbage.

→ **Recommended Mitigation** – No additional mitigation is recommended.

5.3.7 Effects of Marine Debris

Offshore oil and gas operations generate trash including paper, plastic, wood, glass, and metal. Most is associated with galley and food service operations and with operational supplies such as shipping pallets, containers used for drilling fluids and chemical additives (sacks, drums, and buckets), and protective coverings used on mud sacks and drilling pipes (MMS, 2007b). Some personal items, such as hardhats and personal flotation devices, are accidentally lost overboard from time to time. Generally, galley, operational, and household trash is collected and stored on the lower deck near the loading dock in large receptacles covered with netting. Drilling operations require the most supplies, equipment, and personnel, and therefore generate more solid trash than production operations.

It is expected that all solid waste generated during exploratory drilling in the licence area would be transported to shore by service vessels for disposal at approved landfill facilities. Based on historical data for a typical drillship, monthly solid waste is expected to be about 40 000 kg.

Disposal of trash and debris in the ocean is prohibited under MARPOL, and drilling rigs operate under a Garbage Management Plan to ensure adherence to MARPOL. In addition, most petroleum companies have waste management programmes that apply the principles of source reduction, reuse, and recycling to reduce the amount of waste generated.

Pieces of debris that fall overboard, such as welding rods, buckets, and pieces of pipe, are eventually colonised by epibiota. They also attract fishes due to their physical structure on the otherwise flat sea floor, resulting in a minor, local impact on the benthic community (Shinn et al., 1993). The impact is limited to a few metres to tens of metres of the wellbore.

Marine debris can harm marine mammals, turtles, and birds. Marine mammals can become entangled in and ingest trash and debris, including materials lost overboard during offshore oil and gas operations (Laist, 1996). Marine debris is among the threats affecting the population status of both humpback whales and sperm whales (National Marine Fisheries Service, 1991, 2006). Similarly, ingestion of, or entanglement with, accidentally discarded debris can kill or injure sea turtles (Laist, 1996; Lutcavage et al., 1997) and is among the threats affecting the endangered population status of several sea turtle species (National Research Council, 1990). Leatherback turtles are especially attracted to floating debris, particularly plastic bags, because it resembles their preferred food, jellyfish. Ingestion of plastic and styrofoam can result in drowning, lacerations, digestive disorders or blockage, and reduced mobility. Finally, marine debris can also injure or kill birds that ingest or become entangled in it.

→ **Conclusions** – Marine debris accidentally lost overboard from offshore drilling rigs and service vessels has the potential to adversely affect marine mammals, turtles, and birds through entanglement and ingestion. In addition, metal debris such as welding rods and buckets can clutter the sea floor around drillsites.

→ **Existing Control Measures** – Drilling rigs and support vessels must comply with MARPOL requirements including the prohibition of disposing trash into the sea. The discharge requirements for the Mediterranean Sea as a "special area" under Annex V will take effect on 1 May 2009. After that date, disposal into the Mediterranean Sea of the following will be strictly prohibited: all plastics, including but not limited to synthetic ropes, synthetic fishing nets, plastic garbage bags, and all other garbage including paper products, rags, glass metal, bottles, crockery, dunnage, lining and packing materials.

→ **Existing Control Measures** – Under the Hydrocarbons Regulations of 2007, licensees are required to (a) remove all equipment and installations, structures, plants, appliances, and pipelines from the relinquished area or former licensed area in a manner agreed with the Minister pursuant to an abandonment plan provided by the Contract; and (b) perform all necessary site restoration activities in accordance with good international petroleum industry practice, and take all other action necessary to prevent hazards to human life or to the property of others or the environment.

→ **Recommended Mitigation** – No additional mitigation is recommended.

5.3.8 Effects of Air Pollutant Emissions

Drilling rigs typically are powered by diesel engines that emit air pollutants including CO, NO_x, SO_x, PM, VOCs, and greenhouse gases such as CO_2 and CH_4. Support vessels and helicopters will also emit air pollutants from combustion of diesel fuel (vessels) and aviation fuel (helicopters). **Table 5.5** lists estimated emissions for a typical exploratory well.

Table 5.5. Estimated air pollutant emissions for an exploratory well (From: MMS, 2007b).

Source	Emissions (Metric Tonnes/Well)				
	Carbon Monoxide	Nitrogen Oxides	Particulate Matter	Sulphur Oxides	Volatile Organic Compounds
Drilling of an exploratory well	3.9	36.7	0.9	6.2	0.4

Some of these gases are known to degrade to form different compounds, and these degradation products and transformation processes are important in the context of problems such as global warming and acidification. Environmental issues associated with air pollutant emissions include the following:

- CO – contributes indirectly to global warming by enhancing low level ozone production. Poisonous at high concentrations and can potentially enhance photochemical smog formation.

- NO_x – can form ozone at ground level by reacting with VOCs in the presence of sunlight. Ground level (tropospheric) ozone at elevated concentrations is harmful to people, animals, and plants.

- SO_x – contributes to acid deposition (wet and dry), which affects both freshwater and terrestrial ecosystems. Respiratory illness is a potential direct health effect.

- VOCs – contribute to the generation of tropospheric ozone in the presence of NO_x and sunlight, and are associated with the generation of photochemical smog. Direct health effects are eye irritation and coughing; some are carcinogens.

In addition, CO_2 and CH_4 are both greenhouse gases that contribute to global warming.

Air pollutant emissions from drilling rigs are expected to be rapidly diluted and dispersed in the offshore atmosphere. There may be some decrease in air quality within several hundred metres around drilling rigs during drilling. However, no detectable impacts on air quality in Cyprus are expected based on the relatively small quantities of pollutants emitted and the distance from shore.

No air pollutant modelling was done for this Environmental Report. However, a preliminary evaluation of the significance of air pollutant emissions was made by applying a method used in the U.S. Gulf of Mexico (MMS, 2008). In this method, estimated emissions are compared to annual "exemption levels" based on the distance from shore. For the licence area, the nearest portions of Block 1 are 11.4 km from land. The corresponding exemption levels would be 211 metric tonnes for NO_x, PM, SO_x, and VOC, and 11 287 metric tonnes for CO. The emissions for a typical exploratory drilling program (**Table 5.5**) are well below these thresholds, indicating that emissions are not likely to have any significant effects onshore.

→ **Conclusions** – Air pollutant emissions from drilling rigs are expected to have negligible impacts on air quality. Due to the distance offshore, no impacts on coastal or onshore air quality are expected.

→ **Existing Control Measures** – Drilling rigs and support vessels must comply with MARPOL Annex VI, which sets limits on sulphur oxide and nitrogen oxide emissions from ship exhausts and prohibits deliberate emissions of ozone-depleting substances including halons and chlorofluorocarbons. MARPOL also sets limits on emissions of nitrogen oxides from diesel engines and prohibits the incineration of certain products on board such as contaminated packaging materials and polychlorinated biphenyls. Also, under the Hydrocarbons Regulations of 2007, licensees are required to ensure that all machinery, equipment, and installations used by the licensee and subcontractors comply with generally accepted standards in the international petroleum industry and are of proper construction and kept in good working order.

→ **Recommended Mitigation** – No additional mitigation is recommended.

5.3.9 Effects of Well Testing

If a hydrocarbon formation is discovered during exploratory drilling, well testing may be conducted. A well test is a procedure to determine the productive capacity, pressure, permeability, and/or extent of a hydrocarbon reservoir.

A conventional production test (drillstem test) is usually conducted with a tool that allows the well to be opened and closed at the bottom of the hole with a surface-actuated valve. One or more pressure gauges are customarily mounted into the tool and are read and interpreted after the test is completed. The most common test sequence consists of a short flow period, perhaps 5 to 10 minutes, followed by a buildup period of about an hour that is used to determine initial reservoir pressure. This is followed by a flow period of 4 to 24 hours to establish stable flow to the surface, if possible, and then by the final shut-in or buildup test that is used to determine permeability thickness and flow potential (Schlumberger, 2008a).

If hydrocarbons are brought to the surface during the well test, they are disposed of by burning. The oil, water, and chemicals are pumped to a burner on a flare boom where the fluids are atomised in a chamber using compressed air and the mixture ignited. This combustion will result in emissions to the atmosphere. Gas from well testing is either flared or vented directly to the atmosphere.

Table 5.6 lists examples of emissions that could result from burning 5000 bbl of oil and 25 mmscf of gas. Emissions were estimated using emission factors in a spreadsheet used to calculate emissions for Exploration Plans (MMS, 2008).

Table 5.6. Estimated air pollutant emissions from a hypothetical well test.

Source	Pollutant Emitted (metric tonnes)				
	Carbon Monoxide	Nitrogen Oxides	Particulate Matter	Sulphur Oxides	Volatile Organic Compounds
Oil (5000 bbl)	0.48	4.53	0.95	15.49	0.03
Gas (25 mmscf)	4.41	0.81	---	0.01	0.68
Total	4.89	5.34	0.95	15.50	0.71

In addition to the atmospheric emissions shown in the table, burning of crude oil can result in some incomplete combustion and the fallout of unburned oil droplets to the sea surface. Production of a visible sheen on the sea surface would be a violation of water quality standards and should be avoided. High efficiency burners have been developed that minimise incomplete combustion and reduce the potential for hydrocarbon fallout (e.g., Schlumberger, 2008b).

→ **Conclusions** – Air pollutant emissions from well testing will have a localised effect on air quality near the wellsite during the test period. Due to the distance offshore, no impacts on coastal or onshore air quality are expected. Fallout of oil droplets from well testing can produce a sheen on the sea surface.

→ **Existing Control Measures** – Under the Hydrocarbons Regulations of 2007, licensees are required to ensure that all machinery, equipment, and installations used by the licensee and subcontractors comply with generally accepted standards in the international petroleum industry and are of proper construction and kept in good working order.

→ **Recommended Mitigation** – During well testing, licensees should be required to (1) use a high-efficiency burner to reduce the amount of hydrocarbon fallout and (2) monitor the sea surface to ensure that no visible sheen is produced.

5.3.10 Effects of Support Activities

During exploratory drilling, offshore service vessels and helicopters will provide support from an onshore base. A location has not been identified at this stage, but likely candidates would include Larnaca or Limassol. These are both well-developed ports with the capacity to provide the needed support services. Due to the limited nature of exploratory activities, it is anticipated that no new facilities would be needed at this stage.

Typical functions/requirements for an onshore base include:

- dock space to serve as a loading/offloading point for equipment and machinery supporting offshore operations;
- dispatching personnel and equipment;
- temporary storage for materials and equipment; and
- 24-hour dispatcher.

A typical project would involve two offshore service vessels making at least one round trip per day between the shorebase and the drilling rig. The most commonly used types of offshore service vessels for exploratory drilling would be crew boats (about 34 m long, used to transfer personnel to and from the drilling rig) and supply boats (about 55 m long, used to transfer equipment and supplies to the rig). Other vessels that may be used include anchor handling tugs and anchor handling tug supply vessels (which help to deploy the anchors for conventionally moored semi-submersibles).

Additional support for offshore oil and gas exploration activities is provided by helicopters. Typically, one helicopter would be used to transport personnel, deliver smaller essential supplies, and for safety and emergency support. The helicopter is assumed to make two round trips per day. Helicopter operations are likely to be supported out of Larnaca International Airport and/or Paphos International Airport.

Support vessels and helicopters would normally follow the most direct route between the wellsite and the onshore base, weather and traffic permitting.

There is a small possibility of an offshore service vessel striking a marine mammal or sea turtle. The risk is similar to that associated with existing vessel traffic in the region. The rare, critically endangered Mediterranean monk seal may be present in nearshore Cyprus waters (Dendrinos and Demetropoulos, 1999) but is unlikely to be found in offshore waters of the licence area due to the depth and distance from shore. Due to the short duration of exploratory drilling projects and the relatively infrequent nature of the support vessel traffic, the likelihood of striking a marine mammal or turtle is considered low.

Vessel and helicopter traffic could periodically disturb individuals or groups of coastal birds. The impact would be similar to that of existing vessel and aircraft traffic. It is likely that individual birds would experience at most a short-term, behavioural disruption, and the impact is considered minor. However, significant impacts could occur if helicopters traveled frequently over Special Protection Areas (SPAs) designated under the Birds Directive, or other Important Bird Areas (IBAs). There are currently seven designated SPAs in Cyprus (European Commission, 2008). In addition, BirdLife International (2008) identifies 25 IBAs on Cyprus. IBA sites in the vicinity of Limassol include Akrotiri cliffs, Akrotiri salt lake including Bishop's Pool, Phasouri reedbeds, Episkopi cliffs, and Cape Aspro. IBA sites in the vicinity of Larnaca include Larnaca salt lakes and Cape Greco.

No significant impacts on fishing or shipping activities are expected. Any inconvenience to local vessel traffic from support operations is expected to be minimised by notifying the relevant Cyprus maritime authorities of the planned drilling location, support base, and frequency of support vessel operations.

→ **Conclusions** – Support operations for exploratory drilling are likely to use existing port facilities in Cyprus and would represent a negligible increase in the existing level of operations at these ports. No new or expanded facilities are expected. Due to the short duration of exploratory drilling projects and the relatively infrequent nature of the support vessel traffic, the likelihood of striking a marine mammal or turtle is considered low. Helicopters crossing coastal habitats may disturb bird colonies; the impacts would be minor in most cases, but potentially significant if the route passed across coastal SPAs or IBAs.

→ **Existing Control Measures** – No existing measures were identified. It is assumed that licensees would be required to notify the relevant Cyprus maritime authorities of the planned development and production facility location, support base, and frequency of support vessel operations.

→ **Recommended Mitigation** – Licensees should be advised that helicopters engaged in support operations should avoid flying over SPAs and IBAs when traveling to or from the drilling rig. A map of SPAs and IBAs should be provided for this purpose.

5.4 EXPLOITATION (DEVELOPMENT AND PRODUCTION)

5.4.1 Description of Activities

Exploitation is the process of developing and producing commercial quantities of hydrocarbons. Key activities include drilling and completing development wells, installing production facilities and pipelines, routine operation of these systems, and eventual decommissioning. To date, no development or production activities have occurred in the licence area.

A variety of development and production systems could be used within the Cyprus offshore licence area. The type of facilities selected by an operator would depend on factors such as water depth, reservoir type, and proximity to existing oil and gas infrastructure and support operations. Examples could include conventional fixed platforms, compliant towers, floating production systems, or subsea systems controlled remotely from platforms in shallow water or on land. Design, fabrication, installation, and startup of an offshore development and production facility typically requires 7 years or more from discovery to initial production (Regg et al., 2000).

Offshore production facilities conduct limited processing of oil and gas for transport. Examples include liquid/gas separation, H_2S removal, and gas compression. Once transported to shore, the oil or gas would require further processing by facilities such as oil refineries, gas processing plants, or petrochemical plants. The need for such onshore processing plants, if any, has not been determined at this stage.

Exploitation activities also typically include seismic operations such as high-resolution site surveys, vertical seismic profile surveys, and vertical cable surveys, all of which have been previously characterised under **Section 5.2** and are not repeated here.

5.4.1.1 Types of Production Facilities

Figure 5.8 shows several development and production facility types. **Table 5.7** summarises the characteristics of development and production systems and their installation.

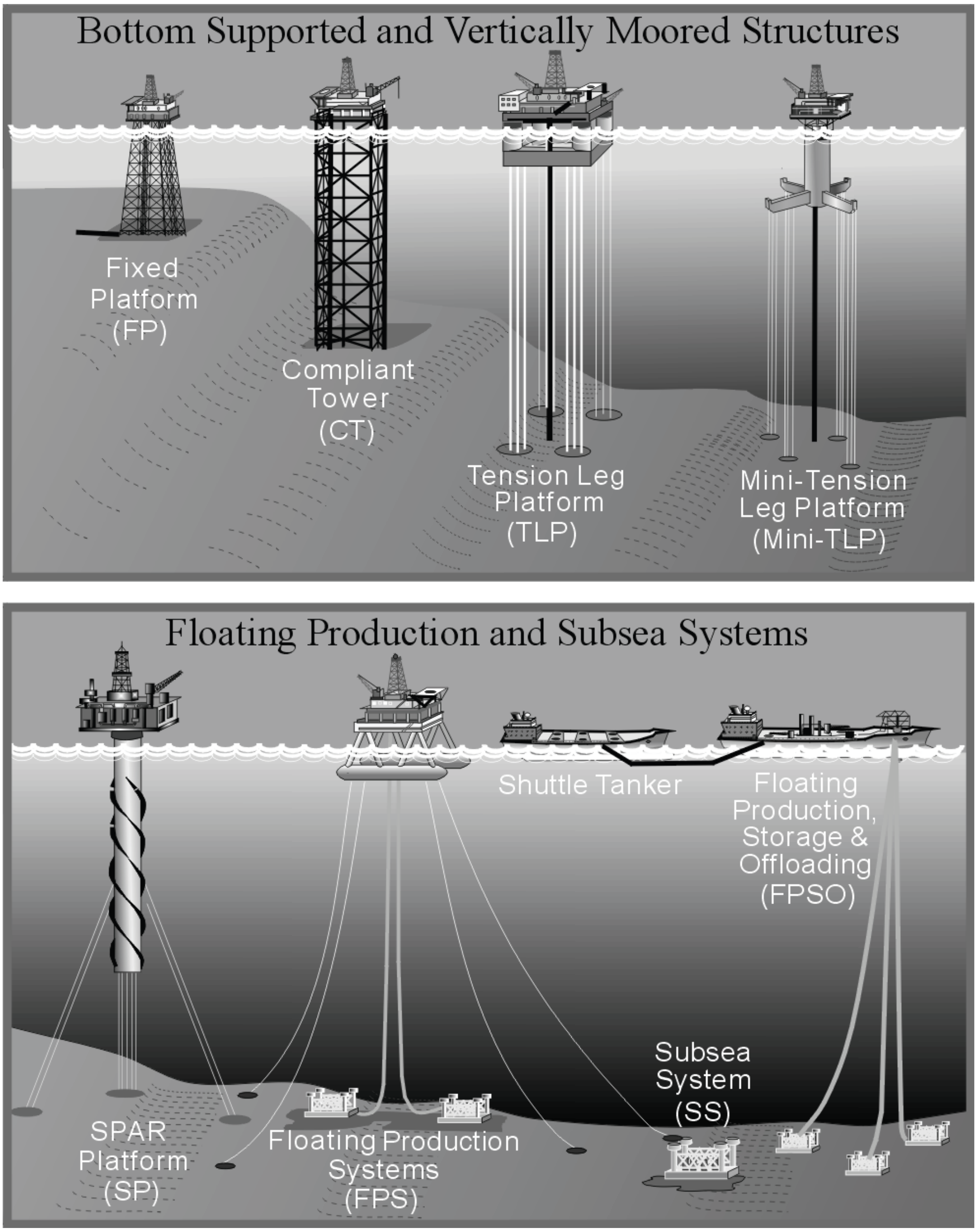


Figure 5.8. Types of deepwater development and production systems (From: Regg et al., 2000).

Table 5.7. Summary of offshore development and production facilities (Adapted from: Global Security, 2008).

Facility and Depth Range	Construction	Sea Floor Anchoring	Overview
Bottom-Founded Systems			
Fixed Platform (water depths less than 600 m)	Welded tubular steel jacket, deck, and surface facility Jacket - a tubular supporting structure for an offshore platform consisting of four, six, or eight 7- to 14-ft diameter tubulars welded together with pipe braces	Piles driven into the sea floor secure the jacket. The jacket is secured to the sea floor by weight and 2-m diameter piles that penetrate several 100 m or more below the mudline Typical base dimensions are 120 m by 150 m. Skirts may also be added to aid the jacket in fixing it to the sea floor. Dimensions can range up to 45 m on a side at the water line	Once the jacket is secured and the deck is installed, additional modules are added for drilling, production, crew operations, and accomodations. Large, barge-mounted cranes position and secure the jacket prior to the installation of the topsides modules. Surface facilities (topsides) are the part of the platform that contains the drilling, production, and crew quarter modules. Topsides dimensions could be 60 m by 60 m per deck level, with four decks, resulting in an overall height of 30 m
Compliant Tower (water depths of 300 to 600 m)	Steel tubular jacket used to support surface facilities Typically, the jacket is composed of four leg tubulars that can range from 1 to 2 m in diameter and are welded together with pipe braces to form a space-frame-like structure	Secured to the sea floor with piles. Mooring is only used in the guyed-tower design. Clump weights may be attached to each mooring line, moving as the tower moves with the wind and wave forces. Base dimensions can range up to 90 m on a side	Similar to fixed platforms, but compliant towers yield to the water and wind movements in a manner similar to floating structures. A compliant tower jacket has smaller dimensions than a fixed platform and may consist of two or more sections; can also have buoyant sections in the upper jacket with mooring lines from jacket to sea floor (i.e., a guyed-tower design) or a combination of the two. The lower jacket is secured to the sea floor and acts as a base for the upper jacket and surface facilities. Large barge-mounted cranes position and secure the jacket and install the surface facility modules
Tension Leg Platform (TLP) Water depths of 300 to 1500 m)	Buoyant platform held in place by a mooring system	Mooring system – a set of tension legs or tendons attached to the platform and connected to a template or foundation on the sea floor. The template is held in place by piles driven into the sea floor	Similar to conventional fixed platforms except that the platform is maintained on location by moorings held in tension by hull buoyancy, which dampens vertical motion of the platform but allows for horizontal movement. Topside facilities and most daily operations are the same as for a conventional platform. Foundation secures the TLP to the sea floor; most foundations are templates laid on the sea floor, then secured by concrete or steel piles driven by use of a hydraulic hammer; other designs include a gravity foundation. As many as 16 concrete piles with dimensions of 30 m in diameter and 120 m long are used (one for each tendon)

Table 5.7. (continued).

Facility and Depth Range	Construction	Sea Floor Anchoring	Overview
Floating Systems			
Spar Water depths up to 3000 m	Deep-draft floating caisson Caisson – a hollow cylindrical structure similar to a very large buoy	A lateral catenary system of 6 to 20 lines keeps the spar on location; mooring lines are a combination of spiral strand wire and chain. Because of its low motion, the spar can use a taut mooring system at a reduced scope and cost compared with a full catenary system. Each mooring line is anchored to the sea floor with a driven or suction pile. Depending on hull size and water depth, the moorings can vary in number up to 20 lines and contain 1100 m of chain and wire. The footprint created by the mooring system can reach a half-mile or more in diameter measured on centre from the hull to the anchor piles	Consists of four major systems – hull, moorings, topsides, and risers. Spars rely on a traditional mooring system (anchor-spread mooring) to maintain position. About 90% of the structure is underwater. The number of wells, wellhead spacing, and facilities weight determine the size of the centre well and the diameter of the hull. Approximate hull diameter for a typical spar is 40 m, with an overall height, once deployed, of approximately 210 m. Spars use three basic types of risers: production, drilling, and export/import. The sea floor pattern (footprint) depends on the number of risers
Semi-submersible production units Water depths from 150 to greater than 3000 m	Platform-shaped; purpose built or modified/retrofitted from an existing semi-submersible mobile offshore drilling units (MODU)	If moored, semi-submersible production units are anchored via 8-, 12-, or 16-point, semi-taut, chain-wire-chain or chain caternary system. Sea floor anchoring via tubular steel suction piles pressed into the sea floor, or via anchors	Semi-submersible production units can be either moored or can remain on site via dynamic positioning (DP). Lengths and widths variable, ranging from 100 to 165 m and 90 to 125 m, respectively. Semi-submersible designs are diverse. The lower hull is made up of three or four pontoons that form a triangular or rectangular ring at the base of the columns. Pontoons are either cylindrical or rectangular. Flowline steel catenary riser porches, located on the hull pontoons, support a variety of flowlines. Various utility risers are distributed around the outside of the hull on the columns
Floating production, storage, and offloading (FPSO) systems Water depths up to and beyond 3000 m	Ship-shaped; purpose built or modified/retrofitted from an existing tanker vessel Floating Storage and Offloading (FSO) units are considered a subset of FPSOs	Either sea floor anchored or dynamically positioned. Sea floor anchoring is via several 15 to 25 m long, large diameter anchor piles, coupled with wire and chain mooring lines, or via multiple drag anchors	FPSO systems are typically ship-shaped; they receive crude oil from deepwater wells and store it in their hull tanks until the crude can be pumped into shuttle tankers or oceangoing barges for transport to shore. FPSO turret structures are designed to anchor the vessel, allow "weather vaning" of the FPSO to accommodate environmental conditions, permit the constant flow of oil and production fluids to the vessel from an undersea field, all while being a structure capable of quick disconnect in the event of emergency. FPSOs may be used as production facilities to develop marginal oil fields or fields in deepwater areas remote from the existing OCS pipeline infrastructure. Alternatively, ship-shaped Floating Storage and Offloading (FSO) systems (vessels with no production processing equipment) can be used to support oil and gas developments. An FSO is typically used as a storage unit for production processed from other platforms that are remote from infrastructure and lack al pipeline to transport oil to the refinery

Offshore production facilities may include bottom-supported and vertically-moored structures, floating production systems, and subsea systems (Offshore, 2007; Global Security, 2008). Bottom-supported and vertically-moored structures include:

- Fixed platforms, which are used in shallow to deep water, with economic water-depth limits of about 610 m. They include both steel jacket platforms and concrete gravity base structures.
- Compliant towers, which are floating platforms that are permanently anchored to the sea floor and feasible in water depths of about 300 to 600 m.
- Tension-leg platforms (TLPs), which are attached to the sea floor with tendons held in tension and are used frequently in water depths of about 300 to 1500 m.

Floating production systems include:

- Spars, which are buoyant structures shaped like a single, large-diameter cylinder, with a functional deck mounted on top. Operational water depths range up to about 3000 m.
- Semi-submersible production units, which are either modified from existing semi-submersible drilling rigs or purpose-built.
- Floating production, storage, and offloading (FPSO) systems, which are ship-shaped vessels with storage and limited treatment facilities. They support both floating and subsea production arrays. FPSOs may be used in water depths ranging up to and beyond 3000 m.

Subsea systems are generally multicomponent sea floor systems that allow for the production of hydrocarbons in water depths that would normally rule out installing conventional fixed or bottom-founded platforms (Regg et al., 2000). Through an array of subsea wells, manifolds, central umbilicals, and flowlines, a subsea system can be located many kilometres away in deeper water and tied back to existing host facilities in shallow water or onshore. Host facilities in deep water would likely be one of several types of floating production systems.

5.4.1.2 Pipelines and Flowlines

Pipelines and flowlines are important components of development and production systems. Generally, pipelines transport hydrocarbons from a producing field to shore, whereas flowlines handle hydrocarbons and other chemicals within a field or between fields and offshore facilities. Flowlines that transport oil and/or gas to subsea manifolds, to a production facility, or between production facilities are considered gathering lines; pipelines that transport produced oil or gas to shore are considered trunklines (Cranswick, 2001).

Pipelines vary in their specifications (i.e., diameter, wall thickness, internal and external pressure thresholds) depending upon factors including the physical and chemical characteristics of the hydrocarbon product, the physical environment (e.g., water depth, slope inclination, potential for span gap), and expected servicing and maintenance requirements, among other factors. Typical pipeline diameters range from 10 to 150 cm and wall thicknesses range from 1 to 4 cm. Pipelines may be configured as a single pipeline, as a pipe-in-pipe arrangement, as flexible pipe, or as a bundle (i.e., multiple pipelines or flowlines bundled and laid together).

Pipelines are thermal- or concrete-coated externally, may be coated internally, and are typically constructed of steel to reduce heat loss and increase stability (Cranswick, 2001; Guo et al., 2005). Deepwater pipelines do not require a concrete weight coating due to the low wave and current conditions, but typically do require a high degree of thermal insulation. Pipelines may also be equipped with cathodic protection to protect the pipeline from external corrosion and leaks. Pipelines may also be outfitted with pressure sensors and remotely operated valves to protect the pipeline from overpressure and to detect abnormal low-pressure conditions (Cranswick, 2001).

Pipelines can be installed by several different methods, including S-lay, J-lay, tow-in lay, and reel barge methods (Cranswick, 2001; Guo et al., 2005) (**Figure 5.9**).

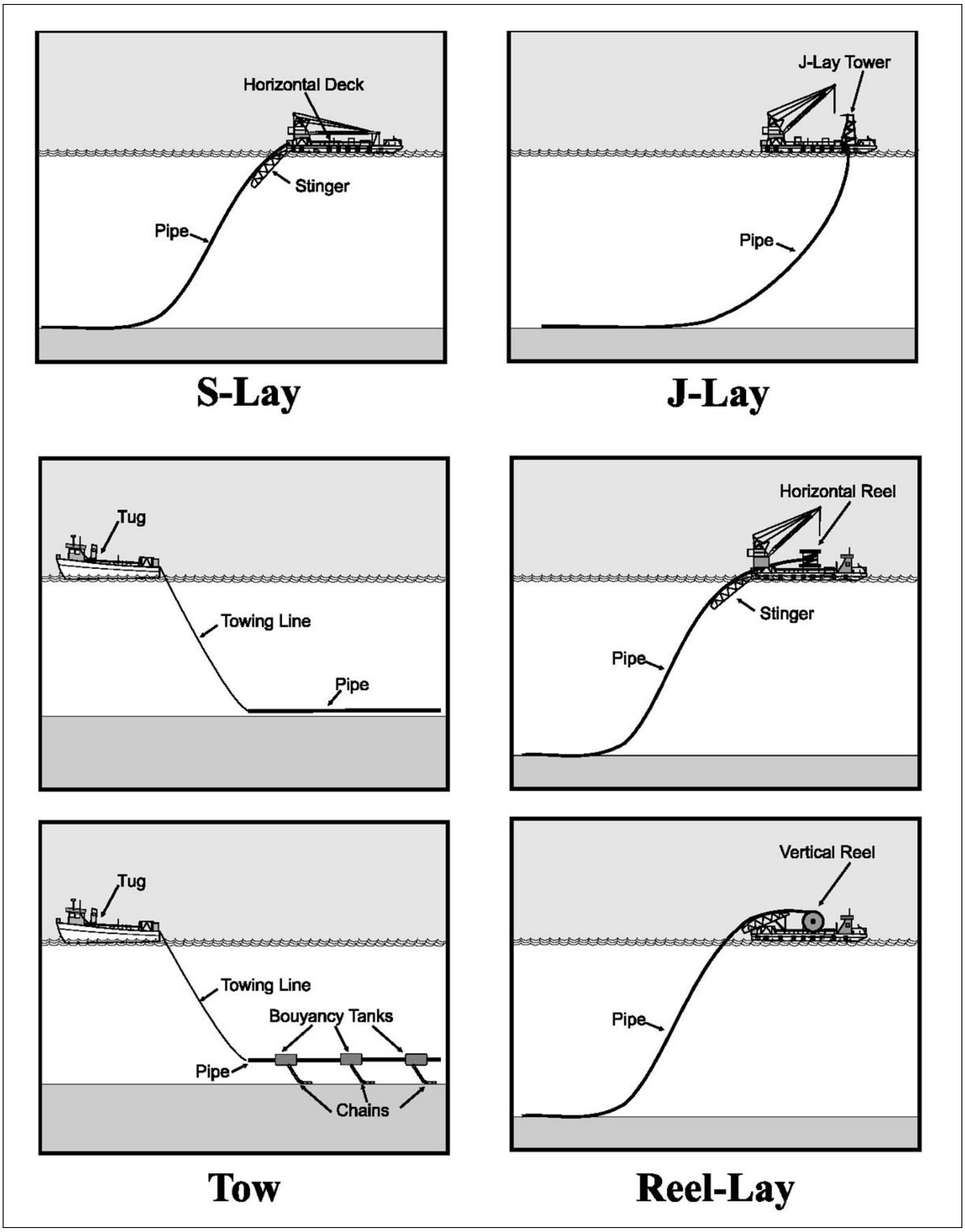


Figure 5.9. Examples of offshore pipelaying methods (From: Cranswick, 2001).

- S-lay – 12 to 25 m sections are welded together on the lay barge and then coated. The lay barge moves forward and the completed sections of pipe enter the water, reaching the sea floor as more sections are welded. A stinger is used to control the degree of pipe bending during deployment. This method is used in shallow to deep water.
- J-lay – sections up to 75 m in length can be handled; J-lay barges have a tall tower on the stern for welding and coating. J-lay deployment of pipe is nearly vertical; J-lay can be used in deeper water than S-lay, but is typically not used in waters 60 to 150 m deep due to limited pipe angle and the bending stress imposed on the pipe.

- Tow-in method – four variations possible: surface tow, mid-depth tow, off-bottom tow, and bottom tow, all of which require a tow vessel. Buoyancy modules are secured to the pipeline, allowing it to float on the sea surface. Floating pipeline is towed to the installation site from shore, then buoyancy modules are removed or the pipeline is flooded, allowing it to sink to the sea floor. Mid-depth tow requires fewer buoyancy modules; off-bottom tow requires the addition of chains to weigh the pipeline down. Bottom tow places the pipeline on the sea floor, where it is dragged into position.
- Reel-barge – typically involves small diameter pipelines; the pipe is welded, coated, and wound on a reel onshore, then deployed offshore for installation. Horizontal reels lay pipe using S-lay deployment; vertical reels most commonly use a J-lay deployment, although an S-lay deployment is possible.

Lay barges can be either conventionally moored (i.e., anchored) or dynamically positioned. Smaller lay barges (i.e., 120 m long by 30 m wide) typically require 8 anchors weighing 14 000 kg each. Larger barges operating in 300 m of water typically require 12 anchors (3 anchors per quarter), each weighing 25 000 kg or more. In general, the larger the lay barge, the greater the anchor requirements (Cranswick, 2001).

To deploy and recover the anchors of an S-lay barge operating in 300 m of water, two anchor handling vessels are required. A smaller lay barge operating in shallower water requires only one smaller anchor-handling vessel. The number of anchor-handling vessels associated with a J-lay barge would be essentially the same as for a similar size barge using the S-lay method. The number of anchor relocations per kilometre of offshore pipeline constructed is a function of the size of the lay barge, water depth, ocean floor conditions in the vicinity of the pipeline installation, and the amount of anchor line that can be stored, deployed, and retrieved by the lay barge.

The practical water depth limit for a large conventionally-moored lay barge that uses the S-lay method is about 300 m, based on a ratio of anchor line length to water depth of about 5 to 1. For pipelines supporting deepwater production facilities, installation by conventionally moored lay barges will probably be limited to those portions of the pipeline routes located in water depths less than 300 m.

Pipeline trenching and burial may also be required in areas heavily used by bottom-founded fishing activities (e.g., trawling), in regions where near bottom conditions are sufficiently rigorous to produce spanning or significant sediment movement, or where regulations require this practice. Trenching methods include conventional excavation with dredging, plowing, jetting, and mechanical trenching (Cranswick, 2001). The area of sea floor disturbance and sedimentation varies depending on the trenching method and variations in bottom topography, sediment density, and currents.

Pipeline installation activities in deepwater areas can be difficult in terms of both route selection and construction. Depending on the location, the sea floor surface can be extremely irregular. Engineering challenges include high hydrostatic pressure, cold temperatures, darkness, and variable subsurface current velocities and directions. Accurate, high-resolution geophysical surveying becomes increasingly important in areas with irregular sea floor. Operators may be expected to analyze high resolution data to minimise pipeline length and avoid areas of unstable sea floor geologic structures and obstructions that might cause excessive pipe spanning, and potentially adverse effects to sensitive benthic communities.

5.4.1.3 Development Drilling Activities

The exploitation phase includes drilling of delineation and production wells, which are sometimes collectively termed development wells (MMS, 2007b). Delineation wells are drilled to help define the extent and location of a hydrocarbon reservoir, and may or may not ultimately become production wells. Development wells may be drilled from movable structures, such as semi-submersibles or drillships (either anchored or dynamically positioned drilling vessels). The number of wells per structure varies according to the type of production structure used, the prospect size, and the drilling/production strategy.

Exploratory drilling activities have been described previously in **Sections 5.3.1** and **5.3.5**. Development drilling is a similar process except the duration is usually shorter (e.g., 40 to 60 days vs. 70 to 90 days for an exploratory well; Regg et al., 2000) and includes well completion. Completion is a term used to describe the assembly of downhole tubulars and equipment required to enable safe and efficient production from an oil or gas well. The process typically includes setting and cementing the production casing, installing some downhole production equipment, perforating the casing and surrounding cement, treating the formation, setting a gravel pack (if needed), and installing production tubing. After a production test determines the desired production rate to avoid damaging the reservoir, the well is ready to go online and produce (MMS, 2007b).

5.4.1.4 Operational Discharges

Effluent discharges generated during development drilling include drilling fluids and cuttings, deck drainage, sanitary wastes, and domestic wastes. These discharges are similar to those described previously in **Sections 5.3.5** and **5.3.6**. Additional waste streams during production include produced water, produced sand, and well treatment, workover, and completion fluids (MMS, 2007b). Minor additional discharges occur from numerous sources such as desalination unit discharges, BOP fluids, boiler blowdown discharges, excess cement slurry, and uncontaminated freshwater and saltwater (USEPA, 1993).

Produced water is formation water that is brought to the surface during production, and it is often the largest volume discharge. Rates of produced water release can vary widely among fields and over time within a field. Generally, the fraction of produced water is low when production begins, increasing over time to a maximum near the end of the field life. In a nearly depleted field, production may be as high as 95% water and 5% petroleum, and over a life of a producing field, the volume of produced water may be 10 times greater than the volume of petroleum.

Volumes of produced water discharged are variable, depending upon the maturity of the producing formation, the type of hydrocarbon being produced, the volume of water required for injection, and the rate of hydrocarbon production realised at the offshore facility. Discharge rates are typically between 2 and 150 000 bbl/day (MMS, 2007b).

Selected chemical characteristics of produced water discharges are presented in **Table 5.8**. Produced water contains a variety of chemicals that have been dissolved from the geologic formations in which the produced water resided for millions of years. These chemicals include inorganic salts from the relic seawater in the formation, metals, organic compounds, and radionuclides. Most produced waters from offshore sources have salinities (total dissolved solid concentrations) greater than that of seawater. In addition, a number of specialty chemicals may be added to produced water during the treatment process.

Table 5.8. Chemical characteristics of produced water discharges from eight production platforms in the U.S. Gulf of Mexico, April 2003 to May 2005 (From: Veil et al., 2005).

Parameter and Unit of Measure	Concentration			
	Mean	Median	Maximum	Minimum
Biochemical oxygen demand (BOD) (mg/L)	957	583	11 108	80
Dissolved BOD (mg/L)	498	432	1 128	132
Suspended BOD (mg/L)	76	57	146	16
Total organic carbon (TOC) (mg/L)	564	261	4 880	26
Dissolved TOC (mg/L)	216	147	620	67
Suspended TOC (mg/L)	32	13	127	5
Nitrate (mg/L)	2.15	1.15	15.8	0.60
Nitrite (mg/L)	0.05	0.05	0.06	0.05
Ammonia (mg/L)	74	74	246	14
Total Kjeldahl nitrogen (mg/L)	83	81	216	17
Orthophosphate (mg/L)	0.43	0.14	6.6	0.10
Total phosphorus (mg/L)	0.71	0.28	7.9	0.10
Conductivity (μmhos/cm)	87 452	86 480	165 000	360
Salinity (ppt)	100	84	251	0
Temperature (°C)	38	32	80	20
pH	6.29	6.50	7.25	1.77

Upon discharge, produced water is diluted rapidly, typically by 30- to 100-fold within tens of metres (OGP, 2005). At distances of 500 to 1000 m from the discharge point, the dilution factor is 1000 to 100 000 or more. Some constituents will precipitate, and others such as trace metals and aromatic hydrocarbons will be scavenged onto PM.

Produced water discharges are subject to regulatory limits for oil content. For example, under the offshore protocol of the Barcelona Convention, oil content is not to exceed a monthly average of 40 mg/L, or 100 mg/L maximum at any time. According to worldwide data from OGP (2007), the average oil content in offshore produced water discharges in 2006 was 17 mg/L.

Produced sand consists of slurried particles, which surface from hydraulic fracturing, and the accumulated formation sands and other particles including scale, which is generated during production (MMS, 2007b). This waste stream also includes sludges generated in the produced water treatment system, such as solids removed in filtration. Produced sand is transported to shore and disposed of as nonhazardous oil-field waste. Estimates of total produced sand generated from a production platform range from 0 to 35 bbl/day (USEPA, 1993).

Three other types of fluids that may be used during exploitation activities are well treatment, workover, and completion fluids. Well treatment fluids, which consist of inhibited acids and petroleum base solvents that are pumped into the well to improve production (USEPA, 1993), are not discharged into the sea. Workover fluids are used to maintain or improve existing well conditions and production rates on wells that have been in production. Completion fluids are brines that are used to displace the drilling fluid and protect formation permeability. Excess workover and completion fluids may be discharged to the sea. Principal contaminants can include oil and grease, metals, and various organic compounds (USEPA, 1993). Fluids circulated through the wellbore are centrifuged to remove any residual hydrocarbons before discharging to the sea.

5.4.1.5 Decommissioning

Decommissioning is the process of dismantling production and transportation facilities and restoration of depleted producing areas in accordance with licence requirements and /or regulations. According to the Hydrocarbons Regulations of 2007, upon termination of a licence or relinquishment of part of the licensed area, licensees are required to (a) remove all equipment and installations, structures, plants, appliances, and pipelines from the relinquished area in a manner agreed with the Minister pursuant to an abandonment plan provided by the Contract; and (b) perform all necessary site restoration activities in accordance with good international petroleum industry practice, and shall take all other action necessary to prevent hazards to human life or to the property of others or the environment.

Various methodologies have been developed to remove offshore production facilities structures during decommissioning (MMS, 2005a). These methods are generally grouped and classified as either explosive or non-explosive, and they can be deployed and operated by divers, ROVs, or from the surface. Factors considered by operators in selecting a method include the target size and type, water depth, economics, environmental concerns, and weather conditions.

For offshore pipelines, the most common international practice is to abandon the pipeline in place (Scandpower Risk Management Inc., 2004). Prior to abandonment, pipelines are purged until the hydrocarbon levels are undetectable. In some cases, after the pipeline is purged, the pipe may be recovered as scrap.

5.4.2 Impact Factors

Based on a preliminary evaluation, hydrocarbon exploitation was identified as an activity with the potential for significant environmental effects, which are analyzed in detail in this section. While the details of development and production are speculative at this stage, eight impact factors were identified: (1) facility installation; (2) presence of structures; (3) drilling discharges; (4) operational discharges; (5) marine debris; (6) air pollutant emissions; (7) support activities; and (8) structure removal. **Table 5.9** summarises the environmental resources potentially affected by each impact factor.

Table 5.9. Impact factors and potentially affected resources for exploitation activities. Potentially significant impacts (X) are highlighted in yellow.

Resource	Facility Installation	Presence of Structures	Drilling Discharges	Operational Discharges	Marine Debris	Air Pollutant Emissions	Support Activities	Structure Removal
Air quality	---	---	---	---	---	o	---	---
Water quality	---	---	o	o	o	---	---	---
Sediments/geology	o	---	o	---	---	---	---	---
Plankton	---	---	o	---	---	---	---	---
Fishes	---	X	o	---	---	---	---	---
Deepwater corals	X	---	X	---	---	---	---	---
Chemosynthetic communities	X	---	X	---	---	---	---	---
Soft bottom benthos	o	---	o	---	o	---	---	o
Marine mammals	---	o	---	---	o	---	o	X
Sea turtles	---	o	---	---	o	---	o	X
Marine birds	---	o	---	---	o	---	X	---
Coastal habitats	---	---	---	---	---	---	---	---
Protected areas	---	---	---	---	---	---	---	---
Fishing activities	---	---	---	---	---	---	o	---
Shipping activities	---	---	---	---	---	---	---	---
Telecommunications cables	o	---	o	---	---	---	---	---
Shipwrecks	X	---	o	---	---	---	---	---
Recreation and tourism	---	---	---	---	---	---	---	---
Coastal communities	---	---	---	---	---	---	---	---

X = potentially significant impact with mitigation recommended; o = minor or negligible impact, no additional mitigation recommended; -- = no impact.

5.4.3 Effects of Facility Installation

Sea floor-disturbing activities during installation of production facilities will resuspend bottom sediments, crush benthic organisms, and produce turbidity. The total area of sea floor disturbed during a typical offshore platform installation is estimated to be 2 ha (MMS, 2007b). Spars and subsea facilities usually disturb smaller areas.

The detailed impacts of facility installation will depend on the type of facility selected for a particular project. Sources of impact for conventional, bottom-founded structures include:

- towing of components to the site;
- placement of structures on the sea floor, including foundation templates, platform jackets, manifolds, well trees, flowline sleds, umbilical termination units, and other equipment;
- driving of piles or anchor piles into the sea floor (e.g., with a hydraulic hammer);
- anchoring of barges during facility installation; and
- effluent discharges, air pollutant emissions, and noise from barges and tugs involved in the facility installation.

Pipeline installation for any particular project is likely to take several weeks to several months. For impact analysis, it is assumed that a pipelaying barge, assisted by an offshore marine supply vessel and crew/work boat, would install pipeline(s) on pre-determined “right of way” corridors. Typically, sections of pipeline are welded together and laid on the sea floor as the barge moves along the pipeline route, using anchors to hold position. If a dynamically positioned pipelaying barge is used for some portion of the work, then anchoring impacts would be avoided along those corridors.

Pipeline installation would crush benthic organisms under the pipeline and anchors and introduce turbidity in the immediate vicinity of the pipelaying operations. Generally, it is estimated that 0.32 ha of sea floor are disturbed for each kilometre of pipeline installation (Cranswick, 2001). Assuming a total corridor length of 25 km for a block relatively close to shore and 160 km for a block far from shore, the impact areas would be 8 ha and 50 ha, respectively. The area actually affected by anchoring will depend on water depth, wind, currents, cable length, the size of the anchor and cable, distance between anchor movements, etc.

Most of the sea floor in the licence area is expected to consist of soft-bottom benthic habitat. Deepwater benthic communities of the Mediterranean Sea are characterised as impoverished, with low density and low diversity (see **Section 4.2.2**). The main concern with regard to potential impacts is the placement of anchors in areas such as deepwater coral communities (e.g., on the Eratosthenes Seamount) or chemosynthetic communities. These areas are associated with elevated densities of epifauna and fishes and are considered relatively rare and ecologically important. Mitigation is recommended so as to avoid impacts.

There are several submarine telecommunications cables passing through the licence area (see **Section 4.3.3**). These features are susceptible to physical damage from sea floor-disturbing activities such as anchoring and placement of structures on the sea floor. However, because the locations of these cables are known, licensees routinely map and avoid them during detailed project planning and it is assumed that impacts would be avoided.

The licence area is in a region where historical shipwrecks are likely to be present (see **Section 4.3.4**). These features are susceptible to physical damage from sea floor-disturbing activities such as anchoring and placement of structures on the sea floor. Mitigation is recommended so as to avoid impacts.

→ **Conclusion**: Installation of production facilities will disturb the sea floor; the extent will depend on the type of structure but is estimated to be 2 ha per platform facility. Pipeline installation typically disturbs of sea floor about 0.32 hectares per kilometre, or 50 hectares for a 160-km pipeline. The impacts are likely to persist for several years. Impacts in soft bottom areas are considered negligible due to low density and low diversity of the deepwater benthic communities. However, placement of facilities in areas of deepwater corals or chemosynthetic communities would represent a significant impact. Potential damage to shipwrecks or other submerged archaeological resources could be significant and should be avoided.

→ **Existing Control Measures**: No existing control measures were identified.

→ **Recommended Mitigation** – Licensees proposing to construct production facilities within the Eratosthenes Seamount area (defined in **Section 6.0**) should be required to use high-resolution seismic survey (i.e., geohazards) data, three-dimensional (3D) seismic survey data, and any other pertinent information available to identify hard bottom areas that could support deepwater coral communities. If any such areas are identified, licensees should be required to maintain a separation distance of at least 100 m from the location of all proposed sea floor disturbances (including those caused by anchors, anchor chains, wire ropes, sea floor template installation, and pipeline construction).

→ **Recommended Mitigation** – Licensees proposing to construct production facilities within the licence area should be required to evaluate the potential for high-density chemosynthetic communities around each proposed facility location. If any such features are identified, maintain a separation distance of at least 100 m from sea floor disturbances (including those caused by anchors, anchor chains, wire ropes, sea floor template installation, and pipeline construction) within the activity footprint.

→ **Recommended Mitigation:** Licensees proposing to construct production facilities in the licence area should be required to (1) conduct a remote sensing survey of the sea floor to evaluate the potential for shipwrecks and other submerged archaeological resources and (2) submit an archaeological assessment report by a qualified marine archaeologist to include any identified archaeological resources and recommendations for avoidance or further investigation (see **Section 6.0** for details).

5.4.4 Effects of the Presence of Structures (including Noise and Lights)

In contrast to exploratory drilling rigs, production facilities typically remain in place for 20 to 30 years. During this time, the physical presence of the platform, as well as noise and lights from routine operations, may affect marine biota including plankton, fishes, marine mammals, sea turtles, and birds. In addition, the presence of subsea pipelines can create an "artificial reef" effect on the sea floor, attracting epibiota and fishes.

Effects on Benthic Communities

Over time, platform legs will develop an attached community of epibiota. Potential colonists typically include ascidians, barnacles, bryozoans, hydroids, and sponges. Data from offshore platforms (Gallaway and Lewbel, 1982) and fouling plate studies (Danek and Lewbel, 1986) indicate that the biomass of fouling biota decreases with increasing water depth. The development of a mature, climax fouling community typically requires several years on newly exposed hard substrates (Marine Resources Research Institute, 1984).

Sporadic sloughing of biological debris from the platform fouling community may produce organic enrichment underneath the platform (Wolfson et al., 1979). Effects may include increased total organic content of sediments and altered benthic communities.

Pipelines will also be colonised by algae and epifauna and will attract fishes. Observations along existing pipelines typically show that epibiota colonise exposed surfaces, and numerous fishes are attracted to submerged structures.

Effects on Plankton and Fishes

Zooplankton and ichthyoplankton may be attracted to lights associated with offshore structures. Fish larvae are strongly attracted to lights at night (Victor, 1991). Light emissions from operations are likely to have negligible impacts on planktonic communities due to the small area of ocean affected.

Offshore platforms attract fishes, providing shelter and food in the form of attached fouling biota (Gallaway and Lewbel, 1982; Wilson et al., 2003, 2005). Offshore structures typically attract epipelagic fishes such as tunas, dolphin, billfishes, and jacks (e.g., Holland et al., 1990; Higashi, 1994). Stanley and Wilson (2000) reported finding 10 000 to 30 000 fishes associated with individual platforms; the lowest numbers were found at the largest and deepest structures. The density of fishes around platforms was 10 times greater than in open water. This “artificial reef effect” is generally considered a beneficial impact.

Effects on Marine Mammals

Some marine mammals may avoid areas around production platforms due to noise. Others might be attracted to fish populations around the structures. The most likely impacts would be short-term behavioural changes such as diving and evasive swimming, disruption of activities, or departure from the area.

Richardson et al. (1995) defined four zones of potential noise effects on marine mammals. In order of increasing severity, they are (1) audibility; (2) responsiveness (behavioural effects); (3) masking; and (4) hearing loss, discomfort, or injury (physical effects). The levels of sound produced during drilling are sufficient to be audible and produce behavioural responses but are much lower than those known to cause hearing loss, discomfort, or injury.

Low-frequency noise from offshore production activities can be detected by marine mammals (Richardson et al., 1995). Mysticetes (baleen whales such as fin whales) are more likely to detect low-frequency sounds than are most odontocetes (e.g., dolphins), which have their best hearing in high frequencies. There is some other offshore drilling and production activity in the region (e.g., offshore Egypt), so this would not represent a novel source. However, noise associated with drilling is relatively weak in intensity, and the animals’ exposure to these sounds would be transient. Some of the noise (from vessel engines and propellers) would be similar to the existing noise associated with shipping traffic in the region.

Effects on Sea Turtles

Some sea turtles may be attracted to offshore structures (Rosman et al., 1987; Lohoefener et al., 1990). However, considering that each drilling rig will be a single, temporary structure, any impacts on turtle populations are likely to be negligible. In the Gulf of Mexico where thousands of offshore structures are present, platform lighting is considered unlikely to appreciably reduce the reproduction, numbers, or distribution of sea turtles (National Marine Fisheries Service, 2001).

Turtle hatchlings are attracted to and can be disoriented by artificial lighting (National Research Council, 1990). It has been hypothesized that they may be attracted to brightly lit offshore structures, where they could be subject to increased predation by birds and fishes that also are attracted to these structures. However, the platform would be far from the nearest shoreline and any turtle nesting beaches. Therefore, the risk of any impacts on hatchlings is small.

Effects on Marine Birds

Both positive and negative impacts of offshore structures on birds have been noted. Some birds may be attracted to offshore structures because of the lights and the fish populations that aggregate around these structures. Birds may use offshore structures for resting, feeding, or as temporary shelter from inclement weather (Russell, 2005). However, birds migrating over water at night have been known to strike offshore structures, resulting in death or injury (Wiese et al., 2001; Russell, 2005).

Visual/Aesthetic Effects

Platforms are not likely to be visible from shore. Offshore structures such as drilling rigs and platforms typically are visible from shore at distances of 5 to 16 km, with small structures (e.g., a single drilling rig) barely visible at 5 km from shore. On a clear night, lights on top of offshore structures could be visible to a distance of approximately 32 km (MMS, 2007b). Minimum distances to shore from individual licence blocks range from 11.4 to 178 km.

→ **Conclusion**: The physical presence of platforms will attract pelagic fishes. Birds may use offshore platforms as stopping places. Noise and lights may cause minor behavioural changes in marine mammals and sea turtles (e.g., attraction or avoidance). Benthic communities may be affected by sloughing of organic debris from platforms, and by the physical presence of pipelines on the sea floor. The impacts are considered minor.

→ **Existing Control Measures**: No existing control measures were identified.

→ **Recommended Mitigation**: No additional measures are recommended.

5.4.5 Effects of Drilling Discharges

The fate and effects of drilling discharges during exploration have been discussed in **Section 5.3.5**. Effects during development drilling would be qualitatively similar. However, because numerous wells would be drilled at each production location, the areal extent and severity of benthic impacts would be greater than for exploratory drilling.

Continental Shelf Associates, Inc. (2006) studied drilling discharge impacts at several sites on the Gulf of Mexico continental slope in water depths of 1033 to 1125 m. Two sites were sampled post-exploration and three sites were sampled post-development. Both WBFs and SBFs were used at these sites. Cuttings deposits covered a maximum area of 108 ha at one post-development site, compared with about 13 ha for a single exploratory well. At both post-exploration and post-development sites, areas of SBF cuttings deposition were associated with elevated organic carbon concentrations and anoxic conditions. Areas within about 500 m of drillsites had patchy zones of disturbed benthic communities, including microbial mats, areas lacking visible benthic macroinfauna, zones dominated by pioneering stage assemblages, and areas devoid of surface-dwelling species. Infaunal and meiofaunal densities generally were higher near drilling, although some faunal groups were less abundant near drillsites. Some stations near drilling had lower diversity, lower evenness, and lower richness indices compared with stations away from drilling. Some stations affected by drilling were dominated by high abundances of one or a few deposit-feeding species, including known pollution indicators. The severity of these impacts was greatest at two post-development sites that had the largest discharge volumes of SBF cuttings during drilling.

Most of the sea floor in the licence area is expected to consist of soft-bottom benthic habitat. Deepwater benthic communities of the Mediterranean Sea are characterised as impoverished, with low density and low diversity (see **Section 4.2.2**). The main concern with regard to potential impacts is the accumulation of SBF cuttings around wellsites in areas such as deepwater coral communities (e.g., on the Eratosthenes Seamount) or chemosynthetic communities. These areas are associated with elevated densities of epifauna and fishes and are considered relatively rare and ecologically important.

Several telecommunications cables pass through the licence area, and historical shipwrecks are likely to be present (see **Sections 4.3.3** and **4.3.4**). Drilling discharges are not likely to adversely affect these features, and it is expected that they would be avoided during site selection. Therefore, no impacts are anticipated.

→ **Conclusion**: Drilling fluids and cuttings will accumulate on the sea floor, resulting in changes in bottom contours, grain size, barium concentrations, and perhaps concentrations of other metals. These changes occur primarily within a few hundred metres around each wellsite and may persist for several years. Impacts of these accumulations in soft bottom areas are considered minor or negligible due to low density and low diversity of the associated deepwater benthic communities. However, discharges in areas of deepwater coral communities or chemosynthetic communities could represent a significant impact and should be avoided.

→ **Existing Control Measures**: No existing control measures were identified.

→ **Recommended Mitigation** – Before conducting drilling activities within the Eratosthenes Seamount area (defined in **Section 6.0**), licensees should be required to use high-resolution seismic survey (i.e., geohazards) data, three-dimensional (3D) seismic survey data, and any other pertinent information available to identify hard bottom areas that could support deepwater coral communities. If any such areas are identified, licensees should be required to maintain a separation distance of at least 500 m from any proposed drilling fluid and cuttings discharge location.

→ **Recommended Mitigation** – Before conducting drilling activities in the licence area, licensees should be required to evaluate the potential for high-density chemosynthetic communities around each proposed wellsite and, if any such features are identified, maintain a separation distance of at least 500 m from the location of any proposed drilling fluid and cuttings discharge.

5.4.6 Effects of Operational Discharges

Routine discharges during production include produced water, workover and completion fluids, treated sewage and domestic wastes (including food waste), deck drainage, and miscellaneous discharges.

Produced water is likely to be the largest effluent discharge during production and would affect water quality near offshore production facilities by adding hydrocarbons, trace metals, and BOD to the environment. Studies indicate that produced water has low intrinsic toxicity (OGP, 2005). Environmental effects have been evaluated in several studies. Studies have demonstrated accumulation of produced water contaminants in sediments around discharging facilities, but limited environmental effects (Neff, 2002; OGP, 2005). The results of ecological and human health risk assessments indicate that constituents in produced water discharges present very little, if any, toxicological risk to the biota or to humans eating fish or shellfish from the area (Continental Shelf Associates, Inc., 1997).

Workover and completion fluids (brines) are expected to be rapidly diluted and have little or no impact on water quality. In the open ocean, these discharges will be rapidly diluted to ambient concentrations and conditions within tens of metres of the discharge point.

Sanitary and domestic waste from manned production facilities and support vessels may affect concentrations of suspended solids, nutrients, and chlorine, as well as generating BOD. It is assumed that one person generates 100 L/d of sanitary waste and 220 L/d of domestic waste. It is predicted that sanitary wastes have an associated BOD of 240 mg/L. These discharges are expected to be rapidly diluted in the open ocean (MMS, 2007b). Impacts would likely be undetectable beyond tens of metres from the source.

As previously discussed, deck drainage consists of all waste resulting from rainfall, rig washing, deck washings, tank cleaning operations, and runoff from curbs and gutters, including drip pans and work areas. Offshore production facilities are designed to contain runoff and prevent oily drainage from being discharged. Because of the separation and treatment of water from oily areas prior to discharge, deck drainage is not expected to produce a visible sheen or any other detectable impacts on water quality. Assuming a typical surface area of about 10 000 m^2 for a production facility and a maximum monthly rainfall of about 100 mm, the monthly average deck drainage would be 1000 m^3.

Additional miscellaneous discharges typically occur from numerous sources on an offshore platform. Examples include uncontaminated freshwater and seawater used for cooling water and ballast, desalination unit discharges, BOP fluids, and boiler blowdown discharges (USEPA, 1993). These discharges must meet MARPOL requirements and are expected to be rapidly diluted in the open ocean. Impacts on water quality would likely be undetectable beyond tens of metres from the source.

- → **Conclusions** – Operational effluent discharges, including produced water, are likely to have minor or negligible effects on water quality within a few tens to hundreds of metres around production facilities.

- → **Existing Control Measures** – Offshore platforms and support vessels must comply with MARPOL requirements including provisions concerning sewage, food waste, oily waste, and garbage.

- → **Recommended Mitigation** – No additional mitigation is recommended.

5.4.7 Effects of Marine Debris

All solid waste generated during development and production will be transported to shore for disposal at approved facilities. In general, less solid waste is generated during production than during drilling activities. Monthly solid waste based on historical data for a typical drillship is expected to be about 40 000 kg, including general waste, galley waste, used waste oil and oil/fuel filters, absorbents, oily water, cardboard, plastic, paper, batteries, wood, etc. Most petroleum companies have implemented waste management programmes that apply the principles of source reduction, reuse, and recycling to reduce the amount of waste generated.

Disposal of trash and debris in the ocean is prohibited under MARPOL, and drilling rigs operate under a Garbage Management Plan to ensure adherence to MARPOL. However, material from drilling rigs occasionally may accidentally fall overboard.

Pieces of debris that fall overboard, such as welding rods, buckets, and pieces of pipe, are eventually colonised by epibiota. They also attract fishes due to their physical structure on the otherwise flat sea floor, resulting in a minor, local impact on the benthic community (Shinn et al., 1993). The impact is limited to a few metres to tens of metres of the wellbore.

Marine debris can harm marine mammals, turtles, and birds. Marine mammals can become entangled in and ingest trash and debris, including materials lost overboard during offshore oil and gas operations (Laist, 1996). Marine debris is among the threats affecting the population status of both humpback whales and sperm whales (National Marine Fisheries Service, 1991, 2006). Similarly, ingestion of, or entanglement with, accidentally discarded debris can kill or injure sea turtles (Laist, 1996; Lutcavage et al., 1997) and is among the threats affecting the endangered population status of several sea turtle species (National Research Council, 1990). Leatherback turtles are especially attracted to floating debris, particularly plastic bags, because it resembles their preferred food, jellyfish. Ingestion of plastic and styrofoam can result in drowning, lacerations, digestive disorders or blockage, and reduced mobility. Finally, marine debris can also injure or kill birds that ingest or become entangled in it.

→ **Conclusions** – Marine debris accidentally lost overboard from offshore production facilities and service vessels has the potential to adversely affect marine mammals, turtles, and birds through entanglement and ingestion. In addition, metal debris such as welding rods and buckets can clutter the sea floor around wellsites.

→ **Existing Control Measures** – Platforms and support vessels must comply with MARPOL requirements including the prohibition of disposing trash into the sea. The discharge requirements for the Mediterranean Sea as a "special area" under Annex V will take effect on 1 May 2009. After that date, disposal into the Mediterranean Sea of the following will be strictly prohibited: all plastics, including but not limited to synthetic ropes, synthetic fishing nets and plastic garbage bags and all other garbage including paper products, rags, glass metal, bottles, crockery, dunnage, lining and packing materials.

→ **Recommended Mitigation** – No additional mitigation is recommended.

5.4.8 Effects of Air Pollutant Emissions

Table 5.10 lists estimated emissions for a typical development well and production platform. Platform equipment typically is powered by natural gas or diesel engines that emit air pollutants including NO_x, CO, SO_2, and VOCs, as well as PM and greenhouse gases such as CO_2 and CH_4. Support vessels and helicopters also emit air pollutants from combustion of diesel fuel (vessels) and aviation fuel (helicopters).

Table 5.10. Estimated air pollutant emissions for a typical development well and production platform (From: MMS, 2007b).

Source	Emissions				
	Carbon Monoxide	Nitrogen Oxides	Particulate Matter	Sulphur Oxides	Volatile Organic Compounds
Drilling of a development well (metric tonnes/well)	5.2	19.5	0.54	2.3	1.9
Production platform operation (metric tonnes/year)	47.3	40.0	0.41	1.8	18.8

As noted previously, some of these gases are known to degrade to form different compounds, and these degradation products and transformation processes are important in the context of problems such as global warming and acidification.

Air pollutant emissions from platforms are expected to be rapidly diluted and dispersed in the offshore atmosphere. There may be some decrease in air quality within several hundred metres around platforms. However, no detectable impacts on air quality in Cyprus are expected based on the relatively small quantities of pollutants emitted and the distance from shore.

No air pollutant modelling was done for this Environmental Report. It is assumed that modelling may be done for individual development and production projects as part of the EIA process, depending on the scope of the project. As an initial approximation, the significance of estimated annual emissions can be evaluated by applying a method used in the U.S. Gulf of Mexico (MMS, 2008). In this method, estimated emissions and compared to annual "exemption levels" based on the distance from shore. For the licence area, the nearest portions of Block 1 are 11.4 km from land, and the corresponding exemption levels would be 233 tons for NO_x, PM, SO_x, and VOC, and 12 442 tons for CO. The annual emissions for a typical production platform (**Table 5.10**) are well below these thresholds, indicating that emissions are not likely to have any significant effects onshore.

→ **Conclusions** – Air pollutant emissions from offshore production facilities are expected to have negligible impacts on air quality. Due to the distance offshore, no impacts on coastal or onshore air quality are expected.

→ **Existing Control Measures** – Offshore platforms and support vessels must comply with MARPOL Annex VI, which sets limits on sulphur oxide and nitrogen oxide emissions from ship exhausts and prohibits deliberate emissions of ozone-depleting substances including halons and chlorofluorocarbons. MARPOL also sets limits on emissions of nitrogen oxides from diesel engines and prohibits the incineration of certain products on board such as contaminated packaging materials and polychlorinated biphenyls. Also, under the Hydrocarbons Regulations of 2007, licensees are required to ensure that all machinery, equipment, and installations used by the licensee and subcontractors comply with generally accepted standards in the international petroleum industry and are of proper construction and kept in good working order.

→ **Recommended Mitigation** – No additional mitigation is recommended.

5.4.9 Effects of Support Activities

During the exploitation phase, offshore service vessels and helicopters will provide support from an onshore base. A location has not been identified at this stage, but likely candidates would include Larnaca or Limassol. These are both well-developed ports with the capacity to provide needed support services. It is not known at this stage whether new or expanded facilities would be needed to support development and production.

A typical project would involve two support vessels making at least one round trip per day between the shorebase and the offshore facility. One helicopter also would be used for personnel movement and other trips as needed to transport critical equipment to the rig. The helicopter is assumed to make two round trips per day and is assumed to operate out of either Larnaca International Airport and/or Paphos International Airport. Support vessels and helicopters would normally follow the most direct route between the wellsite and the onshore base, weather and traffic permitting.

Effects on Marine Mammals

There is a small possibility of a supply boat striking a marine mammal during routine operations. The risk is similar to that associated with existing vessel traffic in the region. Collisions with dolphins or whales are considered highly unlikely; most dolphins are agile swimmers and are unlikely to collide with vessels. Of 11 marine mammal species known to have been hit by vessels, fin whales are struck most frequently, sperm whales are hit commonly, and records of collisions with Bryde's whales are rare (Laist et al., 2001). Although all sizes and types of vessels can collide with whales, most lethal or severe injuries are caused by ships 80 m or longer and traveling 14 knots or faster (Laist et al., 2001).

Vessel strikes are among the threats affecting the population status of both humpback whales and sperm whales (National Marine Fisheries Service, 1991, 2006). Sperm whales are vulnerable to ship strikes because they typically spend up to 10 minutes "rafting" at the surface between deep dives (Jaquet et al., 1998). There have been many reports of sperm whales of different age classes being struck by vessels, including passenger ships and tug boats. There were also instances in which sperm whales approached vessels too closely and were cut by the propellers (National Marine Fisheries Service, 2006).

The rare, critically endangered Mediterranean monk seal may be present in nearshore Cyprus waters (Dendrinos and Demetropoulos, 1999) but is unlikely to be found in offshore waters of the licence area due to the depth and distance from shore.

There is a remote possibility of a supply boat striking a sea turtle during routine operations. Vessel strikes are among the threats affecting the endangered population status of several sea turtle species (National Research Council, 1990). The risk is similar to that associated with existing vessel traffic in the region. Studies indicate that sea turtles are at the sea surface only about 10% of the time and readily sound (dive) to avoid approaching vessels (Byles, 1989; Lohoefener et al., 1990; Keinath and Musick, 1993; Keinath et al., 1996).

Due to the relatively infrequent nature of the support vessel traffic, the likelihood of striking a marine mammal or turtle is considered low.

Effects on Marine Birds

Vessel and helicopter traffic could periodically disturb individuals or groups of coastal birds. It is likely that individual birds would experience at most a short-term, behavioural disruption.

While the impact in general would be minor, it could be significant if helicopters traveled frequently over SPAs designated under the Birds Directive, or other IBAs. There are currently seven designated SPAs in Cyprus (European Commission, 2008). In addition, BirdLife International (2008) identifies 25 IBAs on Cyprus. IBA sites in the vicinity of Limassol include Akrotiri cliffs, Akrotiri salt lake including Bishop's Pool, Phasouri reedbeds, Episkopi cliffs, and Cape Aspro. IBA sites in the vicinity of Larnaca include Larnaca salt lakes and Cape Greco.

Effects on Fishing and Shipping Activities

Support vessels would normally be expected to follow the most direct route between the wellsite and onshore support base, weather conditions permitting. Accordingly, significant impacts on fishing are expected to be avoided.

→ **Conclusions** – Support operations are likely to use existing port facilities in Cyprus and would represent a minor increase in the existing level of operations at these ports. It is not known whether new or expanded facilities are expected to support exploitation operations. Vessel traffic involves a small risk of striking a marine mammal or turtle. The likelihood of striking a marine mammal or turtle is considered low. Helicopters crossing coastal habitats may disturb bird colonies; the impacts would be minor in most cases, but potentially significant if the route passed across coastal SPAs or IBAs.

→ **Existing Control Measures** – No existing measures were identified. It is assumed that licensees would be required to notify the relevant Cyprus maritime authorities of the planned development and production facility location, support base, and frequency of support vessel operations.

→ **Recommended Mitigation** – Licensees should be advised that helicopters engaged in support operations should avoid flying over SPAs and IBAs when travelling to or from the production facility. A map of SPAs and IBAs should be provided for this purpose.

5.4.10 Effects of Structure Removal

During decommissioning, platform facilities would be removed. Typically, the platform legs are cut at the mudline so that no obstruction would protrude from the sea floor (MMS, 2005a). It is not known at this time whether explosive charges would be used during decommissioning in the licence area.

For offshore pipelines, the most common international practice is to abandon the pipeline in place (Scandpower Risk Management Inc., 2004). Prior to abandonment, pipelines are purged until the hydrocarbon levels are undetectable. In some cases, after the pipeline is purged, the pipe may be recovered as scrap. In general, the environmental impacts of abandoning a pipeline in place are minimal, as compared with those of removing it such as emissions and sea floor disturbance (Scandpower Risk Management Inc., 2004).

If explosive charges are used for platform removal, then there is the potential for impacts to fishes, marine mammals, and sea turtles (Klima et al., 1988; Viada et al., 2008). Studies conducted at platform removal sites in the Gulf of Mexico estimated that between 2000 and 6000 fishes were killed during explosive platform removals (Gitschlag et al., 2000). However, the numbers of fish killed typically are small relative to the overall population and existing sources of mortality. Deaths and injuries of marine mammals and turtles have been reported (Klima et al., 1988; Gitschlag et al., 2000) but are now effectively avoided through mitigation and monitoring.

It is assumed that if explosives are used, the decommissioning plan would include monitoring for the presence of marine mammals prior to any underwater detonations. This monitoring is standard industry procedure and would avoid potential impacts of explosives on marine mammals and turtles (Klima et al., 1988; Gitschlag et al., 2000).

→ **Conclusions** – Removal of offshore production structures has the potential to kill or injure marine mammals or turtles if explosives are used to sever the platform legs.

→ **Existing Control Measures** – No existing measures were identified.

→ **Recommended Mitigation** – Licensees should be required to follow international best practice for safe structure removal including monitoring for marine mammals and turtles if explosives are to be used.

5.5 ACCIDENTAL EVENTS

Potential accidents considered in this SEA are (1) oil spills and (2) hydrogen sulphide releases.

5.5.1 Oil Spills

An oil spill is an accident that could occur during any phase of offshore hydrocarbon activities (prospecting, exploration, or exploitation). Potential sources considered here, in order of importance, include (1) a crude oil spill from a blowout; (2) a diesel fuel spill; (3) a drilling fluid base oil spill; and (4) streamer cable fluid leak.

5.5.1.1 Crude Oil Spill from a Blowout

A crude oil spill is a rare event that could occur as a result of a blowout. A blowout is an uncontrolled flow of reservoir fluids into the wellbore, and sometimes catastrophically to the surface. A blowout may consist of saltwater, oil, gas, condensate, or a mixture of these. During drilling, all wells are equipped with a BOP, a special assembly of high pressure valves fitted to the top of a well to prevent high-pressure oil or gas from escaping.

Worldwide statistics from offshore drilling provide a reasonable basis for evaluating spill risk. According to Holand (1997), the average blowout frequency for exploration drilling in the U.S. Gulf of Mexico is 0.00593 blowouts per well drilled, or 1 blowout per 169 exploration wells drilled. Similarly, the MMS Safety and Environmental Management Program blowout incident rate for 1996 to 1999 was approximately 5 blowouts per 1000 well starts, or 1/200 (MMS, 2001). For the North Sea, the estimated frequency is 0.00630 blowouts per well drilled, or 1 blowout per 159 exploration wells (Holand, 1997).

Most blowouts do not result in oil spills. For example, of the 151 well blowouts reported in the Gulf of Mexico from 1971 to 1995, only 18 (i.e., 12%) resulted in oil spills. The total volume released from all of these spills was 1000 bbl of crude oil and condensate (MMS, 2001). Between 1964 and 1999, almost all offshore spills (94%) from drilling and production-related operations on the U.S. outer continental shelf were less than or equal to 1 bbl in size (Anderson and LaBelle, 2000). Generally, historical data indicate that a blowout occurring and resulting in a large oil spill of any size is very unlikely.

The environmental and socioeconomic effects of a crude oil spill could vary substantially depending on the size of the spill, its chemical characteristics, the oceanographic and meteorological conditions at the time, and the effectiveness of spill response measures. At minimum, the spill would affect water quality by producing an oil slick on the sea surface and increasing hydrocarbon concentrations due to dissolved components and small oil droplets.
A spill could affect air quality in the vicinity of the spill site by introducing VOCs through evaporation. A subsurface blowout could also affect benthic communities by resuspending and dispersing sediments within about a 300-m radius (MMS, 2007b). Marine mammals, sea turtles, and coastal and marine birds could be affected through various pathways: direct contact, inhalation of oil or related volatile distillates, ingestion of oil (directly, or indirectly through the consumption of oiled prey species), and impairment of feeding. A spill reaching the shoreline could affect coastal resources, including turtle nesting beaches, marine protected areas, coastal bird populations, and recreation and tourism. Response and cleanup activities in coastal and offshore waters could interfere with local fishing and shipping activities.

→ **Conclusions** – Depending on spill characteristics, oceanographic and meteorological conditions, and the effectiveness of spill response measures, a crude oil spill from a blowout could have significant environmental and socioeconomic effects. Potentially affected resources could include water quality, air quality, benthic communities, marine mammals, sea turtles, marine and coastal birds, coastal habitats, protected areas, recreation and tourism, and coastal communities. Response and cleanup activities in coastal and offshore waters could interfere with local fishing and shipping activities.

→ **Existing Control Measures** – Under MARPOL, ships (including drilling rigs) are required to have in place a Shipboard Oil Pollution and Emergency Plan (SOPEP). The SOPEP will contain the necessary reporting procedures and actions required to control discharge, and the steps necessary to initiate an external response for any spills. In addition, the Hydrocarbons Regulations of 2007 require operators to have a Contingency Plan for hydrocarbon leakages or spillage. Prior to the commencement of any drilling operations, the licensee prepares and submits to the Minister for evaluation and approval a contingency plan for hydrocarbon leakage. In the event of leakage, the licensee is required to immediately apply the contingency plan.

→ **Recommended Mitigation** – No additional mitigation is recommended. However, additional oil spill trajectory modelling is recommended to aid in predicting the fate of an oil spill at various locations in the licence area, identifying potentially affected environmental resources, and determining minimum response times for contingency planning. (See **Chapter 6** for details.)

5.5.1.2 Diesel Fuel Spill

A diesel fuel spill is an accident that could occur during any phase of offshore hydrocarbon activities (prospecting, exploration, or exploitation). Potential sources would include vessel collisions or groundings, tank ruptures, or a hose break during at-sea refuelling operations. A large spill, such as one resulting from a diesel tank rupture, would be an extremely rare event. The probability has not been estimated, but historical data for a highly active region (the Gulf of Mexico) include no such incidents between 1981 and 1999 (Anderson and LaBelle, 2000; MMS, 2007b). Historical data indicate that most diesel spills are <1 bbl, and for spills greater than this, the median size is 5 bbl (MMS, 2000).

Groundings and vessel collisions are a frequent cause of spills in the Mediterranean region. Alexopoulous and Dounias (2005) noted that of 273 ship incidents in the Mediterranean Sea from 1981 to 2000, 123 (45%) caused oil pollution. Grounding, contact and collision were the primary causes for the oil spills during the latter portion of this period (from 1994 to 2000). Tankers and bulk carriers were responsible for almost 77% of oil spills, primarily due to accidents during terminal operations. Accidents occurred due to pipes being ruptured or leaking, mooring ropes being broken, hoses being disconnected or parted, faulty valves, etc.

The environmental and socioeconomic effects of a diesel fuel spill would depend on the size of the spill, the oceanographic and meteorological conditions at the time, and the effectiveness of spill response measures. In general, a diesel fuel spill would be subject to rapid dispersal, weathering, evaporative losses, and dissipation throughout the water column. It would affect air quality in the vicinity of the spill site by introducing VOCs through evaporation. A diesel spill would affect local water quality by increasing hydrocarbon concentrations. Water column biota near the spill site, such as plankton and fishes, could be affected, because diesel fuel is highly toxic. While adult and juvenile fishes may actively avoid a large oil spill, the planktonic eggs and larvae would be unable to avoid contact. Eggs and larvae of fishes will die if exposed to certain toxic fractions of spilled oil.

A diesel fuel spill would not be expected to have any impact on benthic communities, as the hydrocarbons would not be expected to reach the sea floor. In addition, it is unlikely that a small diesel fuel spill would affect coastal water quality or coastal habitats, as minimum distances to shore from individual licence blocks range from 11.4 to 178 km.

→ **Conclusions** – Depending on spill size, oceanographic and meteorological conditions, and the effectiveness of spill response measures, a diesel fuel spill could have significant environmental and socioeconomic effects. The main effects would be degraded water quality near the spill site and localised toxicity to water column biota. Except in the event of a large diesel spill close to shore, significant effects on coastal habitats, protected areas, recreation and tourism, and coastal communities are unlikely. Response and cleanup activities in coastal and offshore waters could interfere with local fishing and shipping activities

→ **Existing Control Measures** – Under MARPOL, ships (including drilling rigs) are required to have in place a SOPEP. The SOPEP will contain the necessary reporting procedures and actions required to control discharge, and the steps necessary to initiate an external response for any spills. In addition, the Hydrocarbons Regulations of 2007 require operators to have a Contingency Plan for hydrocarbon leakages or spillage. Prior to the commencement of any drilling operations, the licensee prepares and submits to the Minister for evaluation and approval a contingency plan for hydrocarbon leakage. In the event of leakage, the licensee is required to immediately apply the contingency plan.

→ **Recommended Mitigation** – No additional mitigation is recommended. However, additional oil spill trajectory modelling is recommended to aid in predicting the fate of an oil spill at various locations in the licence area, identifying potentially affected environmental resources, and determining minimum response times for contingency planning. (See **Chapter 6** for details.)

5.5.1.3 Drilling Fluid Base Oil Spill

SBFs contain a synthetic base oil that is mixed with other constituents to prepare the drilling fluid. In the Gulf of Mexico, an offshore region with frequent drilling activity, there were 53 SBF spills between 2001 and 2004 (MMS, 2007b). Most spills were less than 50 bbl, but three were greater than 1000 bbl. Two of the three large spills were caused by an emergency disconnect of the marine riser, and the third by riser failure. For impact analysis, it was assumed that a small spill of SBF base oil could occur at a wellsite in the licence area.

A drilling fluid base oil spill would be expected to sink to the sea floor (Boland et al., 2004). Most of the impact would be on the sea floor, where the SBF would accumulate. Impacts would be similar to those described previously for SBF cuttings discharges, including elevated organic carbon concentrations and localised anoxia. Benthic community effects could include microbial mats, zones dominated by pioneering stage assemblages or pollution indicator species, and areas devoid of surface-dwelling species (Continental Shelf Associates, Inc., 2006).

→ **Conclusions** – There is a small risk of a spill of base oil from SBFs during exploration or exploitation. The main effects would be on the benthic community beneath the drilling rig or platform, including burial, smothering, and impacts of localised anoxia.

→ **Existing Control Measures** – Under MARPOL, ships (including drilling rigs) are required to have in place a SOPEP. The SOPEP will contain the necessary reporting procedures and actions required to control discharge, and the steps necessary to initiate an external response for any spills.

→ **Recommended Mitigation** – Other recommendations (see **Section 5.3.5** and **5.4.5**) for avoiding deepwater coral and chemosynthetic communities during project siting should suffice to also avoid significant impacts from an SBF base oil spill.

5.5.1.4 Streamer Cable Fluid Leak or Spill

Streamer cables towed by seismic survey vessels typically contain a light aliphatic hydrocarbon (similar to kerosene) for electrical insulation and neutral buoyancy. Breaks in the cable are rare and usually occur when currents drag the cables around a fixed structure (e.g., a platform). Fish bites from large fishes may also occasionally puncture towed streamer cables. If a streamer cable were damaged or began leaking, small volumes of the cable fluid could be released into the ocean. In most cases, the spill would be limited to the volume of one section of the streamer, which is roughly 100 to 200 L of fluid (Continental Shelf Associates, Inc., 2004).

The released fluid would be expected to evaporate rapidly and be quickly diluted by seawater. The area that could be affected by a spill of cable fluid would be within a few metres to tens of metres of the cable. The spill would have a brief, localised impact on water quality by producing a sheen on the sea surface. The impacts would be minor.

Newer cables do not contain buoyancy fluids, but instead rely on a solid foam polymer for buoyancy (Continental Shelf Associates, Inc., 2004). Use of these cables obviously avoids the risk of spilling cable fluid.

→ **Conclusions** – There is a small risk of a leak or spill from streamer cables during seismic surveys. The volume would typically be small (e.g., 100 to 200 L), and the spill would have minor, localised effects on water quality.

→ **Existing Control Measures** – Under MARPOL, ships including seismic survey vessels are required to have in place a SOPEP. The SOPEP will contain the necessary reporting procedures and actions required to control discharge, and the steps necessary to initiate an external response for any spills.

→ **Recommended Mitigation** – No additional mitigation is recommended.

5.5.2 Hydrogen Sulphide Release

A release of hydrogen sulphide (H_2S) is an accident that could occur during the exploration or exploitation phase. Sulphur may be present in oil as elemental sulphur, within H_2S gas, or within organic molecules (MMS, 2007b). Although sulphur-rich petroleum is often called “sour” regardless of the type of sulphur present, the term “sour” should properly be applied to petroleum containing appreciable amounts of H_2S, and “sulphurous” should be applied to other sulphur-rich petroleum types. Gas streams with H_2S are frequently treated offshore by amine units to reduce the corrosive properties of the product.

Environmental, health, and safety concerns associated with an H_2S release include irritation, injury, and lethality to personnel and wildlife, and equipment and pipeline corrosion. However, the risk is highly localised. Normally, dispersion mechanisms in the atmosphere (wind, etc.) cause natural gas leaks and associated H_2S to disperse quickly. According to MMS (2007b), for a very large facility (throughput on the order of 100 MMcfd of produced natural gas) with high concentration levels (on the order of 20 000 ppm) and with very calm winds (speed of <1 m/sec), H_2S levels reduce to 20 ppm at several kilometres from the source; H_2S levels are reduced to 500 ppm at 1 km. Most "sour gas" facilities have H_2S concentrations below 500 ppm, which reduces to 20 ppm within the dimensions of a typical platform (or considerably less).

The risk of significant water column effects is low because H_2S is highly soluble in water and is oxidised over a period of hours (MMS, 2007b).

→ **Conclusions** – An accidental H_2S release could have significant localised effects on air quality and human health. The extent of the risk would depend on the size and H_2S concentration of the release and ambient meteorological conditions.

→ **Existing Control Measures** – Under the Hydrocarbons Regulations of 2007, licensees are required to submit a well location report including geological and geophysical information and safety measures to be used in the drilling of the well.

→ **Recommended Mitigation** – Licensees should be required to submit information on expected H_2S levels for prospective drillsites as part of the approval process for drilling activities. Where there is a significant risk of encountering H_2S during operations, licensees should be required to submit an H_2S Contingency Plan.

5.6 CUMULATIVE AND SYNERGISTIC EFFECTS

Cumulative effects are those resulting from the incremental effects of the proposed action when added to other past, present, and reasonably foreseeable future actions, regardless of who undertakes them. Cumulative effects can result from individually minor, but collectively significant, actions taking place over time.

To evaluate cumulative effects, it is necessary to consider the ecological context of the licence area and the existing environmental stresses and issues. Hadjichristophorou (2002) identifies several key environmental characteristics of the region:

- The Levantine Basin, because of its relative isolation, has a high degree of endemism;
- Salinity and temperature in surface waters are higher in than the rest of the Mediterranean;
- The area is ultra-oligotrophic, i.e., it has a very low concentration of nutrients; and
- It has low productivity due to its ultra-oligotrophic nature, and consequently has a relatively high species diversity and very low biomass.

Demetropoulous (2002) identifies several key factors affecting the ecological equilibrium of the Cyprus marine environment:

- Fishing and overfishing, in particular with trawlers but also with many other methods, in shallow waters;
- Urban and tourism development of the coastal zone, which affects habitats and species dependent on this zone (sea turtles, monk seals, ghost crabs, etc.);

- Pollution – especially increases in nutrients. The sensitivity of the marine waters surrounding Cyprus to nutrients is very high, as the background levels of these substances (nitrates and phosphates) are very low; and

- The Lessepsian migration, which is the movement of Indo-Pacific organisms into the Mediterranean Sea through the Suez Canal. Several hundred species have established themselves in the Eastern Mediterranean and now comprise over 12% of the Eastern Mediterranean marine fauna. Recent immigrants include the green alga *Caulerpa racemosa*, which has spread explosively since about 1990 to cover very large areas of seabed around Cyprus.

The coastal area of Cyprus is under pressure from economic development, including in particular tourism, recreation, urban and infrastructural development and, to a lesser extent, agricultural and industrial development. Important environmental issues identified by Demetropoulous (2002) are presented in **Table 5.11.**

Table 5.11. Important marine environmental issues in Cyprus (From: Demetropoulous, 2002).

Issue	Problems	Status	Trend
Coastal mass tourism/tourism infrastructure	Destruction of coastal habitats (e.g., beaches, sand dunes, maquis) physical alteration of coastline, lights, and trampling	Affects most of the coast of the island. Of special significance to remaining natural areas (e.g., Chrysochou Bay, Akamas)	Increasing rapidly
Urbanisation and industrialization of coastal zone	Destruction of habitats, physical alteration of coastline, pollution, and landscape	Affects mainly the vicinity of coastal towns, but also natural areas, wetlands, etc.	Increasing
Fishing on sensitive ecosystems/habitats	Trawling on *Posidonia* meadows	Affects most of the south coast (Cape Pyla to Paphos). More serious in Episkopi Bay to Petra to Romiou	Stable
Pollution mainly from organic pollutants and nutrients	Destruction of habitats	Affects mainly Limassol Bay and Zygi – Moni area	Stable – some increase in nutrients
Coastal works – mainly breakwaters	Affects habitats/species in shallow waters and beaches	Apparent mainly but not exclusively in bays, Limassol, Larnaca. Potential problem in Chrysochou Bay	Stable – increasing threats in new areas/bays
Freshwater availability	Affects coastal wetlands and coastal salt lakes	Important for the functioning of wetlands and aquatic birds	Stable – increasing
Overfishing	Affects species diversity/equilibria	More apparent in area between Larnaca and Paralimni	Stable – slight increases
Invasive species	Affects species diversity/equilibria	Widespread	Increasing

In addition to the issues associated with activities in Cyprus, the Mediterranean Sea is in a region with numerous pollution sources and other threats to ecological health. A report by Greenpeace (2006) identifies several regional issues including overfishing, aquaculture, offshore hydrocarbon activities, refineries, sand and gravel extraction, spills from tanker traffic, pollution from terrestrial runoff, and climate change.

Table 5.12 presents an evaluation of the potential for significant cumulative effects from the hydrocarbon licensing programme.

Table 5.12. Potential cumulative effects associated with the hydrocarbon licensing programme.

Environmental Resource	Routine Programme Effects (excluding Accidents)	Other Regional Activities Affecting the Resource	Significant Cumulative Effect Likely?
Air quality	• Minor effects on air quality similar to existing vessel and aircraft traffic in region	• Air pollutant emissions from other ships and aircraft • Distant pollution sources (e.g., cities and industries in southern and eastern Europe)	No
Water quality	• Turbidity from drilling discharges; elevated nutrients, suspended solids, and biochemical oxygen demand from other effluents	• Effluents from existing ship traffic • Agricultural runoff and urban effluents • Spills from tankers and other ships	No
Sediments/geology	• Minor sea floor disturbance due to placement of structures and/or anchors; altered sediment grain size due to drilling discharges	• Bottom trawling • Agricultural runoff and coastal erosion	No
Plankton	• Minor, transient effects due to effluent discharges	• Effluents from existing ship traffic • Spills from tankers and other ships	No
Fishes	• Minor, transient effects due to effluent discharges	• Existing fishing activities including overfishing	No
Deepwater corals	• Potential physical damage due to placement of structures and/or anchors	• Bottom trawling	No
Chemosynthetic communities	• Potential physical damage due to placement of structures and/or anchors	• Bottom trawling	No
Soft bottom benthos	• Potential physical damage due to placement of structures and/or anchors; burial and smothering by drilling discharges	• Bottom trawling	No
Marine mammals	• Disturbance/avoidance due to noise • Potential for vessel strikes • Potential for ingestion of or entanglement with marine debris	• Existing ship traffic (noise, effluents, spills)	No
Sea turtles	• Disturbance/avoidance due to noise • Potential for vessel strikes • Potential for ingestion of or entanglement with marine debris	• Existing ship traffic (noise, effluents, spills)	No
Marine and coastal birds	• Disturbance due to noise • Potential for ingestion of or entanglement with marine debris	• Existing aircraft traffic (noise) • Coastal development	No
Coastal habitats	• Little or no effect (depends on need for and location of pipeline landfalls, if any)	• Coastal development	No
Protected areas	• Little or no effect (depends on need for and location of pipeline landfalls, if any)	• Coastal development	No
Fishing activities	• Possibility of temporary exclusion from certain areas; potential gear damage or entanglement	• Overfishing • Invasive species	No
Shipping activities	• Possibility of temporary exclusion from certain areas	• None identified	No
Telecommunications cables	• Assumed to be avoided during placement of structures and anchors	• None identified	No
Shipwrecks	• Potential physical damage due to placement of structures and/or anchors	• Bottom trawling • Anchoring of other ships	No
Recreation and tourism	• Little or no effect	• Coastal development, urbanisation • Coastal pollution	No
Coastal communities	• Little or no effect	• Coastal development, urbanisation • Coastal pollution	No

5.7 TRANSBOUNDARY EFFECTS

The licence area is near or adjacent to the EEZ of several countries in the region, including Turkey, Lebanon, Syria, Israel, and Egypt.

As discussed in **Sections 5.2** through **5.5**, most of the effects of offshore hydrocarbon activities are localised within the immediate vicinity of wellsites, pipelines, or other facility locations and are unlikely to affect neighboring jurisdictions.

Table 5.13 presents an evaluation of the potential for transboundary effects, based on the impact factors for each phase of hydrocarbon activities (prospecting, exploration, and exploitation) as well as accidental events. The evaluation identifies two sources of potentially significant transboundary effects – a crude oil spill from a blowout and a diesel fuel spill. The actual effects of an oil spill could vary substantially depending on spill volume, chemical composition of the spilled oil, oceanographic and meteorological conditions, and the effectiveness of spill response measures.

Table 5.13. Potential sources and significance of transboundary effects.

Impact Factor	Potential Source of Transboundary Effects	Potentially Significant?
Prospecting		
Airgun noise	Noise detectable many kilometres away, but risk of significant impacts (e.g., to marine mammals and sea turtles) is limited to a few hundred metres from survey vessels in the Cyprus offshore licence area	No
Vessel traffic and towed streamers	Some survey lines and towed streamers may extend slightly into adjacent jurisdictions	No
Effluent discharges	Discharges rapidly diluted near survey vessels in the Cyprus offshore licence area	No
Air pollutant emissions	Emissions rapidly dispersed near survey vessels in the Cyprus offshore licence area	No
Sea floor disturbance	Effects limited to sites where cables or equipment are laid on the sea floor in the Cyprus offshore licence area	No
Exploration		
Drilling rig installation and removal	Effects limited to wellsites and anchor locations in the Cyprus offshore licence area	No
Drilling rig presence	Effects limited to vicinity of drilling rigs in the Cyprus offshore licence area	No
Drilling discharges	Turbidity plumes may extend several kilometres from drilling rigs in the Cyprus offshore licence area, and thin layers of drilling fluids may be dispersed over many kilometres	No
Other effluent discharges	Discharges rapidly diluted near drilling rigs in the Cyprus offshore licence area	No
Marine debris	Floating debris can disperse over a wide area; sea floor effects limited to vicinity of drilling rigs in the Cyprus offshore licence area	No
Air pollutant emissions	Emissions rapidly dispersed near drilling rigs in the Cyprus offshore licence area	No
Well testing	Emissions (and any oil droplets from fallout) rapidly dispersed near drilling rigs in the Cyprus offshore licence area	No
Support activities	Effects occur between wellsites in the Cyprus offshore licence area and shorebase(s) in Cyprus	No
Exploitation		
Facility installation	Effects occur mainly near wellsites in the Cyprus offshore licence area and along pipeline routes (if any) to shore in Cyprus	No
Presence of structures	Effects limited to vicinity of offshore structures in the Cyprus licence area	No
Drilling discharges	Turbidity plumes may extend several kilometres from drilling rigs in the Cyprus offshore licence area, and thin layers of drilling fluids may be dispersed over many kilometres	No

Table 5.13. (continued).

Impact Factor	Potential Source of Transboundary Effects	Potentially Significant?
Operational discharges	Discharges rapidly diluted near offshore facilities in the Cyprus licence area	No
Marine debris	Floating debris can disperse over a wide area; sea floor effects limited to vicinity of offshore facilities in the Cyprus licence area	No
Air pollutant emissions	Emissions rapidly dispersed near offshore facilities in the Cyprus licence area	No
Support activities	Effects occur between offshore facilities in the Cyprus licence area and shorebase(s) in Cyprus	No
Structure removal	Effects limited to offshore facility locations in the Cyprus licence area	No
Accidents		
Crude oil spill from a blowout	Effects could extend into neighboring jurisdictions depending on spill volume, chemical composition, oceanographic and meteorological conditions, and effectiveness of spill response measures	Yes
Diesel fuel spill	Effects could extend into neighboring jurisdictions depending on spill volume, chemical composition, oceanographic and meteorological conditions, and effectiveness of spill response measures	Yes
Drilling fluid base oil spill	Effects limited to vicinity of drilling rigs in the Cyprus offshore licence area	No
Streamer cable fluid leak or spill	Effects limited to vicinity of seismic survey vessels in the Cyprus offshore licence area	No
Hydrogen sulphide release	Effects limited to vicinity of drilling rigs or production facilities in the Cyprus offshore licence area	No

5.8 EFFECT SUMMARY

Table 5.14 summarises potential effects of offshore hydrocarbon activities in the Cyprus licence area based on the discussion in **Sections 5.2** through **5.5**. The effects are grouped by phase (prospecting, exploration, and exploitation), followed by a separate listing for Accidents. Within each phase, effects are organised by the impact factors identified for that phase. The table lists existing control measures and, for potentially significant effects (as defined in **Section 5.1.2**), any additional recommended mitigation measures. Additional details of mitigation and other recommendations are discussed in **Chapter 6**.

Table 5.14. Summary of potential effects from offshore hydrocarbon activities in the licence area of the Republic of Cyprus.

Impact Factor	Potentially Significant Effects	Minor or Negligible Effects	Existing Control Measures Identified	Additional Mitigation Recommended
Prospecting				
Airgun noise	• Auditory trauma to marine mammals and sea turtles (including endangered, critically endangered, and vulnerable species)	• Disturbance of fishes, plankton, other organisms	• None	• Require licensees to implement a protocol to reduce the risk of auditory trauma to marine mammals and sea turtles. The protocol should include at a minimum provisions for soft start, visual monitoring, and shutdown of the array
Vessel traffic and towed streamers	• Potential conflicts with fishing or shipping activities (e.g., temporary exclusion from certain areas, gear damage or entanglement)	• Small risk of vessels striking a marine mammal or sea turtle	• Hydrocarbon Regulations of 2007 require licensees to conduct operations in an environmentally acceptable and safe manner. It is assumed that licensees would notify Cyprus maritime authorities of survey location and schedule. Also, it is assumed that survey vessels would use appropriate signals in accordance with International Maritime Law	• Require licensees to consult with stakeholders prior to conducting streamer surveys to ensure that conflicts with fishing and shipping activities are minimised
Effluent discharges	• None	• Minor impacts on water quality similar to existing vessels in region	• MARPOL compliance	• None
Air pollutant emissions	• None	• Minor impacts on air quality similar to existing vessel and aircraft traffic in region	• MARPOL compliance	• None
Sea floor disturbance	• None	• Minor sea floor disturbance due to placement of cables or receiver boxes	• None	• None

Table 5.14. (continued).

Impact Factor	Potentially Significant Effects	Minor or Negligible Effects	Existing Control Measures Identified	Additional Mitigation Recommended
Exploration				
Drilling rig installation and removal	• Physical damage to deepwater corals (Eratosthenes Seamount), chemosynthetic communities, or historic shipwrecks due to placement of structures and/or anchors	• Physical damage to soft bottom benthos	• None	• Require licensees to evaluate project area for deepwater corals and chemosynthetic communities • Require licensees to maintain a separation distance of 100 m between any potential deepwater coral or chemosynthetic communities and any sea floor disturbances (including anchoring) within the activity footprint • Require licensees to conduct a remote sensing survey to evaluate project area for shipwrecks and submit an archaeological assessment report by a qualified marine archaeologist, including recommendations for avoidance or further study
Drilling rig presence (including noise and lights)	• None	• Drilling rigs are likely to attract pelagic fishes and plankton; noise may cause marine mammals or sea turtles to avoid the area	• None	• None
Drilling discharges	• Burial and anoxia effects on deepwater corals (Eratosthenes Seamount) or chemosynthetic communities if present within 500 m	• Burial and anoxia effects on soft bottom benthos	• None	• Require licensees to evaluate project area for potential presence of deepwater corals and chemosynthetic communities, and maintain a separation distance of at least 500 m from any drilling discharges
Other effluent discharges	• None	• Minor impacts on water quality near drilling rigs, similar to existing ship traffic in region	• MARPOL compliance	• None

Table 5.14. (continued).

Impact Factor	Potentially Significant Effects	Minor or Negligible Effects	Existing Control Measures Identified	Additional Mitigation Recommended
Marine debris	• Risk of death or injury to marine mammals, sea turtles, or birds due to ingestion of or entanglement with accidentally discarded debris	• Water quality impacts; cluttering of sea floor and shorelines	• MARPOL compliance • Hydrocarbon Regulations of 2007 require licensees to perform site restoration activities in accordance with good international petroleum industry practice	• None (existing measures assumed to be effective in avoiding significant effects)
Air pollutant emissions	• None	• Minor impacts on air quality, similar to other vessel and aircraft traffic in region	• MARPOL compliance	• None
Well testing	• Fallout of oil droplets due to incomplete combustion could produce a sheen on sea surface	• Minor impacts on air quality	• MARPOL compliance	• Require licensees to use a high-efficiency burner to minimise fallout of oil droplets and monitor for sheen on sea surface
Support activities	• Helicopters flying over Special Protection Areas (SPAs) and Important Bird Areas (IBAs) could disturb coastal birds	• Small risk of vessel striking a marine mammal or sea turtle	• None	• Advise licensees to avoid flying over SPAs and IBAs
Exploitation				
Facility installation	• Physical damage to deepwater corals (Eratosthenes Seamount), chemosynthetic communities, or historic shipwrecks due to placement of structures and/or anchors	• Physical damage to soft bottom benthos	• None	• Require licensees to evaluate project area for deepwater corals and chemosynthetic communities • Require licensees to maintain a separation distance of 100 m between any potential deepwater coral or chemosynthetic communities and any sea floor disturbances (including anchoring, sea floor template installation, and pipeline construction) • Require licensees to conduct a remote sensing survey to evaluate project area for shipwrecks and submit an archaeological assessment report by a qualified marine archaeologist, including recommendations for avoidance or further study

Table 5.14. (continued).

Impact Factor	Potentially Significant Effects	Minor or Negligible Effects	Existing Control Measures Identified	Additional Mitigation Recommended
Presence of structures	• None	• Platforms are likely to attract pelagic fishes and plankton; noise may affect behaviour of marine mammals or turtles	• None	• None
Drilling discharges	• Burial and anoxia effects on deepwater corals (Eratosthenes Seamount) or chemosynthetic communities if present within 500 m	• Burial and smothering of soft bottom benthos	• None	• Require licensees to evaluate project area for potential presence of deepwater corals and chemosynthetic communities, and maintain a separation distance of at least 500 m from any drilling discharges •
Operational discharges	• None	• Minor impacts on water quality near offshore facilities, similar to existing ship traffic in region	• MARPOL compliance	• None
Marine debris	• Risk of death or injury to marine mammals, turtles, or birds due to ingestion of or entanglement with accidentally discarded debris	• Water quality impacts; cluttering of sea floor and shorelines	• MARPOL compliance • Hydrocarbon Regulations of 2007 require licensees to perform site restoration activities in accordance with good international petroleum industry practice	• None (existing measures assumed to be effective in avoiding significant effects)
Air pollutant emissions	• None	• Minor impacts on air quality, similar to other vessel and aircraft traffic in region	• MARPOL compliance	• None
Support activities	• Helicopters flying over SPAs and IBAs could disturb coastal birds	• Small risk of vessel striking a marine mammal or sea turtle	• None	• Advise licensees to avoid flying over SPAs and IBAs
Structure removal	• Potential death or injury of a marine mammal or turtle (including endangered, critically endangered, or vulnerable species) if explosives are used	• Death or injury of fishes and other marine life near structures	• None	• Require protocol for protecting marine mammals and turtles during structure removal in accordance with international best practice

Table 5.14. (continued).

Impact Factor	Potentially Significant Effects	Minor or Negligible Effects	Existing Control Measures Identified	Additional Mitigation Recommended
Accidents				
Oil spills including • Crude oil spill from a blowout • Diesel fuel spill • Drilling fluid base oil spill • Streamer cable fluid leak or spill	• Depending on size and nature of spill, effects could include violation of water quality standards; contamination of sediments; death or injury of marine mammals, turtles, and birds; contamination of coastal habitats including beaches; and interference with fishing, shipping, recreation, and tourism during response and cleanup operations	• Localised effects on air quality due to volatilisation of hydrocarbons • Effects on soft bottom benthos around wellsites in the event of a subsea blowout or a drilling fluid base oil spill sinking to the sea floor	• MARPOL requires Shipboard Oil Pollution Emergency Plan • Hydrocarbons Regulations of 2007 require licensees to (1) have an approved Contingency Plan for hydrocarbon leakage; (2) respond in a case of an accident, using reasonable and necessary measures in accordance with generally accepted practices applied in the international petroleum industry	• Oil spill trajectory modelling should be conducted to aid in understanding the fate of an oil spill at various locations in the licence area, the potentially affected environmental resources, and minimum response times
H_2S release	• Violation of air quality standards; potential death or injury of humans on offshore facilities and adjacent waters; potential death or injury of wildlife including birds	• None	• Under the Hydrocarbons Regulations of 2007, licensees are required to submit a well location report including geological and geophysical information and safety measures to be used in the drilling of the well	• Licensees should be required to submit information on expected H_2S levels for prospective drillsites as part of the approval process for drilling activities. • Where there is a significant risk of encountering H_2S during operations, licensees should be required to submit an H_2S Contingency Plan

Chapter 6
Conclusions and Recommendations

6.1 KEY FINDINGS AND RECOMMENDATIONS

The purpose of this Environmental Report is to evaluate the likely significant environmental effects of implementing the hydrocarbon licensing programme in the study area. Key issues and recommendations are presented below.

Issue #1 Effects of Sea Floor Disturbances and Drilling Discharges on Deepwater Corals (Eratosthenes Seamount)

The Eratosthenes Seamount is located near the centre of the licence area, primarily in Blocks 7 and 8, but also extending slightly into Blocks 11 and 12 (**Figure 6.1**). It can be defined by a box extending from approximately from 33°20’ to 34°N latitude and 32°20’ to 33°E longitude. The seamount measures 120 km in length and is 80 km wide at its base. It rises approximately 2000 m from the surrounding abyssal plain, reaching a water depth of 690 m at the top of the feature. Although the geology of the seamount has been studied extensively (see **Section 4.1.2.1**), very little is known about the associated biological communities (see **Section 4.2.2.3**).

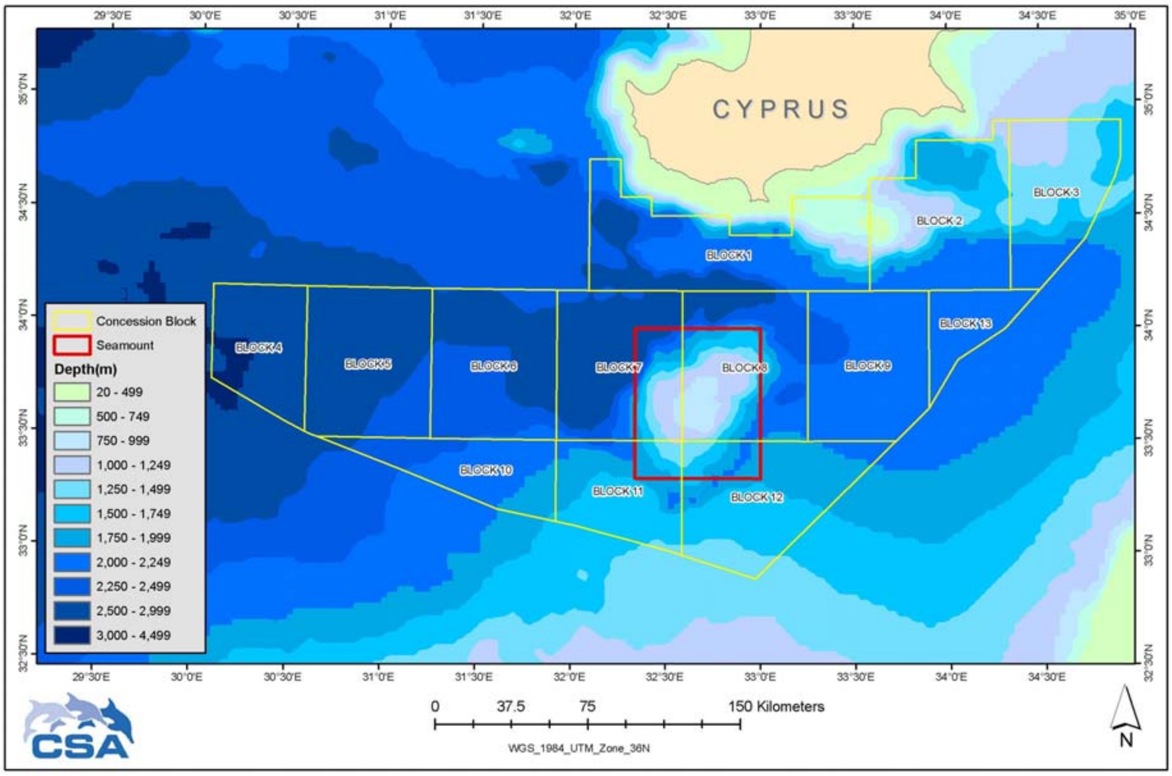


Figure 6.1. Location of the Eratosthenes Seamount as defined by a box extending from 33°20’ to 34°N latitude and 32°20’ to 33°E longitude.

In the only biological study to date, Galil and Zibrowius (1998) documented the presence of a diverse and rich fauna on the top of the seamount and found invertebrate abundances to be higher than at sites of comparable depth in the eastern Levantine Basin. The same study documented the presence of rare deepwater scleractinian corals as well as commercially important shrimp species. The surprising faunal diversity and density indicate a uniquely rich environment, possibly an isolated refuge for relict populations of species that have disappeared from the adjacent continental slope. Additional environmental studies of the Eratosthenes Seamount are recommended (see **Section 6.3**).

Interest in deepwater corals has increased rapidly in the last decade as more coral systems are discovered and their importance in providing habitat for a diverse community, including commercially important fisheries species, is realised. With the increasing influence of human activity in deep waters, including deepwater fisheries and energy resource development, an understanding of the biology and distribution of these corals has become vital to their protection (for examples, see Rogers, 1999; Koenig et al., 2000; Gage, 2001; Koslow et al., 2001; Fosså et al., 2002; Hall-Spencer et al., 2002; Schroeder, 2002). Efforts are currently underway to minimise anthropogenic disturbance on the *Lophelia* “Darwin Mounds” off the coast of Ireland, Norwegian *Lophelia* banks, Australian seamount corals, *Primnoa* (a deepwater octocoral) stands in the Gulf of Alaska, and *Primnoa* off the eastern coast of Canada. These corals often provide habitat for deepwater fisheries species (Koslow et al., 2001; Andrews et al., 2002; Hall-Spencer et al., 2002). In addition to these commercially important species, these deepwater coral habitats may contain abundances of macrofauna orders of magnitude higher than the surrounding sea floor.

The Eratosthenes Seamount does not have any formal protected status (e.g., as an SPA under the Barcelona Convention or an SCI or SAC under the Habitats Directive – Council Directive 92/43/EEC of 21 May 1992). However, in 2006, the GFCM recommended that demersal fishing with towed dredges and bottom trawl nets be banned in the seamount area. In addition, the Council of the European Union proposed a regulation protecting vulnerable habitats such as reefs, seamounts, deepwater corals, hydrothermal vents, and sponge beds from bottom fishing activities. It was adopted by the European Parliament in 2008 (Council Regulation No. 734/2008 of 15 July 2008).

The ban on trawling and dredging on the Eratosthenes Seamount is prudent because these activities indiscriminately sweep the sea floor. In contrast, offshore hydrocarbon activities produce localised (and in many cases, avoidable) effects at specific, known sites. For example, deepwater corals could be susceptible to physical damage from anchoring, placement of production facilities on the sea floor, and installation of pipelines. Based on the water depths in the seamount area, it is expected that either conventionally moored (anchored) or dynamically positioned vessels could be used. Conventionally moored drilling rigs, production facilities, and pipelaying barges use an array of anchors to maintain position, and these have the potential for significant effects. Dynamically positioned vessels do not anchor on the sea floor.

Unlike shallow water corals, which are dependent on sunlight for reef-building activities, deepwater corals are not likely to be significantly affected by intermittent turbidity from drilling discharges. However, if present at or near a wellsite, the corals could be buried by cuttings deposits. As discussed in **Section 5.3.5**, these effects are most likely to occur within about 500 m of wellsites.

The SEA did not identify any Cyprus regulations or guidelines specifically protecting deepwater corals or the Eratosthenes Seamount during offshore hydrocarbon activities. However, several marine areas offshore the U.K., including Saturn Reef (a shallow water reef), Dogger Bank (a sand bank), and the Braemer and Scanner Pockmark features (potential chemosynthetic community sites) were designated or proposed under the Habitats Directive as SACs (Department of Trade and Industry, 2007). Although the Eratosthenes Seamount is not formally designated as an SPA under the Barcelona Convention, it is helpful to review the relevant provisions of the offshore protocol of the convention applicable to such areas. Article 21 of the protocol specifies that Parties take special measures in conformity with international law to prevent, abate, combat, and control pollution arising from activities in SPAs. These can include special restrictions or conditions when granting authorizations for such areas, such as the preparation and evaluation of

EIAs and the elaboration of special provisions in such areas concerning monitoring, removal of installations, and prohibition of any discharge. Annex V(B) of the protocol specifically prohibits oil-based cuttings discharges from these areas.

Most significant effects of hydrocarbon activities on deepwater corals on the Eratosthenes Seamount could be avoided by requiring licensees to conduct site-specific mitigation for individual projects. This is the basis for the following recommendations.

> **Recommendations** – Prior to conducting activities that involve drilling, anchoring, placement of drilling rigs or production facilities on the sea floor, or installation of pipelines, licensees should be required to use high-resolution seismic survey (i.e., geohazards) data, 3D seismic survey data, and any other pertinent information available, to identify hard bottom areas that could support deepwater coral communities. If any such areas are identified, licensees should be required to conduct muds and cuttings discharge modelling to establish a separation distance that will protect these hard bottom areas and associated biological communities. In other parts of the world (i.e., the Gulf of Mexico), licensees are required to maintain the following separation distances: at least 500 m from each proposed drilling fluid and cuttings discharge location; and at least 100 m from the location of all other proposed sea floor disturbances (including those caused by anchors, anchor chains, wire ropes, sea floor template installation, and pipeline construction) (MMS, 2004). The Eratosthenes Seamount area is defined by a box extending from 33° to 34°N latitude and 32° to 33°E longitude.

Issue #2 Effects of Sea Floor Disturbances and Drilling Discharges on Chemosynthetic Communities

Chemosynthetic communities are rare, often high-density deepwater assemblages that exist independent of photosynthesis (MacDonald, 2002). They are based on symbiotic bacteria that oxidise simple compounds such as hydrogen sulfide (H_2S) and methane (CH_4). At water depths beyond those supporting photosynthesis and where seepage of hydrocarbons, venting of hydrothermal fluids, or other geological processes supply abundant reduced compounds, chemosynthesis can become the dominant component of the ecosystem. While the underlying process is microbial, chemosynthetic communities in the deep sea achieve prominence because of the symbiotic partnership between chemosynthetic bacteria and invertebrate hosts such as tubeworms and mussels (Fisher, 1990).

The existence of chemosynthetic communities in the licence area has not been documented, but the potential clearly exists in the region. Maps from the HERMES (Hotspot Ecosystems Research on the Margins of European Seas) project show several such habitats in the eastern Mediterranean (Weaver et al., 2004). Recent acoustic data collection surveys have documented the widespread distribution of mud volcanoes and related mud flows, fluid seeps, and brines along the Cyprus Arc (Huguen et al., 2005), which runs between the Eratosthenes Seamount and the Cyprus mainland. In addition, the geological presentation in the licence package for the 1st Licensing Round cites gas venting, gas chimneys, and natural oil slicks (i.e., from seepage) in the region (BeicipFranlab, 2007). These characteristics are indicative of conditions that could support chemosynthetic communities (Le Pichon, 1990; MacDonald, 2002; Roy et. al., 2004).

During offshore hydrocarbon activities, chemosynthetic communities would be susceptible to physical damage from anchoring, placement of production facilities on the sea floor, and installation of pipelines (see **Sections 5.3.3** and **5.4.3**). Based on the water depths in the licence area, it is expected that either conventionally moored (anchored) or dynamically positioned vessels could be used. Conventionally moored drilling rigs, production facilities, and pipelaying barges use an array of anchors to maintain position, and these have the most potential for significant effects. Dynamically positioned vessels do not anchor on the sea floor.

Because they do not depend on sunlight, chemosynthetic communities are not likely to be significantly affected by turbidity from drilling discharges. However, if present within about 500 m of a wellsite, these communities could be buried by cuttings deposits.

EU recognition of the ecological importance of chemosynthetic communities is reflected in the previously mentioned regulation (No. 734/2008) protecting hydrothermal vents (one type of chemosynthetic community) from bottom fishing activities. However, the Environmental Report did not identify any EU or Cyprus regulations or guidelines specifically protecting chemosynthetic communities during offshore hydrocarbon activities. In the absence of EU regulations, guidance is available from experience in another region where chemosynthetic communities have been discovered near intense offshore hydrocarbon activities – the Gulf of Mexico (MMS, 2007a). Studies in that area have shown that high-density chemosynthetic sites are associated with recognizable geophysical features and can be effectively avoided. For about 10 years, the MMS has implemented a mitigation measure that has proved effective in protecting these communities. Those requirements are the basis for the following recommendation.

> **Recommendation** – Prior to conducting exploration or exploitation activities that involve drilling, anchoring, placement of drilling rigs or production facilities on the sea floor, or installation of pipelines, licensees should be required to use high-resolution seismic survey (i.e., geohazards) data, 3D seismic data, and any other pertinent information available to identify shallow geologic features that could support high-density chemosynthetic communities such as (a) hydrocarbon-charged sediments associated with surface faulting, (b) acoustic void zones associated with surface faulting, (c) mounds or knolls, and (d) gas or oil seeps. If any such features are identified, licensees should be required to maintain the following separation distances: at least 500 m from each proposed drilling fluid and cuttings discharge location, and at least 100 m from the location of all other proposed sea floor disturbances (including those caused by anchors, anchor chains, wire ropes, sea floor template installation, and pipeline construction).

Issue #3 Effects of Sea Floor Disturbances on Shipwrecks and Submerged Archaeological Resources

The licence area is in a region where historical shipwrecks and other submerged archaeological resources are likely to be present. These features are susceptible to physical damage from sea floor-disturbing activities such as anchoring, placement of production facilities on the sea floor, and installation of pipelines (see **Sections 5.3.3** and **5.4.3**).

The SEA did not identify any Cyprus regulations or guidelines specifically protecting shipwrecks and other submerged archaeological resources during offshore hydrocarbon activities. However, guidance is available from experience in another region where shipwrecks have been discovered near intense offshore hydrocarbon activities – the Gulf of Mexico (MMS, 2005b). This experience indicates that likely locations of shipwrecks and submerged archaeological sites can be delineated by conducting a remote sensing survey of the seabed and near-surface sediments. Therefore, it is recommended that licensees be required to conduct a remote sensing survey and an archaeological assessment prior to conducting sea floor-disturbing activities. Typically, such archaeological surveys and assessments are conducted in conjunction with other surveys that an operator conducts prior to drilling or production (e.g., for shallow geohazards).

> **Recommendation** – Prior to conducting exploration or exploitation activities that involve anchoring, placement of drilling rigs or production facilities on the sea floor, or installation of pipelines, licensees should be required to conduct a remote sensing survey of the sea floor to evaluate the potential for shipwrecks and other submerged archaeological resources. The surveys should use a line spacing of 300 m and be conducted using a towed, dual-channel, dual-frequency, side-scan sonar system to

provide continuous planimetric images of the sea floor. A system that operates at no less than 100 kHz should be used to provide sufficient resolution of sea floor conditions. Licensees should be required to submit an archaeological assessment report by a qualified marine archaeologist to include any identified archaeological resources and recommendations for avoidance or further investigation. Based on the report, the Ministry could require avoidance or other protective measures.

Issue #4 Effects of Airgun Noise on Marine Mammals and Turtles

The region supports a diverse marine mammal fauna, including several species listed by the IUCN as endangered (e.g., fin whale) or vulnerable (e.g., sperm whale). Common species are likely to include the bottlenose dolphin, common dolphin, Risso's dolphin, and striped dolphin. The rare, critically endangered Mediterranean monk seal may be present in nearshore Cyprus waters but is unlikely to be found in offshore waters of the licence area due to the depth and distance from shore. Three sea turtles species occur in the area; the green and loggerhead turtles are listed by the IUCN as endangered, and the leatherback turtle is listed as critically endangered.

During seismic surveys, there is a risk of temporary or permanent auditory trauma to marine mammals and sea turtles within a range of a several hundred metres of a typical airgun array, particularly if they swim beneath the array (see **Section 5.2.3**). Mysticetes (e.g., fin whales) and deep-diving odontocetes (e.g., sperm whales and beaked whales) are probably at greater risk than small odontocetes. Relatively little is known of sea turtle hearing, but sounds produced by airguns overlap with the frequency range where turtle hearing is most sensitive. Behavioural responses of marine mammals and sea turtles, such as avoidance, may occur at ranges of several kilometres from an airgun array.

The SEA did not identify any Cyprus regulations or guidelines specifically protecting marine mammals or sea turtles from auditory trauma during seismic surveys. Such mitigation measures have only come into common use within about the last decade, and there are many uncertainties about their effectiveness. Mitigation recommendations are proposed based on widely used protective measures that have been developed for the U.K. (JNCC, 2004, 2008) and the U.S. Gulf of Mexico (MMS, 2007a).

Recommendation – During seismic surveys, licensees should be required to implement a protocol to reduce the risk of auditory trauma to marine mammals and sea turtles. The protocol should include at a minimum the following provisions:

- **Soft start** – Every time the use of the seismic array is initiated, "soft-start" procedures should be used to allow time for marine mammals and turtles to move away before the array reaches full power. The process should begin with the smallest source in an array and build up slowly over 20 to 40 minutes.

- **Visual monitoring** – Beginning at least 30 minutes before startup during daylight hours, visual observers should monitor a safety (exclusion) zone of 500-m radius around the source vessel. Startup of the array cannot begin until the safety zone is clear of marine mammals and turtles for at least 20 minutes.

- **Shutdown of the array** – Visual monitoring of the sea surface should continue while the seismic array is operating during daylight hours, and the array should be shut down if a whale, monk seal, or sea turtle enters the safety zone during visual monitoring. A whale is defined as a cetacean other than Family Delphinidae (i.e., including any baleen, sperm, or beaked whale species).

Issue #5 Effects of Seismic Survey Vessels and Towed Streamers on Fishing and Shipping

Fishing activities in the licence area include bottom trawling and long-lining (see **Section 4.3.1**). During seismic surveys with towed streamers, some fishing and shipping activities may be temporarily interrupted due to the extent of the moving safety zone around the streamers (see **Section 5.2.4**). The safety zones could result in temporary exclusion of fishing boats and other ships from certain areas. Some vessels would need to detour around the array. There is also the possibility of entanglement with long-line sets.

No existing control measures for this activity were identified. However, the Hydrocarbons Regulations of 2007 require licensees to ensure that operations are conducted in an environmentally acceptable and safe manner, consistent with the applicable environmental legislation and good international industry practice. Also, it is assumed that survey vessels would use appropriate signals in accordance with International Maritime Law (including communications via radio, lights, and flags) to warn other vessels of the exclusion zone.

> **Recommendation** – Licensees should be required to consult with stakeholders prior to conducting streamer surveys to ensure that conflicts with fishing and shipping activities are minimised.

Issue #6 Effects of Well Testing on Air and Water Quality

If a hydrocarbon formation is discovered during exploratory drilling, well testing may be conducted. A well test (drillstem test) is a procedure to determine the productive capacity, pressure, permeability, and/or extent of a hydrocarbon reservoir. If hydrocarbons are brought to the surface during the well test, they are disposed of by burning. The oil, water, and chemicals are pumped to a burner on a flare boom where the fluids are atomized in a chamber with compressed air and the mixture ignited. This combustion will result in emissions to the atmosphere. Gas from well testing is either flared or vented directly to the atmosphere.

Air pollutant emissions from well testing will have a localised effect on air quality near the wellsite during the test period (see **Section 5.3.9**). Due to the distance offshore, no effects on coastal or onshore air quality are expected. However, fallout of oil droplets from well testing can produce a sheen on the sea surface, which would represent a significant effect.

> **Recommendation** – During well testing, licensees should be required to (1) use a high-efficiency burner to reduce the amount of hydrocarbon fallout and (2) monitor the sea surface to ensure that no visible sheen is produced.

Issue #7 Effects of Helicopter Traffic on Important Bird Areas

Vessel and helicopter traffic could periodically disturb individuals or groups of coastal birds. The effects would be similar to those of existing vessel and aircraft traffic. It is likely that individual birds would experience at most a short-term, behavioural disruption, and the effect is considered minor. However, significant effects could occur if helicopters traveled frequently over Special Protection Areas (SPAs) designated under the Birds Directive, or other Important Bird Areas (IBAs) (see **Section 5.3.10** and **5.4.9**). There are currently seven designated SPAs in Cyprus (European Commission, 2008). In addition, BirdLife International (2008) identifies 25 IBAs on Cyprus. IBA sites in the vicinity of Limassol include Akrotiri Cliffs, Akrotiri Salt Lake including Bishop's Pool, Phasouri Reedbeds, Episkopi Cliffs, and Cape Aspro. IBA sites near Larnaca include Larnaca salt lakes and Cape Greco.

Recommendation – Licensees should be advised that helicopters engaged in support operations should avoid flying over SPAs and IBAs when traveling to or from the drilling rig. A map of SPAs and IBAs should be provided for this purpose.

Issue #8 Effects of Structure Removals on Marine Mammals and Sea Turtles

If offshore production facilities are established in the licence area, they would eventually be decommissioned at the end of their useful life. During decommissioning, offshore production facilities such as platforms would be removed. Typically, the platform legs are cut at the sea floor so that no obstruction would protrude. It is not known at this time whether explosive charges would be used during decommissioning in the licence area. For offshore pipelines, the most common international practice is to clean the pipeline and abandon it in place.

If explosive charges are used for platform removal, then there is the potential for effects on marine mammals and sea turtles, including endangered, critically endangered, and vulnerable species (see **Section 5.4.10**). The risk of deaths and injuries of marine mammals and turtles can be effectively avoided through monitoring during structure removals.

Recommendation – Licensees should be required to follow international best practice for safe structure removal during decommissioning. Prior to structure removals, a decommissioning plan should be prepared that includes monitoring for the presence of marine mammals and sea turtles to avoid effects of underwater detonations.

Issue #9 Effects of Oil Spills

Oil spills are rare events, but the environmental and socioeconomic effects can be significant. Potential spill sources, risks, and effects are discussed in **Section 5.5**.

Spill prevention measures and contingency planning are key elements in reducing the risk of significant effects from oil spills. Under the Hydrocarbons Regulations of 2007, prior to the commencement of any drilling operations, the licensee must prepare and submit to the Minister for evaluation and approval a contingency plan for hydrocarbon leakage and fire. In the event of leakage or fire, the licensee immediately applies the relevant contingency plan. In a case where an emergency or accident affects the environment, the licensee is required to take reasonable and necessary measures in accordance with generally accepted practices applied in the international petroleum industry.

Oil spill trajectory modelling is a useful aid in contingency planning. The Mediterranean oil spill trajectory model known as MEDSLIK has been used extensively in the region (Lardner et al., 1998; Zodiatis et al., 2005b,c, 2007; see **Appendix D**). MEDSLIK is coupled with high-frequency wind and high-resolution ocean data from several operational ocean forecasting systems in the Mediterranean and is used by response agencies from Italy, Malta, Syria, Israel, and Cyprus, as well as by the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC), in cases of major oil spill incidents (Zodiatis et al., 2005b,c). For the Eastern Mediterranean Levantine Basin, including the Cyprus EEZ, MEDSLIK is coupled with the CYCOFOS (Cyprus Coastal Ocean Forecasting and Observing System) of the Cyprus Oceanography Centre and SKIRON (University of Athens), respectively, for ocean and wind forecasting data.

A pilot study of predicting trajectories from spills in the Cyprus EEZ was conducted by the Cyprus Oceanography Centre using summer meteorological and oceanographic conditions (June 2007 data). Results showed that for this particular period, the coast of Cyprus was not at risk (**Figure 6.2**). This is the first step in a set of spill trajectories that need to be carried out for a risk map analysis. More modelling over multiple seasons and regions needs to be carried out.

This could be done using one or two points per block, or potential sites of exploration or exploitation activity, using forcing conditions from the several years of forecast oceanographic and meteorological data. The additional trajectory modelling would aid in predicting the fate of an oil spill at various locations in the licence area, identifying potentially affected environmental resources, and determining minimum response times for contingency planning.

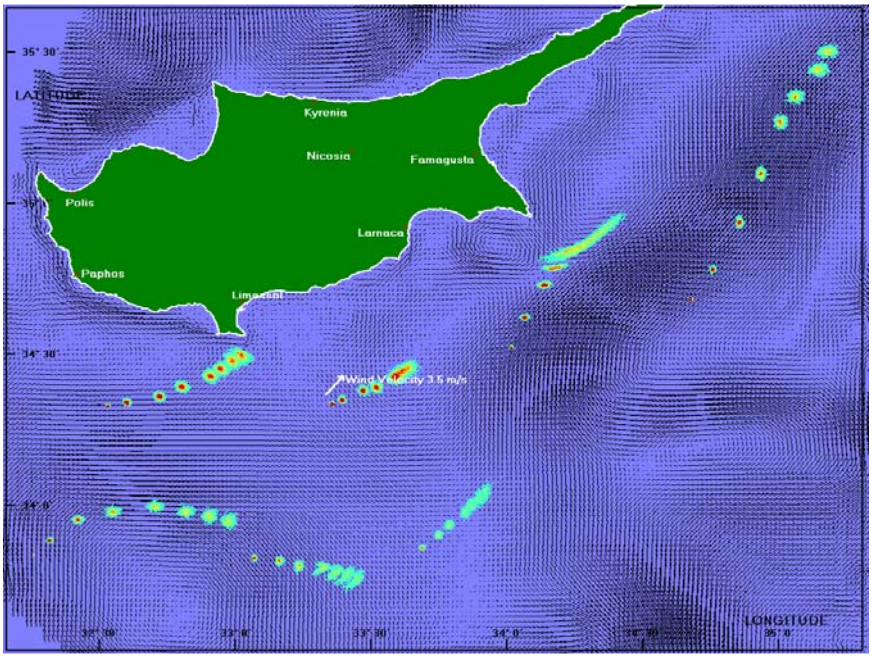


Figure 6.2. An example of the MEDSLIK oil spill predictions during a pilot study carried out by the Cyprus Oceanography Centre using summer meteorological and oceanographic data.

Recommendation – Conduct additional spill trajectory modelling using MEDSLIK to identify likely spill trajectories from multiple launch points in the licence area using seasonal meteorological and oceanographic data. Use the results to determine the likely fate of spills in the licence area, potentially affected environmental resources, and minimum times for a spill to reach shorelines of Cyprus and other countries in the region.

6.2 RECOMMENDATIONS FOR ADDITIONAL CONTROL, MANAGEMENT, AND MONITORING

The Republic of Cyprus recently revised its legal framework to fully harmonise it with Directive 94/22/EC of the European Parliament on conditions for granting and using authorisations for the prospection, exploration, and production of hydrocarbons. The Hydrocarbons Law of 2007 and the Hydrocarbons Regulations of 2007 constitute the basic legal framework for offshore oil and gas activities in the licence area.

The Hydrocarbons Regulations of 2007 include provisions relating to protection of the environment, contingency planning, drilling practices, well abandonment, and construction and maintenance of installations, pipelines, and related facilities, as summarised previously in **Table 3.6**. However, Cyprus does not currently have regulations controlling drilling fluids and cuttings, produced water, or related discharges from offshore facilities. Most EU countries with offshore hydrocarbon activities have enacted laws, regulations, or guidance concerning effluent discharges. For example, in the U.K., the Offshore Chemical Regulations 2002 control the use and discharge of chemicals in the offshore oil and gas industry (U.K. Department of Business Enterprise and Regulatory Reform, 2008).

No EU directives or guidance were identified concerning regulation of discharges from offshore hydrocarbon activities. However, two parallel sets of guidance have been used by other EU countries: the OSPAR Convention and the Barcelona Convention.

OSPAR Convention. For most of the hydrocarbon-producing states of western Europe, the "Convention for the Protection of the Marine Environment of the North-East Atlantic" (OSPAR Convention) is the basis for national laws governing the discharge of offshore effluents. OSPAR contracting parties are Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the U.K. Kingdom. The EU is also a party, but Cyprus is not. Mediterranean EU countries that are not OSPAR parties include Greece, Italy, and Malta.

Activities under the OSPAR Convention are organised into six strategies: (1) protection and conservation of marine biodiversity and ecosystems; (2) eutrophication; (3) hazardous substances; (4) offshore oil and gas industry; (5) radioactive substances; and (6) monitoring and assessment. The offshore oil and gas industry strategy includes decisions and recommendations concerning offshore chemicals, produced water, organic-phase drilling fluids, management of offshore cuttings piles, disposal of disused offshore installations, environmental management systems, toxicity testing, monitoring and reporting, and related topics. Member states commit to implementing OSPAR decisions and recommendations in their national regulatory system. In addition, the OSPAR Harmonised Offshore Chemical Notification Format (HOCNF) is widely used internationally.

Barcelona Convention. In 1976, 16 Mediterranean countries adopted the "Convention for the Protection of the Mediterranean Sea Against Pollution" (Barcelona Convention). In 1995, the parties adopted an amended version of the Barcelona Convention, renamed the "Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean." Cyprus is a party to the Barcelona Convention, along with the EU and 20 other countries, including EU members France, Greece, Italy, Malta, Slovenia, and Spain.

The Barcelona Convention includes an offshore protocol specifically developed to control pollution during offshore hydrocarbon activities (see **Appendix C**). This protocol was adopted in 1994 and has been signed and ratified by Cyprus; however, it has not yet entered into force because it has not been ratified by the requisite number of countries. (No other EU countries have ratified the protocol, although it has been signed by Greece, Italy, Malta, Slovenia, and Spain.) The offshore protocol addresses control of harmful or noxious substances and materials; oil and oily mixtures; drilling fluids and cuttings; sewage; garbage; reception facilities, instructions, and sanctions; safety measures; contingency planning; monitoring; removal of installations; specially protected areas; and transboundary pollution. Key provisions of the offshore protocol have been summarised in **Table 3.4**.

Because Cyprus has ratified the Barcelona Convention offshore protocol, it would be a logical starting point for developing discharge requirements for offshore hydrocarbon activities. According to a review by Jones et al. (2002), it is the basis for produced water discharge standards in several Mediterranean EU countries (i.e., Greece and the Mediterranean Sea areas of France and Spain). In addition, the Barcelona Convention offshore protocol provides a comprehensive set of guidelines for various aspects of offshore activities in a single document, in contrast to the numerous decisions, recommendations, and amendments of the OSPAR Convention. Two disadvantages of the Barcelona Convention offshore protocol are that it has not legally entered into force and its provisions are somewhat out of date. In the 14 years since the Barcelona Convention offshore protocol was developed, the OSPAR Convention recommendations have been continually updated and modified based on technological improvements and the results of environmental studies and monitoring data. For example, OSPAR imposes stricter limits on oil and grease concentration in produced water as well as the percentage retention of organic-phase fluids on discharged cuttings.

<u>Recommendation</u> – Discharge requirements should be established for drilling fluid and cuttings, produced water, and other effluents from offshore hydrocarbon activities in the licence area. In developing the requirements, the Barcelona Convention offshore protocol and the OSPAR Convention offshore oil and gas industry strategy should be considered as sources of guidance. In addition, it is recommended that detailed requirements of the Barcelona Convention offshore protocol and its annexes should be reviewed to ensure that all hydrocarbon activities in the licence area are consistent with the requirements of the protocol.

6.3 DATA GAPS

This Environmental Report included a review of existing environmental and socioeconomic data for the region. While data gaps were recognised for several individual topics as noted in **Chapter 4**, the most important one that is relevant to the offshore licensing programme is the lack of knowledge concerning the ecology of the Eratosthenes Seamount, including the extent and biological characteristics of its deepwater coral communities. Galil and Zibrowius (1998) conducted the only study to date, which included one trawl sample and nine box cores collected on top of the seamount. It is recommended that a reconnaissance study of the seamount be conducted, including a combination of side-scan sonar surveys to map the extent of emergent hard bottom, visual observations (e.g., using a benthic camera) to document the presence of deepwater corals and other epifauna in relation to sea floor characteristics, and collection of benthic samples (e.g., dredges, trawls, box cores) to aid in identifying the fauna. Filling these data gaps will be useful in establishing a better baseline of the pre-existing environmental conditions, but this is not considered a prerequisite to continuing with the licensing activities.

In summary, the relevant data gaps identified in the Environmental Report, with recommendations for further study, are as follows:

- Assessment of Eratosthenes Seamount ecology including deepwater corals;
- Measurements of hydrocarbon and trace metal concentrations in sea floor sediments from the licence area to provide a useful baseline for detecting future changes due to offshore hydrocarbon activities;
- Extension or increase of resolution of the existing ocean flow models in order to improve the accuracy and reliability of oil spill fate and trajectory modeling; and
- Collection of additional subsurface current, temperature, and salinity data in the licence area at sufficiently high temporal and/or spatial resolution to constrain ocean flow forecasting models and circulation hypotheses.

Chapter 7
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APPENDICES

Appendix A

List of Contributors

Contributor	Position on Team	Affiliation	Duties
Dr. Andrew Clark	Overall Project Manager – Ocean Engineer	MCS	Overall Program Management
Dr. Ioannis Glekas	Project Co-Manager/ Sr. Engineer	Aeoliki	Local (Cyprus) Project Oversight, liaison with Ministry, Acoustic Assessment
Dr. Dimitris Glekas	Project Co-Manager/ Sr. Engineer	Aeoliki	Local (Cyprus) Project Oversight, liaison with Ministry, Shoreward Infrastructure
Dr. Alan Hart	Project Co-Manager, Sr. Scientist	CSA	Project management for CSA, Plankton Assessment
Dr. Neal Phillips	Oil and Gas Impact Specialist	CSA	Standardize impact assessment methodology, prepare SEA Overview/Executive Summary, technical review of entire document
Dr. David Gettleson	Oil and Gas Impact Specialist	CSA	Review of oil and gas impacts, technical review of entire document
Mr. John Thompson	Environmental Specialist	CSA	Oil and gas impact assessment - nearshore and coastal habitats
Mr. Steve Viada	Marine Biologist Marine Mammals/Sea Turtles/Birds/Benthos Specialist	CSA	Marine Mammals/Sea Turtles/Birds/Benthos Assessment
Mr. Bruce Graham	Marine Biologist - Benthos Specialist	CSA	Review and synthesis of Benthos environmental compilation, prepare resource-based impact assessment
Dr. Luis Lagera	Health, Safety, and Environmental and Water and Sediment Quality Impact Assessment Specialist	CSA	Discipline-based review and synthesis of draft environmental compilation, prepare resource-based impact assessment, address HSE considerations in control, management, and monitoring sections
Mr. David Snyder	Marine Bipologist - Fish Specialist	CSA	Review and synthesis of environmental compilation, prepare resource-based impact assessment
Keith VanGraeifland	GIS Specialist	CSA	Prepare project GIS and GIS products
Ms. Kristen Metzger	Information Specialist	CSA	Conduct literature searches and maintain project literature database/bibliography
Dr. Cecelia Hannides	Marine Biologist	MCS	Phytoplankton, Zooplankton, Benthos, Chemical Oceanography, Areas of Special Concern
Dr. George Zodiatis	Physical Oceanographic Advisor	MCS – University of Cyprus Oceanographic Centre	Oil Slick Modelling

Contributor	Position on Team	Affiliation	Duties
Dr. Daniel Hayes	Physical Oceanographer	MCS – University of Cyprus	Hydrography, Physical Oceanography, oil spill recommendations, liaison with local team members.
Mr. Andreas Demetropoullos	Sr. Biologist	Aeoliki	Information Review, Synthesis, and Reporting
Mr. Solomon Ioannou	Sr. Environmental Engineer	Aeoliki	Environmental/Socioeconomic Assessment
Mr. Vasilis Papamichalis	Environmental Engineer	Aeoliki -	Environmental Assessment
Dr. Kostantinos Xenofontos	Sr. Scientist - Geologist	Aeoliki – University of Cyprus	Geological, Geological Morphology
Dr. Georgios Georgiou	Professor of Mathematics	MCS – University of Cyprus	Seafloor morphology, bathymetry
Dr. George Kallos	Atmospheric Scientist	MCS – University of Athens	Air quality, Atmospheric Phenomena, Meteorology
Dr. Tassos Tselepides	Professor, Research Director, Deep-sea Ecology	MCS-Hellenic Center for Marine Research	Coast and near shore benthos

Appendix B

Barcelona Convention – Offshore Protocol

“Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil”

Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil

The Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil was adopted on 14 October 1994 by the Conference of Plenipotentiaries held in Madrid and has not yet entered into force.

The Contracting Parties to the present Protocol,

Being Parties to the Convention for the Protection of the Mediterranean Sea against Pollution, adopted at Barcelona on 16 February 1976,

Bearing in mind Article 7 of the said Convention,

Bearing in mind the increase in the activities concerning exploration and exploitation of the Mediterranean seabed and its subsoil,

Recognizing that the pollution which may result therefrom represents a serious danger to the environment and to human beings,

Desirous of protecting and preserving the Mediterranean Sea from pollution resulting from exploration and exploitation activities,

Taking into account the Protocols related to the Convention for the Protection of the Mediterranean Sea against Pollution and, in particular, the Protocol concerning Cooperation in Combating Pollution of the Mediterranean Sea by Oil and Other Harmful Substances in Cases of Emergency, adopted at Barcelona on 16 February 1976, and the Protocol concerning Mediterranean Specially Protected Areas, adopted at Geneva on 3 April 1982, *Bearing in mind* the relevant provisions of the United Nations Convention on the Law of the Sea, done at Montego Bay on 10 December 1982 and signed by many Contracting Parties,

Recognizing the differences in levels of development among the coastal States, and taking account of the economic and social imperatives of the developing countries,

Have agreed as follows:

SECTION I
GENERAL PROVISIONS

ARTICLE 1
DEFINITIONS

For the purposes of this Protocol:

(a) "Convention" means the Convention for the Protection of the Mediterranean Sea against Pollution, adopted at Barcelona on 16 February 1976;

(b) "Organization" means the body referred to in Article 17 of the Convention;

(c) "Resources" means all mineral resources, whether solid, liquid or gaseous;

(d) "Activities concerning exploration and/or exploitation of the resources in the Protocol Area" (hereinafter referred to as "activities") means:

(i) Activities of scientific research concerning the resources of the seabed and its subsoil;

(ii) Exploration activities:

– Seismological activities; surveys of the seabed and its subsoil; sample taking;

– Exploration drilling;

(iii) Exploitation activities:

– Establishment of an installation for the purpose of recovering resources, and activities connected therewith;

– Development drilling;

– Recovery, treatment and storage;

– Transportation to shore by pipeline and loading of ships;

– Maintenance, repair and other ancillary operations;

(e) "Pollution" is defined as in Article 2, paragraph (a), of the Convention;

(f) "Installation" means any fixed or floating structure, and any integral part thereof, that is engaged in activities, including, in particular:

(i) Fixed or mobile offshore drilling units;

(ii) Fixed or floating production units including dynamically-positioned units;

(iii) Offshore storage facilities including ships used for this purpose;

(iv) Offshore loading terminals and transport systems for the extracted products, such as submarine pipelines;

(v) Apparatus attached to it and equipment for the reloading, processing, storage and disposal of substances removed from the seabed or its subsoil;

(g) "Operator" means:

(i) Any natural or juridical person who is authorized by the Party exercising jurisdiction over the area where the activities are undertaken (hereinafter referred to as the "Contracting Party") in accordance with this Protocol to carry out activities and/or who carries out such activities; or

(ii) Any person who does not hold an authorization within the meaning of this Protocol but is de facto in control of such activities;

(h) “Safety zone” means a zone established around installations in conformity with the provisions of general international law and technical requirements, with appropriate markings to ensure the safety of both navigation and the installations;

(i) “Wastes” means substances and materials of any kind, form or description resulting from activities covered by this Protocol which are disposed of or are intended for disposal or are required to be disposed of;

(j) “Harmful or noxious substances and materials” means substances and materials of any kind, form or description, which might cause pollution, if introduced into the Protocol Area;

(k) “Chemical Use Plan” means a plan drawn up by the operator of any offshore installation which shows:

(i) The chemicals which the operator intends to use in the operations;

(ii) The purpose or purposes for which the operator intends to use the chemicals;

(iii) The maximum concentrations of the chemicals which the operator intends to use within any other substances, and maximum amounts intended to be used in any specified period;

(iv) The area within which the chemical may escape into the marine environment;

(l) “Oil” means petroleum in any form including crude oil, fuel oil, oily sludge, oil refuse and refined products and, without limiting the generality of the foregoing, includes the substances listed in the Appendix to this Protocol;

(m) “Oily mixture” means a mixture with any oil content;

(n) “Sewage” means:

(i) Drainage and other wastes from any form of toilets, urinals and water-closet scuppers;

(ii) Drainage from medical premises (dispensary, sick bay, etc.) via wash basins, wash tubs and scuppers located in such premises;

(iii) Other waste waters when mixed with the drainages defined above;

(o) "Garbage" means all kinds of food, domestic and operational waste generated during the normal operation of the installation and liable to be disposed of continuously or periodically, except those substances which are defined or listed elsewhere in this Protocol;

(p) "Freshwater limit" means the place in water courses where, at low tides and in a period of low freshwater flow, there is an appreciable increase in salinity due to the presence of sea water.

Article 2
Geographical Coverage

1. The area to which this Protocol applies (referred to in this Protocol as the "Protocol Area") shall be:

(a) The Mediterranean Sea Area as defined in Article 1 of the Convention, including the continental shelf and the seabed and its subsoil;

(b) Waters, including the seabed and its subsoil, on the landward side of the baselines from which the breadth of the territorial sea is measured and extending, in the case of watercourses, up to the freshwater limit.

2. Any of the Contracting Parties to this Protocol (referred to in this Protocol as "the Parties") may also include in the Protocol area wetlands or coastal areas of their territory.

3. Nothing in this Protocol, nor any act adopted on the basis of this Protocol, shall prejudice the rights of any State concerning the delimitation of the continental shelf.

Article 3
General Undertakings

1. The Parties shall take, individually or through bilateral or multilateral cooperation, all appropriate measures to prevent, abate, combat and control pollution in the Protocol Area resulting from activities, *inter alia* by ensuring that the best available techniques, environmentally effective and economically appropriate, are used for this purpose.

2. The Parties shall ensure that all necessary measures are taken so that activities do not cause pollution.

Section II
Authorization System

Article 4
General Principles

1. All activities in the Protocol Area, including erection on site of installations, shall be subject to the prior written authorization for exploration or exploitation from the competent authority. Such authority, before granting the authorization, shall be satisfied that the installation has been constructed according to international standards and practice and that the operator has the technical competence and the financial capacity to carry out the activities. Such authorization shall be granted in accordance with the appropriate procedure, as defined by the competent authority.

2. Authorization shall be refused if there are indications that the proposed activities are likely to cause significant adverse effects on the environment that could not be avoided by compliance with the conditions laid down in the authorization and referred to in Article 6, paragraph 3, of this Protocol.

3. When considering approval of the siting of an installation, the Contracting Party shall ensure that no detrimental effects will be caused to existing facilities by such siting, in particular, to pipelines and cables.

Article 5
Requirements for Authorizations

1. The Contracting Party shall prescribe that any application for authorization or for the renewal of an authorization is subject to the submission of the project by the candidate operator to the competent authority and that any such application must include, in particular, the following:

(a) A survey concerning the effects of the proposed activities on the environment; the competent authority may, in the light of the nature, scope, duration and technical methods employed in the activities and of the characteristics of the area, require that an environmental impact assessment be prepared in accordance with Annex IV to this Protocol;

(b) The precise definition of the geographical areas where the activity is envisaged, including safety zones;

(c) Particulars of the professional and technical qualifications of the candidate operator and personnel on the installation, as well as of the composition of the crew;

(d) The safety measures as specified in Article 15;

(e) The operator's contingency plan as specified in Article 16;

(f) The monitoring procedures as specified in Article 19;

(g) The plans for removal of installations as specified in Article 20;

(h) Precautions for specially protected areas as specified in Article 21;

(i) The insurance or other financial security to cover liability as prescribed in Article 27, paragraph 2 (b).

2. The competent authority may decide, for scientific research and exploration activities, to limit the scope of the requirements laid down in paragraph 1 of this Article, in the light of the nature, scope, duration and technical methods employed in the activities and of the characteristics of the area.

Article 6
Granting of Authorizations

1. The authorizations referred to in Article 4 shall be granted only after examination by the competent authority of the requirements listed in Article 5 and Annex IV.

2. Each authorization shall specify the activities and the period of validity of the authorization, establish the geographical limits of the area subject to the authorization and specify the technical requirements and the authorized installations. The necessary safety zones shall be established at a later appropriate stage.

3. The authorization may impose conditions regarding measures, techniques or methods designed to reduce to the minimum risks of and damage due to pollution resulting from the activities.

4. The Parties shall notify the Organization as soon as possible of authorizations granted or renewed. The Organization shall keep a register of all the authorized installations in the Protocol Area.

Article 7
Sanctions

Each Party shall prescribe sanctions to be imposed for breach of obligations arising out of this Protocol, or for non-observance of the national laws or regulations implementing this Protocol, or for non-fulfilment of the specific conditions attached to the authorization.

Section III
Wastes and Harmful or Noxious Substances and Materials

Article 8
General Obligation

Without prejudice to other standards or obligations referred to in this Section, the Parties shall impose a general obligation upon operators to use the best available, environmentally effective and economically appropriate techniques and to observe internationally accepted standards regarding wastes, as well as the use, storage and discharge of harmful or noxious substances and materials, with a view to minimizing the risk of pollution.

Article 9
Harmful or Noxious Substances and Materials

1. The use and storage of chemicals for the activities shall be approved by the competent authority, on the basis of the Chemical Use Plan.

2. The Contracting Party may regulate, limit or prohibit the use of chemicals for the activities in accordance with guidelines to be adopted by the Contracting Parties.

3. For the purpose of protecting the environment, the Parties shall ensure that each substance and material used for activities is accompanied by a compound description provided by the entity producing such substance or material.

4. The disposal into the Protocol Area of harmful or noxious substances and materials resulting from the activities covered by this Protocol and listed in Annex I to this Protocol is prohibited.

5. The disposal into the Protocol Area of harmful or noxious substances and materials resulting from the activities covered by this Protocol and listed in Annex II to this Protocol requires, in each case, a prior special permit from the competent authority.

6. The disposal into the Protocol Area of all other harmful or noxious substances and materials resulting from the activities covered by this Protocol and which might cause pollution requires a prior general permit from the competent authority.

7. The permits referred to in paragraphs 5 and 6 above shall be issued only after careful consideration of all the factors set forth in Annex III to this Protocol.

Article 10
Oil and Oily Mixtures and Drilling Fluids and Cuttings

1. The Parties shall formulate and adopt common standards for the disposal of oil and oily mixtures from installations into the Protocol Area:

(a) Such common standards shall be formulated in accordance with the provisions of Annex V, A;

(b) Such common standards shall not be less restrictive than the following, in particular:

(i) For machinery space drainage, a maximum oil content of 15 mg per litre whilst undiluted;

(ii) For production water, a maximum oil content of 40 mg per litre as an average in any calendar month; the content shall not at any time exceed 100 mg per litre;

(c) The Parties shall determine by common agreement which method will be used to analyze the oil content.

2. The Parties shall formulate and adopt common standards for the use and disposal of drilling fluids and drill cuttings into the Protocol Area. Such common standards shall be formulated in accordance with the provisions of Annex V, B.

3. Each Party shall take appropriate measures to enforce the common standards adopted pursuant to this Article or to enforce more restrictive standards that it may have adopted.

Article 11
Sewage

1. The Contracting Party shall prohibit the discharge of sewage from installations permanently manned by 10 or more persons into the Protocol Area except in cases where:

(a) The installation is discharging sewage after treatment as approved by the competent authority at a distance of at least four nautical miles from the nearest land or fixed fisheries installation, leaving the Contracting Party to decide on a case by case basis; or

(b) The sewage is not treated, but the discharge is carried out in accordance with international rules and standards; or

(c) The sewage has passed through an approved sewage treatment plant certified by the competent authority.

2. The Contracting Party shall impose stricter provisions, as appropriate, where deemed necessary, *inter alia* because of the regime of the currents in the area or proximity to any area referred to in Article 21.

3. The exceptions referred to in paragraph 1 shall not apply if the discharge produces visible floating solids or produces colouration, discolouration or opacity of the surrounding water.

4. If the sewage is mixed with wastes and harmful or noxious substances and materials having different disposal requirements, the more stringent requirements shall apply.

Article 12
Garbage

1. The Contracting Party shall prohibit the disposal into the Protocol Area of the following products and materials:

(a) All plastics, including but not limited to synthetic ropes, synthetic fishing nets and plastic garbage bags;

(b) All other non-biodegradable garbage, including paper products, rags, glass, metal, bottles, crockery, dunnage, lining and packing materials.

2. Disposal into the Protocol Area of food wastes shall take place as far away as possible from land, in accordance with international rules and standards.

3. If garbage is mixed with other discharges having different disposal or discharge requirements, the more stringent requirements shall apply.

Article 13
Reception Facilities, Instructions and Sanctions

The Parties shall ensure that:

(a) Operators dispose satisfactorily of all wastes and harmful or noxious substances and materials in designated onshore reception facilities, except as otherwise authorized by the Protocol;

(b) Instructions are given to all personnel concerning proper means of disposal;

(c) Sanctions are imposed in respect of illegal disposals.

Article 14
Exceptions

1. The provisions of this Section shall not apply in case of:

(a) *Force majeure* and in particular for disposals:

– to save human life,

– to ensure the safety of installations,

– in case of damage to the installation or its equipment,

on condition that all reasonable precautions have been taken after the damage is discovered or after the disposal has been performed to reduce the negative effects.

(b) The discharge into the sea of substances containing oil or harmful or noxious substances or materials which, subject to the prior approval of the competent authority, are being used for the purpose of combating specific pollution incidents in order to minimize the damage due to the pollution.

2. However, the provisions of this Section shall apply in any case where the operator acted with the intent to cause damage or recklessly and with knowledge that damage will probably result.

3. Disposals carried out in the circumstances referred to in paragraph 1 of this Article shall be reported immediately to the Organization and, either through the Organization or directly, to any Party or Parties likely to be affected, together with full details of the circumstances and of the nature and quantities of wastes or harmful or noxious substances or materials discharged.

Section IV
Safeguards

Article 15
Safety Measures

1. The Contracting Party within whose jurisdiction activities are envisaged or are being carried out shall ensure that safety measures are taken with regard to the design, construction, placement, equipment, marking, operation and maintenance of installations.

2. The Contracting Party shall ensure that at all times the operator has on the installations adequate equipment and devices, maintained in good working order, for protecting human life, preventing and combating accidental pollution and facilitating prompt response to an emergency, in accordance with the best available environmentally effective and economically appropriate techniques and the provisions of the operator's contingency plan referred to in Article 16.

3. The competent authority shall require a certificate of safety and fitness for the purpose (hereinafter referred to as "certificate") issued by a recognized body to be submitted in respect of production platforms, mobile offshore drilling units, offshore storage facilities, offshore loading systems and pipelines and in respect of such other installations as may be specified by the Contracting Party.

4. The Parties shall ensure through inspection that the activities are conducted by the operators in accordance with this Article.

Article 16
Contingency Planning

1. In cases of emergency the Contracting Parties shall implement *mutatis mutandis* the provisions of the Protocol concerning Cooperation in Combating Pollution of the Mediterranean Sea by Oil and Other Harmful Substances in Cases of Emergency.

2. Each Party shall require operators in charge of installations under its jurisdiction to have a contingency plan to combat accidental pollution, coordinated with the contingency plan of the Contracting Party established in accordance with the Protocol concerning Cooperation in Combating Pollution of the Mediterranean Sea by Oil and Other

Harmful Substances in Cases of Emergency and approved in conformity with the procedures established by the competent authorities.

3. Each Contracting Party shall establish coordination for the development and implementation of contingency plans. Such plans shall be established in accordance with guidelines adopted by the competent international organization. They shall, in particular, be in accordance with the provisions of Annex VII to this Protocol.

Article 17
Notification

Each Party shall require operators in charge of installations under its jurisdiction to report without delay to the competent authority:

(a) Any event on their installation causing or likely to cause pollution in the Protocol Area;

(b) Any observed event at sea causing or likely to cause pollution in the Protocol Area.

Article 18
Mutual Assistance in Cases of Emergency

In cases of emergency, a Party requiring assistance in order to prevent, abate or combat pollution resulting from activities may request help from the other Parties, either directly or through the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC), which shall do their utmost to provide the assistance requested.

For this purpose, a Party which is also a Party to the Protocol concerning Cooperation in Combating Pollution of the Mediterranean Sea by Oil and Other Harmful Substances in Cases of Emergency shall apply the pertinent provisions of the said Protocol.

Article 19
Monitoring

1. The operator shall be required to measure, or to have measured by a qualified entity, expert in the matter, the effects of the activities on the environment in the light of the nature, scope, duration and technical methods employed in the activities and of the characteristics of the area and to report on them periodically or upon request by the competent authority for the purpose of an evaluation by such competent authority according to a procedure established by the competent authority in its authorization system.

2. The competent authority shall establish, where appropriate, a national monitoring system in order to be in a position to monitor regularly the installations and the impact of the activities on the environment, so as to ensure that the conditions attached to the grant of the authorization are being fulfilled.

Article 20
Removal of Installations

1. The operator shall be required by the competent authority to remove any installation which is abandoned or disused, in order to ensure safety of navigation, taking into account the guidelines and standards adopted by the competent international organization. Such removal shall also have due regard to other legitimate uses of the sea, in particular fishing, the protection of the marine environment and the rights and duties of other Contracting Parties. Prior to such removal, the operator under its responsibility shall take all necessary measures to prevent spillage or leakage from the site of the activities.

2. The competent authority shall require the operator to remove abandoned or disused pipelines in accordance with paragraph 1 of this Article or to clean them inside and abandon them or to clean them inside and bury them so that they neither cause pollution, endanger navigation, hinder fishing, threaten the marine environment, nor interfere with other legitimate uses of the sea or with the rights and duties of other Contracting Parties. The competent authority shall ensure that appropriate publicity is given to the depth, position and dimensions of any buried pipeline and that such information is indicated on charts and notified to the Organization and other competent international organizations and the Parties.

3. The provisions of this Article apply also to installations disused or abandoned by any operator whose authorization may have been withdrawn or suspended in compliance with Article 7.

4. The competent authority may indicate eventual modifications to be made to the level of activities and to the measures for the protection of the marine environment which had initially been provided for.

5. The competent authority may regulate the cession or transfer of authorized activities to other persons.

6. Where the operator fails to comply with the provisions of this Article, the competent authority shall undertake, at the operator's expense, such action or actions as may be necessary to remedy the operator's failure to act.

Article 21
Specially Protected Areas

For the protection of the areas defined in the Protocol concerning Mediterranean Specially Protected Areas and any other area established by a Party and in furtherance of the goals stated therein, the Parties shall take special measures in conformity with international law, either individually or through multilateral or bilateral cooperation, to prevent, abate, combat and control pollution arising from activities in these areas.

In addition to the measures referred to in the Protocol concerning Mediterranean Specially Protected Areas for the granting of authorization, such measures may include, *inter alia*:

(a) Special restrictions or conditions when granting authorizations for such areas:

(i) The preparation and evaluation of environmental impact assessments;

(ii) The elaboration of special provisions in such areas concerning monitoring, removal of installations and prohibition of any discharge.

(b) Intensified exchange of information among operators, the competent authorities, Parties and the Organization regarding matters which may affect such areas.

Section V
Cooperation

Article 22
Studies and Research Programmes

In conformity with Article 13 of the Convention, the Parties shall, where appropriate, cooperate in promoting studies and undertaking programmes of scientific and technological research for the purpose of developing new methods of:

(a) Carrying out activities in a way that minimizes the risk of pollution;

(b) Preventing, abating, combating and controlling pollution, especially in cases of emergency.

Article 23
International Rules, Standards and Recommended Practices and Procedures

1. The Parties shall cooperate, either directly or through the Organization or other competent international organizations, in order to:

(a) Establish appropriate scientific criteria for the formulation and elaboration of international rules, standards and recommended practices and procedures for achieving the aims of this Protocol;

(b) Formulate and elaborate such international rules, standards and recommended practices and procedures;

(c) Formulate and adopt guidelines in accordance with international practices and procedures to ensure observance of the provisions of Annex VI.

2. The Parties shall, as soon as possible, endeavour to harmonize their laws and regulations with the international rules, standards and recommended practices and procedures referred to in paragraph 1 of this Article.

3. The Parties shall endeavour, as far as possible, to exchange information relevant to their domestic policies, laws and regulations and the harmonization referred to in paragraph 2 of this Article.

Article 24
Scientific and Technical Assistance to Developing Countries

1. The Parties shall, directly or with the assistance of competent regional or other international organizations, cooperate with a view to formulating and, as far as possible, implementing programmes of assistance to developing countries, particularly in the fields of science, law, education and technology, in order to prevent, abate, combat and control pollution due to activities in the Protocol Area.

2. Technical assistance shall include, in particular, the training of scientific, legal and technical personnel, as well as the acquisition, utilization and production by those countries of appropriate equipment on advantageous terms to be agreed upon among the Parties concerned.

Article 25
Mutual Information

The Parties shall inform one another directly or through the Organization of measures taken, of results achieved and, if the case arises, of difficulties encountered in the application of this Protocol. Procedures for the collection and submission of such information shall be determined at the meetings of the Parties.

Article 26
Transboundary Pollution

1. Each Party shall take all measures necessary to ensure that activities under its jurisdiction are so conducted as not to cause pollution beyond the limits of its jurisdiction.

2. A Party within whose jurisdiction activities are being envisaged or carried out shall take into account any adverse environmental effects, without discrimination as to whether such effects are likely to occur within the limits of its jurisdiction or beyond such limits.

3. If a Party becomes aware of cases in which the marine environment is in imminent danger of being damaged, or has been damaged, by pollution, it shall immediately notify other Parties which in its opinion are likely to be affected by such damage, as well as the Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea (REMPEC), and provide them with timely information that would enable them, where necessary, to take appropriate measures. REMPEC shall distribute the information immediately to all relevant Parties.

4. The Parties shall endeavour, in accordance with their legal systems and, where appropriate, on the basis of an agreement, to grant equal access to and treatment in administrative proceedings to persons in other States who may be affected by pollution or other adverse effects resulting from proposed or existing operations.

5. Where pollution originates in the territory of a State which is not a Contracting Party to this Protocol, any Contracting Party affected shall endeavour to cooperate with the said State so as to make possible the application of the Protocol.

Article 27
Liability and Compensation

1. The Parties undertake to cooperate as soon as possible in formulating and adopting appropriate rules and procedures for the determination of liability and compensation for damage resulting from the activities dealt with in this Protocol, in conformity with Article 16 of the Convention.

2. Pending development of such procedures, each Party:

(a) Shall take all measures necessary to ensure that liability for damage caused by activities is imposed on operators, and they shall be required to pay prompt and adequate compensation;

(b) Shall take all measures necessary to ensure that operators shall have and maintain insurance cover or other financial security of such type and under such terms as the Contracting Party shall specify in order to ensure compensation for damages caused by the activities covered by this Protocol.

Section VI
Final Provisions

Article 28
Appointment of Competent Authorities

Each Contracting Party shall appoint one or more competent authorities to:

(a) Grant, renew and register the authorizations provided for in Section II of this Protocol;

(b) Issue and register the special and general permits referred to in Article 9 of this Protocol;

(c) Issue the permits referred to in Annex V to this Protocol;

(d) Approve the treatment system and certify the sewage treatment plant referred to in Article 11, paragraph 1, of this Protocol;

(e) Give the prior approval for exceptional discharges referred to in Article 14, paragraph 1 (b), of this Protocol;

(f) Carry out the duties regarding safety measures referred to in Article 15, paragraphs 3 and 4, of this Protocol;

(g) Perform the functions relating to contingency planning described in Article 16 and Annex VII to this Protocol;

(h) Establish monitoring procedures as provided in Article 19 of this Protocol;

(i) Supervise the removal operations of the installations as provided in Article 20 of this Protocol.

ARTICLE 29
TRANSITIONAL MEASURES

Each Party shall elaborate procedures and regulations regarding activities, whether authorized or not, initiated before the entry into force of this Protocol, to ensure their conformity, as far as practicable, with the provisions of this Protocol.

ARTICLE 30
MEETINGS

1. Ordinary meetings of the Parties shall take place in conjunction with ordinary meetings of the Contracting Parties to the Convention held pursuant to Article 18 of the Convention. The Parties may also hold extraordinary meetings in accordance with Article 18 of the Convention.

2. The functions of the meetings of the Parties to this Protocol shall be, *inter alia*:

(a) To keep under review the implementation of this Protocol and to consider the efficacy of the measures adopted and the advisability of any other measures, in particular in the form of annexes and appendices;

(b) To revise and amend any annex or appendix to this Protocol;

(c) To consider the information concerning authorizations granted or renewed in accordance with Section II of this Protocol;

(d) To consider the information concerning the permits issued and approvals given in accordance with Section III of this Protocol;

(e) To adopt the guidelines referred to in Article 9, paragraph 2, and Article 23, paragraph 1 (c), of this Protocol;

(f) To consider the records of the contingency plans and means of intervention in emergencies adopted in accordance with Article 16 of this Protocol;

(g) To establish criteria and formulate international rules, standards and recommended practices and procedures in accordance with Article 23, paragraph 1, of this Protocol, in whatever form the Parties may agree;

(h) To facilitate the implementation of the policies and the achievement of the objectives referred to in Section V, in particular the harmonization of national and European Community legislation in accordance with Article 23, paragraph 2, of this Protocol;

(i) To review progress made in the implementation of Article 27 of this Protocol;

(j) To discharge such other functions as may be appropriate for the application of this Protocol.

ARTICLE 31
RELATIONS WITH THE CONVENTION

1. The provisions of the Convention relating to any Protocol shall apply with respect to this Protocol.

2. The rules of procedure and the financial rules adopted pursuant to Article 24 of the Convention shall apply with respect to this Protocol, unless the Parties to this Protocol agree otherwise.

ARTICLE 32
FINAL CLAUSE

1. This Protocol shall be open for signature at Madrid from 14 October 1994 to 14 October 1995, by any State Party to the Convention invited to the Conference of Plenipotentiaries of the Coastal States of the Mediterranean Region on the Protocol for the Protection of the Mediterranean Sea against Pollution resulting from Exploration and Exploitation of the Seabed and its Subsoil, held at Madrid on 13 and 14 October 1994. It shall also be open until the same dates for signature by the European Community and by any similar regional economic grouping of which at least one member is a coastal State of the Protocol Area and which exercises competence in fields covered by this Protocol in conformity with Article 30 of the Convention.

2. This Protocol shall be subject to ratification, acceptance or approval. Instruments of ratification, acceptance or approval shall be deposited with the Government of Spain, which will assume the functions of Depositary.

3. As from 15 October 1995, this Protocol shall be open for accession by the States referred to in paragraph 1 above, by the European Community and by any grouping referred to in that paragraph.

4. This Protocol shall enter into force on the thirtieth day following the date of deposit of at least six instruments of ratification, acceptance or approval of, or accession to, the Protocol by the Parties referred to in paragraph 1 of this Article.

In Witness whereof the undersigned, being duly authorized, have signed this Protocol.

Annex I
Harmful or Noxious Substances and Materials the Disposal of which in the Protocol Area is Prohibited

A. The following substances and materials and compounds thereof are listed for the purposes of Article 9, paragraph 4, of the Protocol. They have been selected mainly on the basis of their toxicity, persistence and bioaccumulation:

1. Mercury and mercury compounds

2. Cadmium and cadmium compounds

3. Organotin compounds and substances which may form such compounds in the marine environment *

4. Organophosphorus compounds and substances which may form such compounds in the marine environment *

5. Organohalogen compounds and substances which may form such compounds in the marine environment *

6. Crude oil, fuel oil, oily sludge, used lubricating oils and refined products

7. Persistent synthetic materials which may float, sink or remain in suspension and which may interfere with any legitimate use of the sea

8. Substances having proven carcinogenic, teratogenic or mutagenic properties in or through the marine environment

9. Radioactive substances, including their wastes, if their discharges do not comply with the principles of radiation protection as defined by the competent international organizations, taking into account the protection of the marine environment

B. The present Annex does not apply to discharges which contain substances listed in section A that are below the limits defined jointly by the Parties and, in relation to oil, below the limits defined in Article 10 of this Protocol.

* *With the exception of those which are biologically harmless or which are rapidly converted into biologically harmless substances.*

Annex II
Harmful or Noxious Substances and Materials the Disposal of which in the Protocol Area is Subject to a Special Permit

A. The following substances and materials and compounds thereof have been selected for the purpose of Article 9, paragraph 5, of the Protocol.

1. Arsenic

2. Lead

3. Copper

4. Zinc

5. Beryllium

6. Nickel

7. Vanadium

8 Chromium

9. Biocides and their derivatives not covered in Annex I

10. Selenium

11. Antimony

12. Molybdenum

13. Titanium

14. Tin

15. Barium (other than barium sulphate)

16. Boron

17. Uranium

18. Cobalt

19. Thallium

20. Tellurium

21. Silver

22. Cyanides

B. The control and strict limitation of the discharge of substances referred to in section A must be implemented in accordance with Annex III.

Annex III
Factors to be Considered for the Issue of the Permits

For the purpose of the issue of a permit required under Article 9, paragraph 7, particular account will be taken, as the case may be, of the following factors:

A. Characteristics and composition of the waste

1. Type and size of waste source (e.g. industrial process);

2. Type of waste (origin, average composition);

3. Form of waste (solid, liquid, sludge, slurry, gaseous);

4. Total amount (volume discharged, e.g. per year);

5. Discharge pattern (continuous, intermittent, seasonally variable, etc.);

6. Concentrations with respect to major constituents, substances listed in Annex I, substances listed in Annex II, and other substances as appropriate;

7. Physical, chemical and biochemical properties of the waste.

B. Characteristics of waste constituents with respect to their harmfulness

1. Persistence (physical, chemical, biological) in the marine environment;

2. Toxicity and other harmful effects;

3. Accumulation in biological materials or sediments;

4. Biochemical transformation producing harmful compounds;

5. Adverse effects on the oxygen content and balance;

6. Susceptibility to physical, chemical and biochemical changes and interaction in the aquatic environment with other sea-water constituents which may produce harmful biological or other effects on any of the uses listed in Section E below.

C. Characteristics of discharge site and receiving marine environment

1. Hydrographic, meteorological, geological and topographical characteristics of the area;

2. Location and type of the discharge (outfall, canal, outlet, etc.) and its relation to other areas (such as amenity areas, spawning, nursery and fishing areas, shellfish grounds) and other discharges;

3. Initial dilution achieved at the point of discharge into the receiving marine environment;

4. Dispersion characteristics such as effects of currents, tides and wind on horizontal transport and vertical mixing;

5. Receiving water characteristics with respect to physical, chemical, biological and ecological conditions in the discharge area;

6. Capacity of the receiving marine environment to receive waste discharges without undesirable effects.

D. Availability of waste technologies

The methods of waste reduction and discharge for industrial effluents as well as domestic sewage should be selected taking into account the availability and feasibility of:

(a) Alternative treatment processes;

(b) Reuse or elimination methods;

(c) On-land disposal alternatives;

(d) Appropriate low-waste technologies.

E. Potential impairment of marine ecosystem and sea-water uses

1. Effects on human life through pollution impact on:

   (a) Edible marine organisms;

   (b) Bathing waters;

   (c) Aesthetics.

2. Effects on marine ecosystems, in particular living resources, endangered species and critical habitats.

3. Effects on other legitimate uses of the sea in conformity with international law.

Annex IV
Environmental Impact Assessment

1. Each Party shall require that the environmental impact assessment contains at least the following:

(a) A description of the geographical boundaries of the area within which the activities are to be carried out, including safety zones where applicable;

(b) A description of the initial state of the environment of the area;

(c) An indication of the nature, aims, scope and duration of the proposed activities;

(d) A description of the methods, installations and other means to be used, possible alternatives to such methods and means;

(e) A description of the foreseeable direct or indirect short and long-term effects of the proposed activities on the environment, including fauna, flora and the ecological balance;

(f) A statement setting out the measures proposed for reducing to the minimum the risk of damage to the environment as a result of carrying out the proposed activities, including possible alternatives to such measures;

(g) An indication of the measures to be taken for the protection of the environment from pollution and other adverse effects during and after the proposed activities;

(h) A reference to the methodology used for the environmental impact assessment;

(i) An indication of whether the environment of any other State is likely to be affected by the proposed activities.

2. Each Party shall promulgate standards taking into account the international rules, standards and recommended practices and procedures, adopted in accordance with Article 23 of the Protocol, by which environmental impact assessments are to be evaluated.

Annex V
Oil and Oily Mixtures and Drilling Fluids and Cuttings

The following provisions shall be prescribed by the Parties in accordance with Article 10:

A. Oil and Oily Mixtures

1. Spills of high oil content in processing drainage and platform drainage shall be contained, diverted and then treated as part of the product, but the remainder shall be treated to an acceptable level before discharge, in accordance with good oilfield practice;

2. Oily waste and sludges from separation processes shall be transported to shore;

3. All the necessary precautions shall be taken to minimize losses of oil into the sea from oil collected or flared from well testing;

4. All the necessary precautions shall be taken to ensure that any gas resulting from oil activities should be flared or used in an appropriate manner.

B. Drilling Fluids and Drill Cuttings

1. Water-based drilling fluids and drill cuttings shall be subject to the following requirements:

   (a) The use and disposal of such drilling fluids shall be subject to the Chemical Use Plan and the provisions of Article 9 of this Protocol;

   (b) The disposal of the drill cuttings shall either be made on land or into the sea in an appropriate site or area as specified by the competent authority.

2. Oil-based drilling fluids and drill cuttings are subject to the following requirements:

   (a) Such fluids shall only be used if they are of a sufficiently low toxicity and only after the operator has been issued a permit by the competent authority when it has verified such low toxicity;

   (b) The disposal into the sea of such drilling fluids is prohibited;

(c) The disposal of the drill cuttings into the sea is only permitted on condition that efficient solids control equipment is installed and properly operated, that the discharge point is well below the surface of the water, and that the oil content is less than 100 grams of oil per kilogram dry cuttings;

(d) The disposal of such drill cuttings in specially protected areas is prohibited;

(e) In case of production and development drilling, a programme of seabed sampling and analysis relating to the zone of contamination must be undertaken.

3. Diesel-based drilling fluids:

The use of diesel-based drilling fluids is prohibited. Diesel oil may exceptionally be added to drilling fluids in such circumstances as the Parties may specify.

Annex VI
Safety Measures

The following provisions shall be prescribed by the Parties in accordance with Article 15:

(a) That the installation must be safe and fit for the purpose for which it is to be used, in particular, that it must be designed and constructed so as to withstand, together with its maximum load, any natural condition, including, more specifically, maximum wind and wave conditions as established by historical weather patterns, earthquake possibilities, seabed conditions and stability, and water depth;

(b) That all phases of the activities, including storage and transport of recovered resources, must be properly prepared, that the whole activity must be open to control for safety reasons and must be conducted in the safest possible way, and that the operator must apply a monitoring system for all activities;

(c) That the most advanced safety systems must be used and periodically tested in order to minimize the dangers of leakages, spillages, accidental discharges, fire, explosions, blow-outs or any other threat to human safety or the environment, that a trained specialized crew to operate and maintain these systems must be present and that this crew must undertake periodic exercises. In the case of authorized not permanently manned installations, the permanent availability of a specialized crew shall be ensured;

(d) That the installation and, where necessary, the established safety zone, must be marked in accordance with international recommendations so as to give adequate warning of its presence and sufficient details for its identification;

(e) That in accordance with international maritime practice, the installations must be indicated on charts and notified to those concerned;

(f) That, in order to secure observance of the foregoing provisions, the person and/or persons having the responsibility for the installation and/or the activities, including the person responsible for the blow-out preventer, must have the qualifications required by the competent authority, and that sufficient qualified staff must be permanently available. Such qualifications shall include, in particular, training, on a continuing basis, in safety and environmental matters.

Annex VII
Contingency Plan

A. The operator's contingency plan

1. Operators are obliged to ensure:

(a) That the most appropriate alarm system and communication system are available at the installation and they are in good working order;

(b) That the alarm is immediately raised on the occurrence of an emergency and that any emergency is immediately communicated to the competent authority;

(c) That, in coordination with the competent authority, transmission of the alarm and appropriate assistance and coordination of assistance can be organized and supervised without delay;

(d) That immediate information about the nature and extent of the emergency is given to the crew on the installation and to the competent authority;

(e) That the competent authority is constantly informed about the progress of combating the emergency;

(f) That at all times sufficient and most appropriate materials and equipment, including stand-by boats and aircraft, are available to put into effect the emergency plan;

(g) That the most appropriate methods and techniques are known to the specialized crew referred to in Annex VI, paragraph (c), in order to combat leakages, spillages, accidental discharges, fire, explosions, blow-outs and any other threat to human life or the environment;

(h) That the most appropriate methods and techniques are known to the specialized crew responsible for reducing and preventing long-term adverse effects on the environment;

(i) That the crew is thoroughly familiar with the operator's contingency plan, that periodic emergency exercises are held so that the crew has a thorough working knowledge of the equipment and procedures and that each individual knows exactly his role within the plan.

2. The operator shall cooperate, on an institutional basis, with other operators or entities capable of rendering necessary assistance, so as to ensure that, in cases where the magnitude or nature of an emergency creates a risk for which assistance is or might be required, such assistance can be rendered.

B. National coordination and direction

The competent authority for emergencies of a Contracting Party shall ensure:

(a) The coordination of the national contingency plan and/or procedures and the operator's contingency plan and control of the conduct of actions, especially in case of significant adverse effects of the emergency;

(b) Direction to the operator to take any action it may specify in the course of preventing, abating or combating pollution or in the preparation of further action for that purpose, including placing an order for a relief drilling rig, or to prevent the operator from taking any specified action;

(c) The coordination of actions in the course of preventing, abating or combating pollution or in preparation for further action for that purpose within the national jurisdiction with such actions undertaken within the jurisdiction of other States or by international organizations;

(d) Collection and ready availability of all necessary information concerning the existing activities;

(e) The provision of an up-to-date list of the persons and entities to be alerted and informed about an emergency, its development and the measures taken;

(f) The collection of all necessary information concerning the extent and means of combating contingencies, and the dissemination of this information to interested Parties;

(g) The coordination and supervision of the assistance referred to in Part A above, in cooperation with the operator;

(h) The organization and if necessary, the coordination of specified actions, including intervention by technical experts and trained personnel with the necessary equipment and materials;

(i) Immediate communication to the competent authorities of other Parties which might be affected by a contingency to enable them to take appropriate measures where necessary;

(j) The provision of technical assistance to other Parties, if necessary;

(k) Immediate communication to the competent international organizations with a view to avoiding danger to shipping and other interests.

List of Oils *

Asphalt solutions

Blending Stocks
Roofers Flux
Straight Run Residue

Oils

Clarified
Crude Oil
Mixtures containing crude oil
Diesel Oil
Fuel Oil No. 4
Fuel Oil No. 5
Fuel Oil No. 6
Residual Fuel Oil
Road Oil
Transformer Oil
Aromatic Oil (excluding vegetable oil)
Lubricating Oils and Blending Stocks
Mineral Oil
Motor Oil
Penetrating Oil
Spindle Oil
Turbine Oil

Distillates

Straight Run
Flashed Feed Stocks

Gas Oil

Cracked

** The list of oils should not necessarily be considered as exhaustive.*

Jet Fuels

JP-1 (Kerosene)
JP-3
JP-4
JP-5 (Kerosene, Heavy)
Turbo Fuel
Kerosene
Mineral Spirit

Naphtha

Solvent
Petroleum
Heartcut Distillate Oil

Gasoline Blending Stocks

Alkylates – fuel
Reformates
Polymer – fuel

Gasolines

Casinghead (natural)
Automotive
Aviation
Straight Run
Fuel Oil No. 1 (Kerosene)
Fuel Oil No. 1-D
Fuel Oil No. 2
Fuel Oil No. 2-D

Appendix C

Bathymetry and Topography

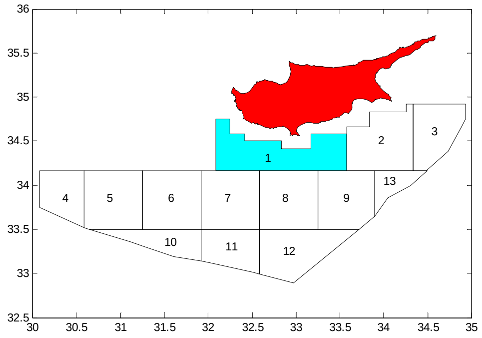
There are several publicly available global bathymetry datasets which are reviewed in Marks and Smith (2006). For this report we have used the 1-minute GEBCO data for the Mediterranean (http://www.gebco.net). The General Bathymetric Chart of the Oceans (GEBCO) functions under the auspices of the International Hydrographic Organization (IHO) and the Intergovernmental Oceanographic Commission (IOC). This is a 1-min grid constructed from a series of paper and digital contour maps at 1:10 million scale. These maps were contoured at 500 m depth intervals, by hand, from both digital and analog ship soundings.

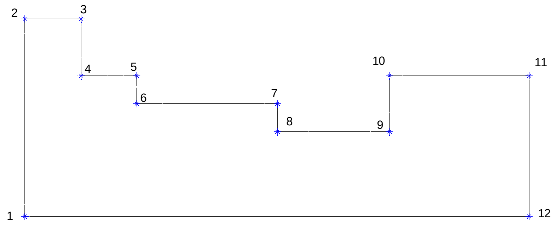
In **Tables C.1-C.13**, useful data for all exploration blocks are provided: (a) the coordinates of all vertices defining each block and the longitude and latitude ranges: (b) the minimum and maximum depths and their locations; (c) an estimate of the average depth in each block which is calculated by simply averaging depth values of all nodes of the gridded data that are inside the block. It is clear that this average is biased to the northern nodes of the block; and (d) the approximate area of the block.

In **Figures C.1** to **C.13**, the bathymetry contours as well as the three-dimensional plots of the seafloor over each block are plotted. The contours correspond to isobaths with a step of 200 m. The locations of the minimum and maximum depths in each block are also shown. For clarity, the contour plots (without color filling) are also plotted in **Figures C.1**a to **C.13a**.

Table C.1. Useful data for Exploration Block 1.

EXPLORATION BLOCK 1





GENERAL INFORMATION	
Longitude range	32.083333 - 33.583333
Latitude range	34.166667 - 34.750000
Area	5728.3 km^2
Minimum depth	310 m at (33.583333, 34.433333)
Maximum depth	2734 m at (32.200000, 34.450000)
Average depth	1924.8 m

VERTEX COORDINATES		
n	**Longitude**	**Latitude**
1	32.083333	34.166667
2	32.083333	34.750000
3	32.250000	34.750000
4	32.250000	34.588883
5	32.416667	34.588883
6	32.416667	34.500000
7	32.833333	34.500000
8	32.833333	34.416667
9	33.166667	34.416667
10	33.166667	34.583333
11	33.583333	34.583333
12	33.583333	34.166667

EXPLORATION BLOCK 1

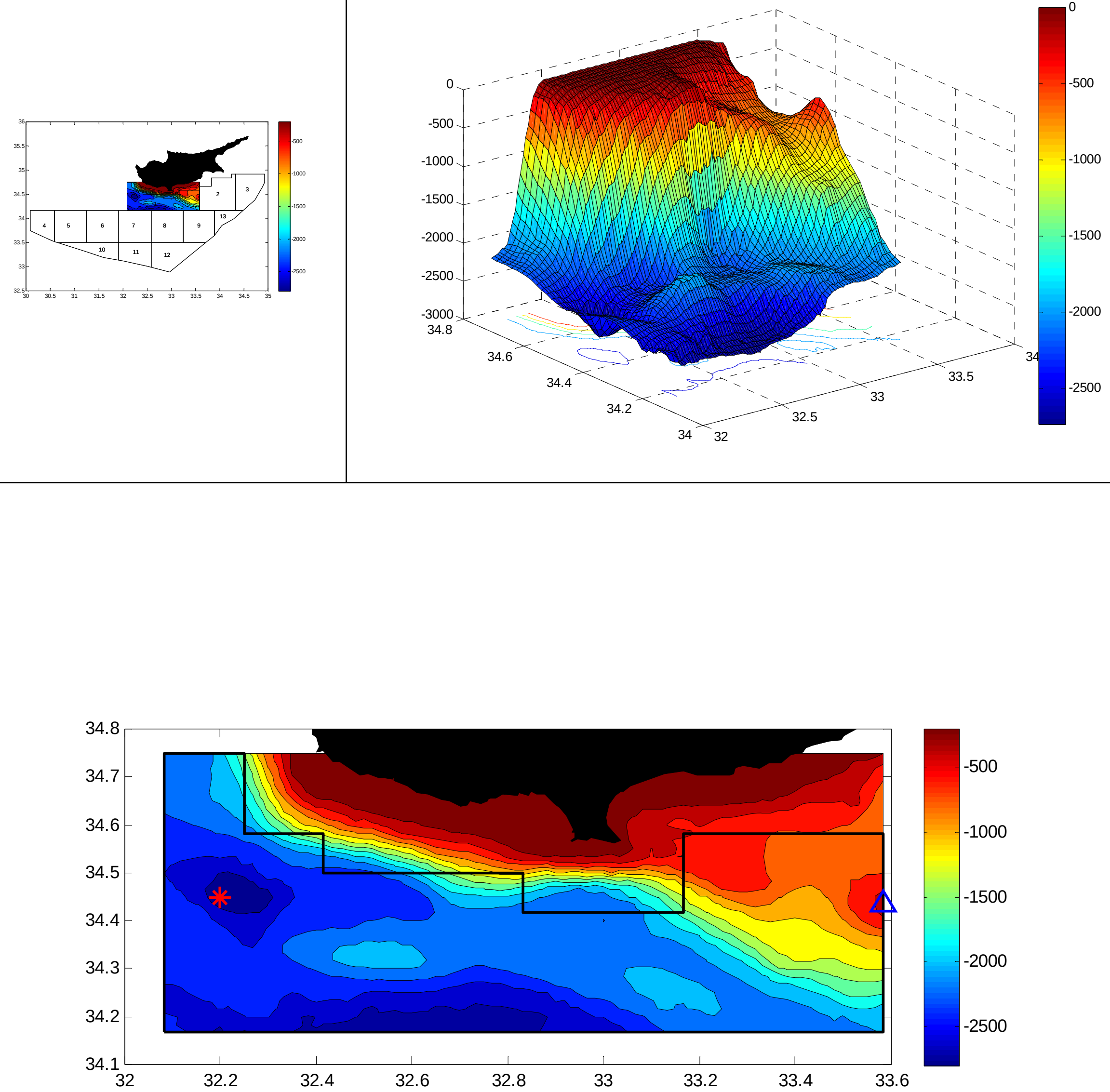


Figure C.1. Bathymetry of Exploration Block 1 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. It should be noted that the axes in the 3D plot are not in scale. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2734 m at (32.2, 34.45) and minimum depth is 310 m at (33.583333, 34.433333). The average depth is 1925 m.

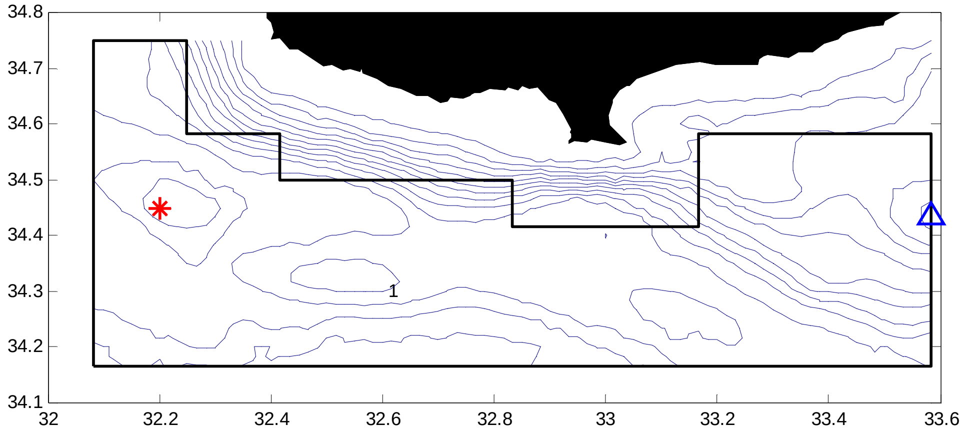
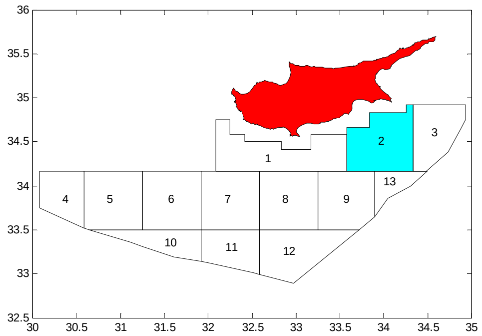
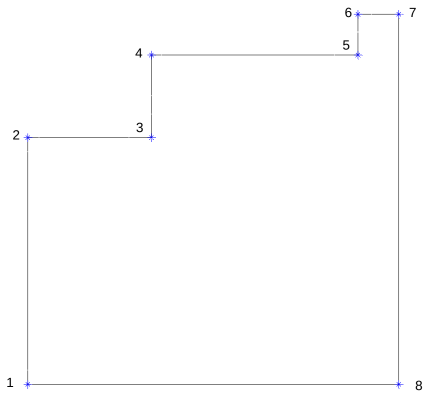


Figure C.1a. Bathymetry of Exploration Block 1 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2734 m at (32.2, 34.45) and minimum depth is 310 m at (33.583333, 34.433333). The average depth is 1925 m.

Table C.2. Useful data for Exploration Block 2.

EXPLORATION BLOCK 2





GENERAL INFORMATION	
Longitude range	33.583333 – 34.333333
Latitude range	34.166667 - 34.916667
Area	4731.6 km^2
Minimum depth	266 m at (33.616667, 34.433333)
Maximum depth	2082 m at (33.800000, 34.166667)
Average depth	1549.1 m

VERTEX COORDINATES		
n	**Longitude**	**Latitude**
1	33.583333	34.166667
2	33.583333	34.666667
3	33.833333	34.666667
4	33.833333	34.833333
5	34.250000	34.833333
6	34.250000	34.916667
7	34.333333	34.916667
8	34.333333	34.166667

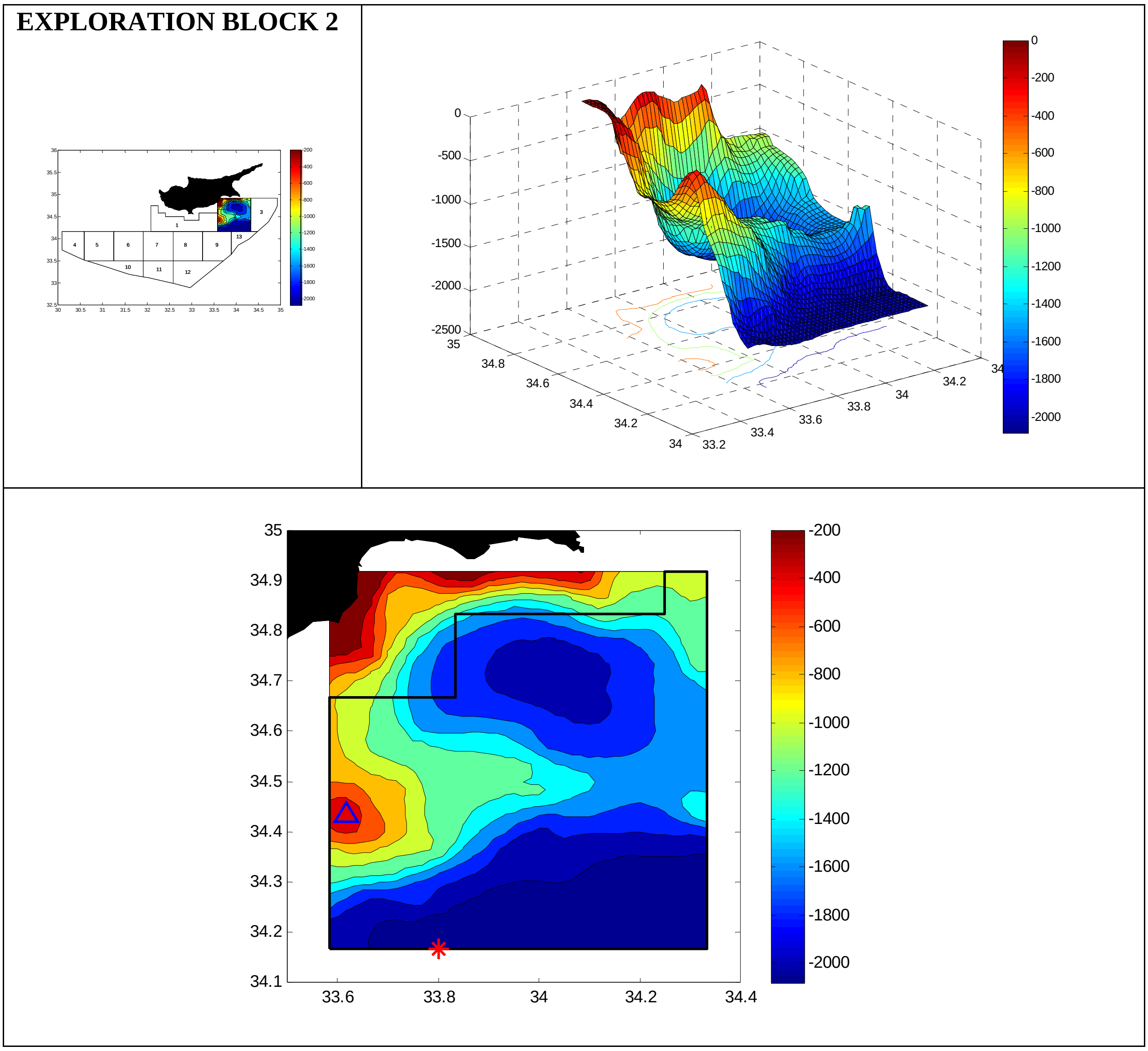


Figure C.2. Bathymetry of Exploration Block 2 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. It should be noted that the axes in the 3D plot are not in scale. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2082 m at (33.8, 34.166667) and minimum depth is 266 m at (33.616667, 34.433333). The average depth is 1549 m.

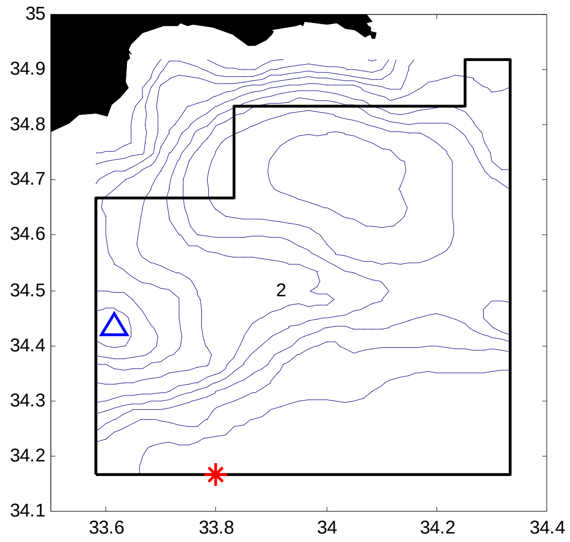
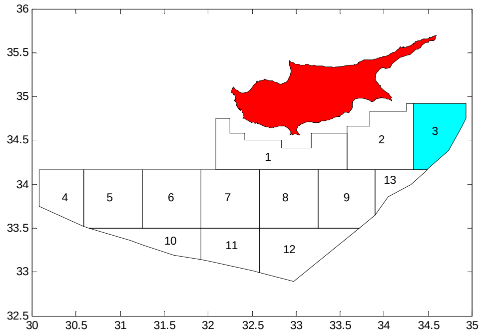
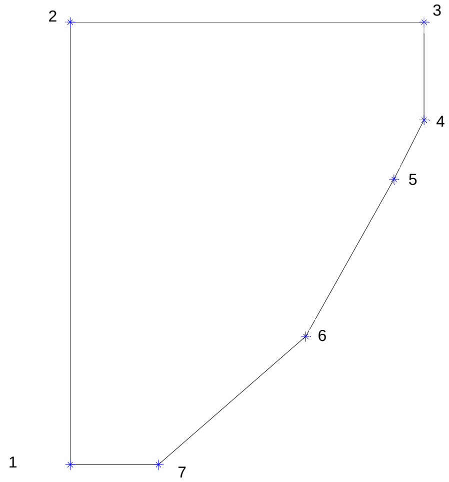


Figure C.2a. Bathymetry of Exploration Block 2 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2082 m at (33.8, 34.166667) and minimum depth is 266 m at (33.616667, 34.433333). The average depth is 1549 m.

Table C.3. Useful data for Exploration Block 3.

EXPLORATION BLOCK 3





GENERAL INFORMATION

Longitude range	34.333333 – 34.933333
Latitude range	34.166667 - 34.916667
Area	3490.2 km^2
Minimum depth	869 m at (34.466667, 34.750000)
Maximum depth	2057 m at (34.333333, 34.316667)
Average depth	1495.6 m

VERTEX COORDINATES

n	Longitude	Latitude
1	34.333333	34.166667
2	34.333333	34.916667
3	34.933333	34.916667
4	34.933333	34.750000
5	34.883333	34.650000
6	34.733333	34.383333
7	34.483333	34.166667

EXPLORATION BLOCK 3

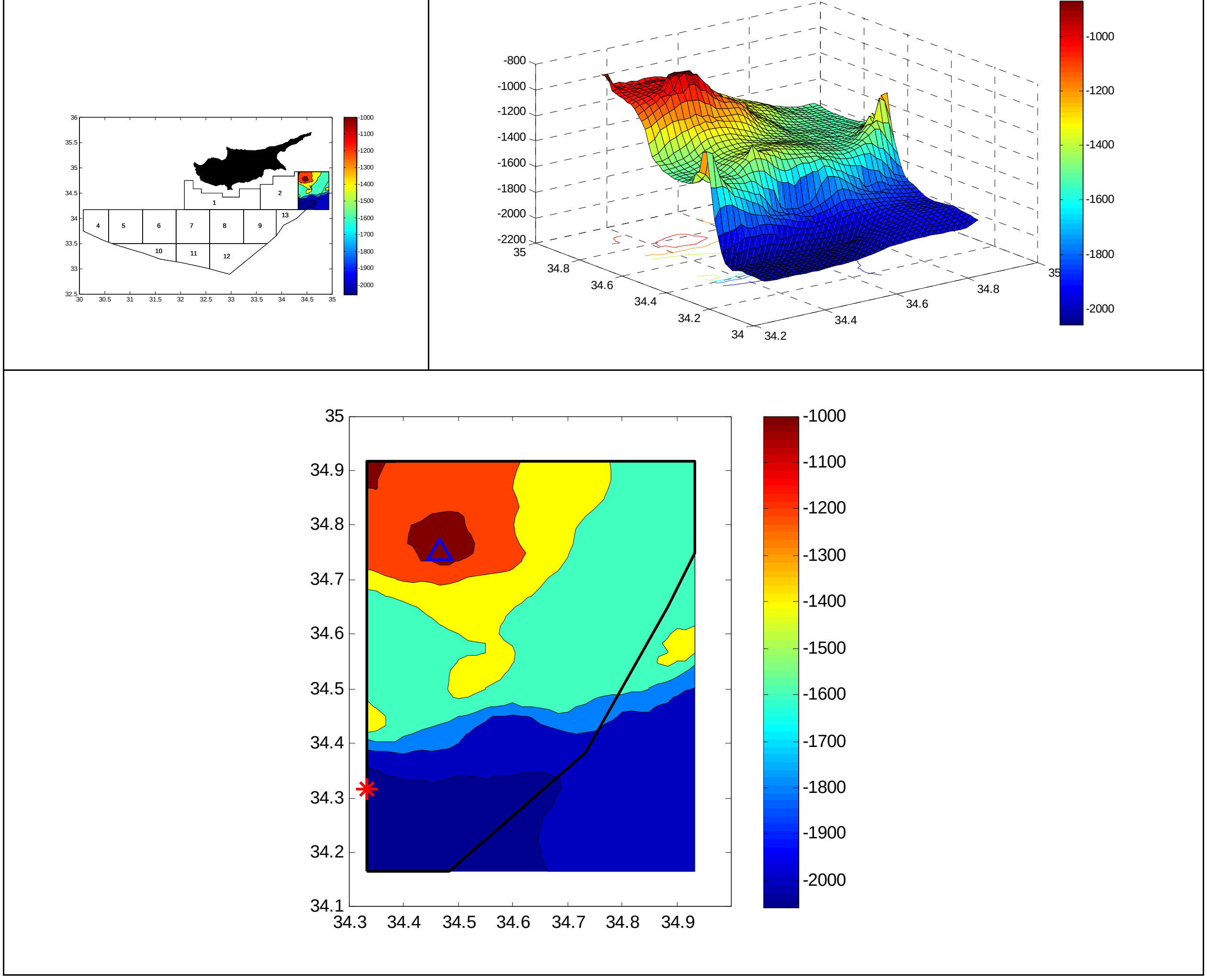


Figure C.3. Bathymetry of Exploration Block 3 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. It should be noted that the axes in the 3D plot are not in scale. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2057 m at (34.333333, 34.316667) and minimum depth is 869 m at (34.466667, 34.75). The average depth is 1496 m.

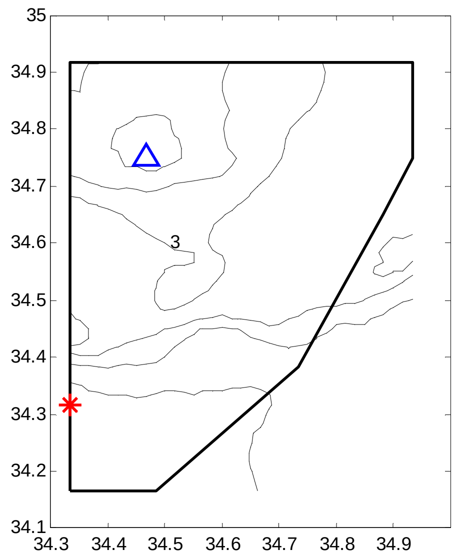
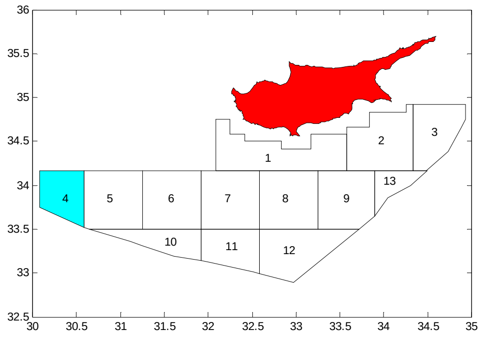
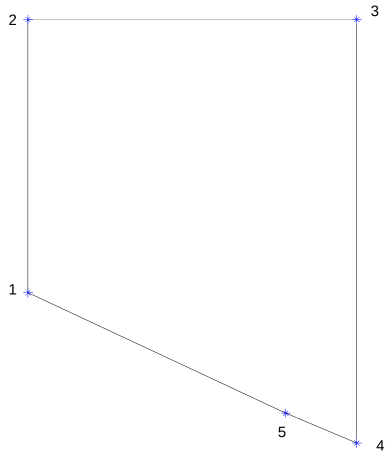


Figure C.3a. Bathymetry of Exploration Block 3 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2057 m at (34.333333, 34.316667) and minimum depth is 869 m at (34.466667, 34.75). The average depth is 1496 m.

Table C.4. Useful data for Exploration Block 4.

EXPLORATION BLOCK 4





GENERAL INFORMATION	
Longitude range	30.083333 – 30.583333
Latitude range	33.522222 - 34.166667
Area	2729.0 km^2
Minimum depth	2521 m at (30.583333, 34.166667)
Maximum depth	3005 m at (30.083333, 33.933333)
Average depth	2712.1 m

VERTEX COORDINATES		
n	**Longitude**	**Latitude**
1	30.083333	33.750000
2	30.083333	34.166667
3	30.583333	34.166667
4	30.583333	33.522222
5	30.475000	33.566667

EXPLORATION BLOCK 4

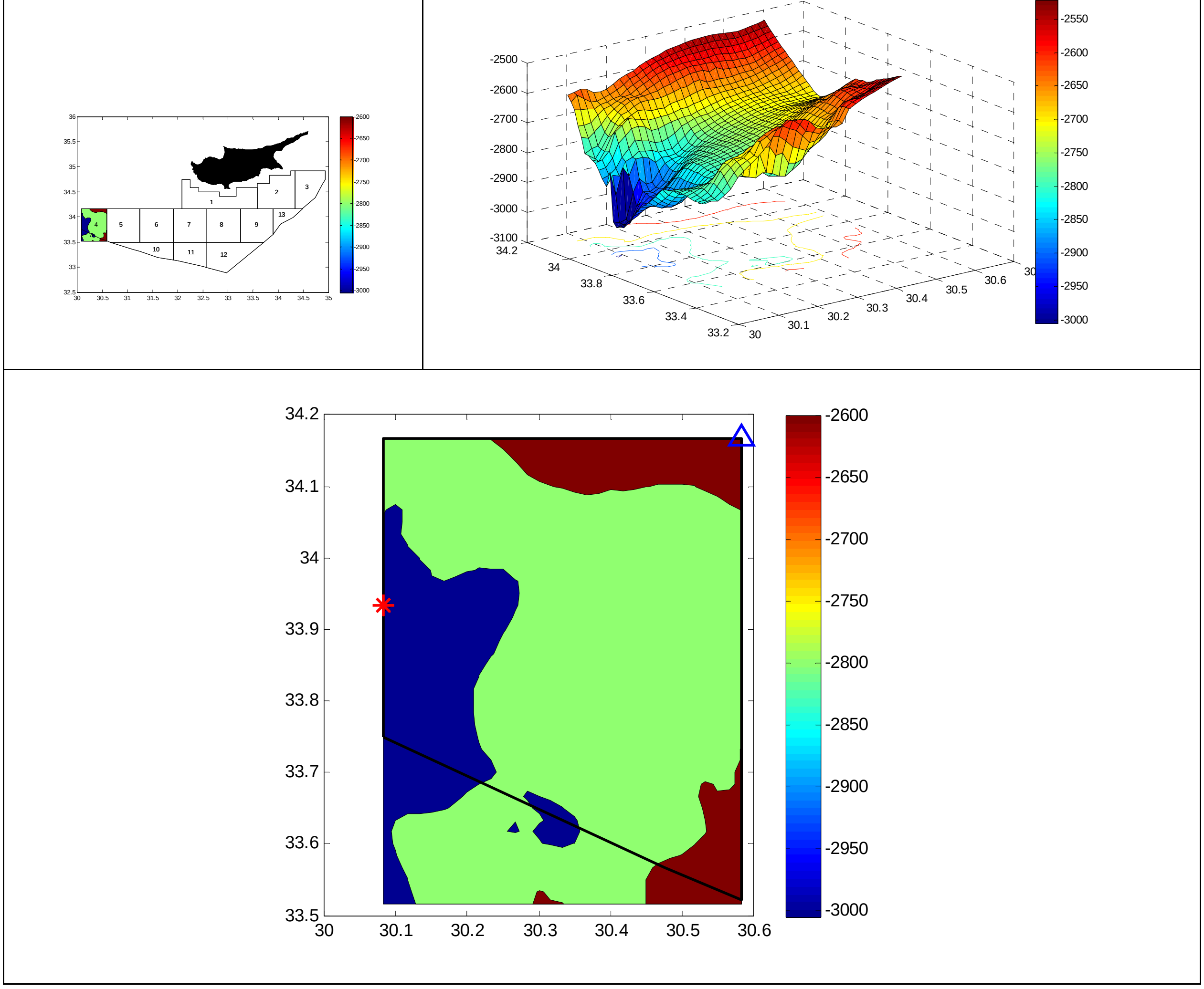


Figure C.4. Bathymetry of Exploration Block 4 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. It should be noted that the axes in the 3D plot are not in scale. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 3005 m at (30.083333, 33.9333333) and minimum depth is 2521 m at (30.583333, 34.166667). The average depth is 2712 m.

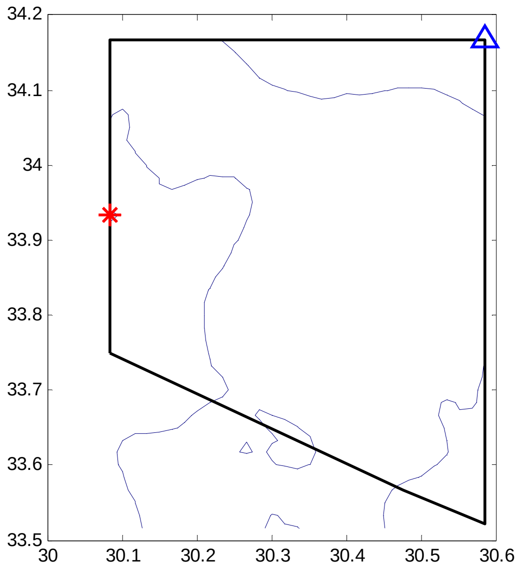
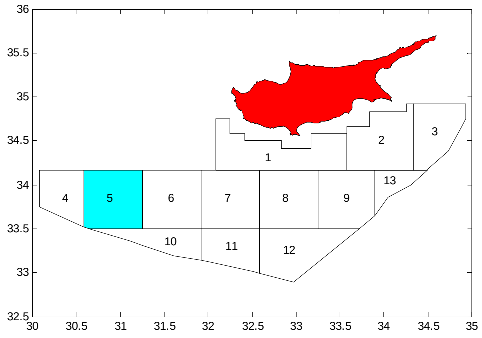
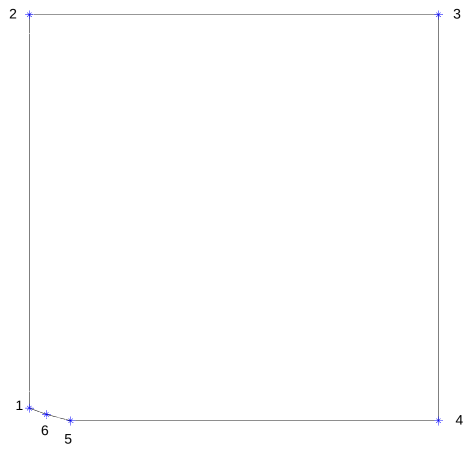


Figure C.4a. Bathymetry of Exploration Block 4 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 3005 m at (30.083333, 33.9333333) and minimum depth is 2521 m at (30.583333, 34.166667). The average depth is 2712 m.

Table C.5. Useful data for Exploration Block 5.

EXPLORATION BLOCK 5





GENERAL INFORMATION	
Longitude range	30.583333 – 31.250000
Latitude range	33.500000 - 34.166667
Area	4547.8 km^2
Minimum depth	2280 m at (31.25, 33.5)
Maximum depth	2704 m at (30.583333, 33.9)
Average depth	2506.1 m

VERTEX COORDINATES		
n	**Longitude**	**Latitude**
1	30.583333	33.522222
2	30.583333	34.166667
3	31.250000	34.166667
4	31.250000	33.500000
5	30.650556	33.500000
6	30.611111	33.511111

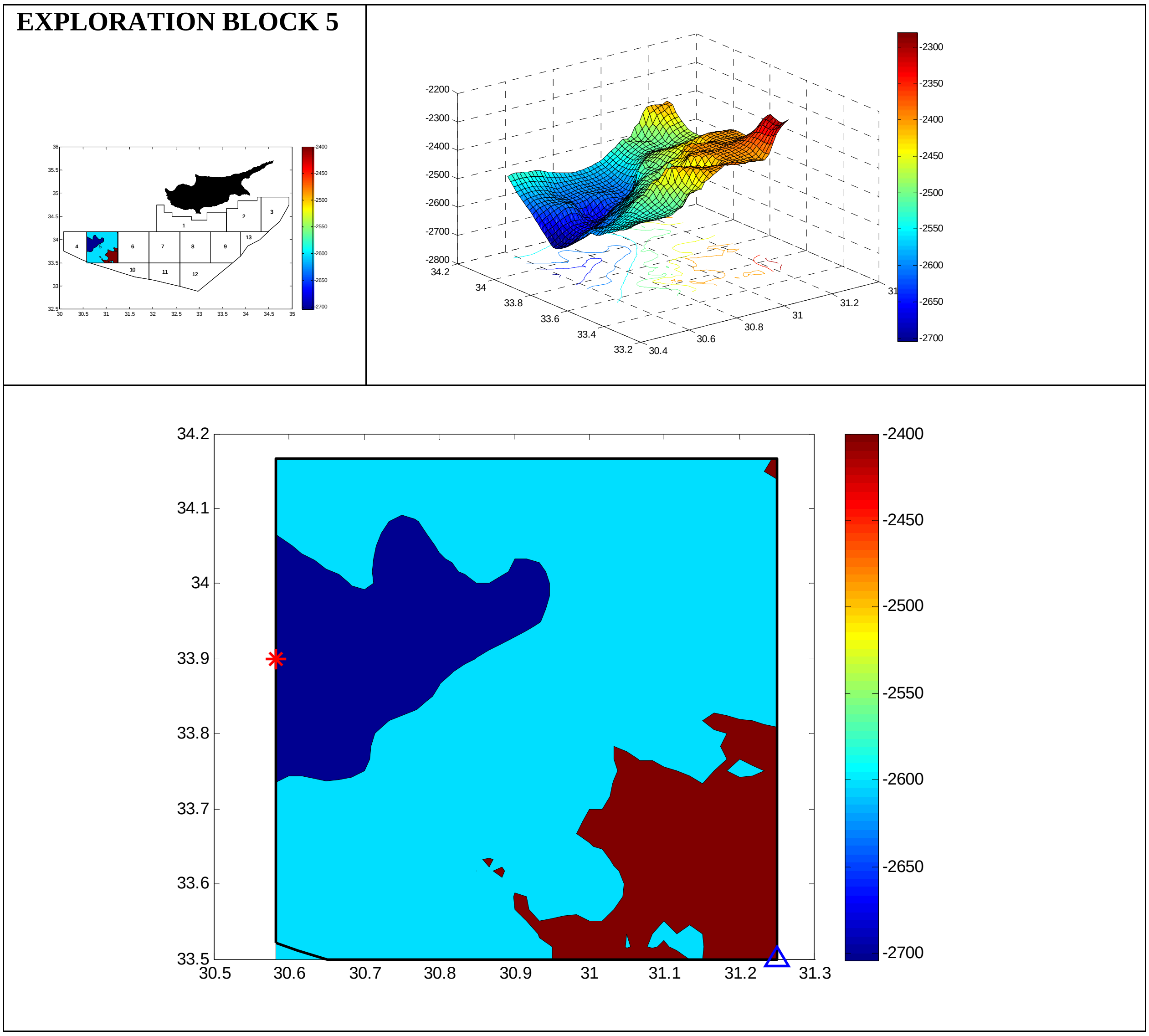


Figure C.5. Bathymetry of Exploration Block 5 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. It should be noted that the axes in the 3D plot are not in scale. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2704 m at (30.583333, 33.9) and minimum depth is 2280 m at (31.25, 33.5). The average depth is 2506 m.

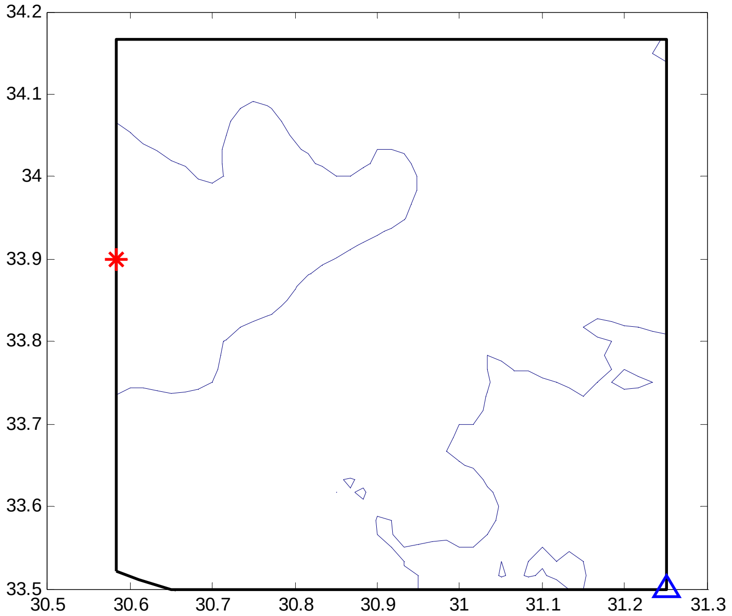
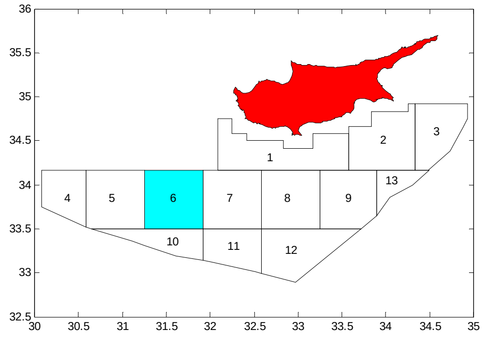
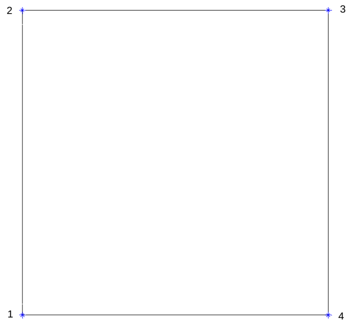


Figure C.5a. Bathymetry of Exploration Block 5 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2704 m at (30.583333, 33.9) and minimum depth is 2280 m at (31.25, 33.5). The average depth is 2506 m.

Table C.6. Useful data for Exploration Block 6.

EXPLORATION BLOCK 6





GENERAL INFORMATION	
Longitude range	31.250000 – 31.916667
Latitude range	33.500000 - 34.166667
Area	4554.8 km^2
Minimum depth	2033 m at (31.916667, 33.5)
Maximum depth	2539 m at (31.916667, 33.666667)
Average depth	2401.2 m

VERTEX COORDINATES		
n	**Longitude**	**Latitude**
1	31.250000	33.500000
2	31.250000	34.166667
3	31.916667	34.166667
4	31.916667	33.500000

EXPLORATION BLOCK 6

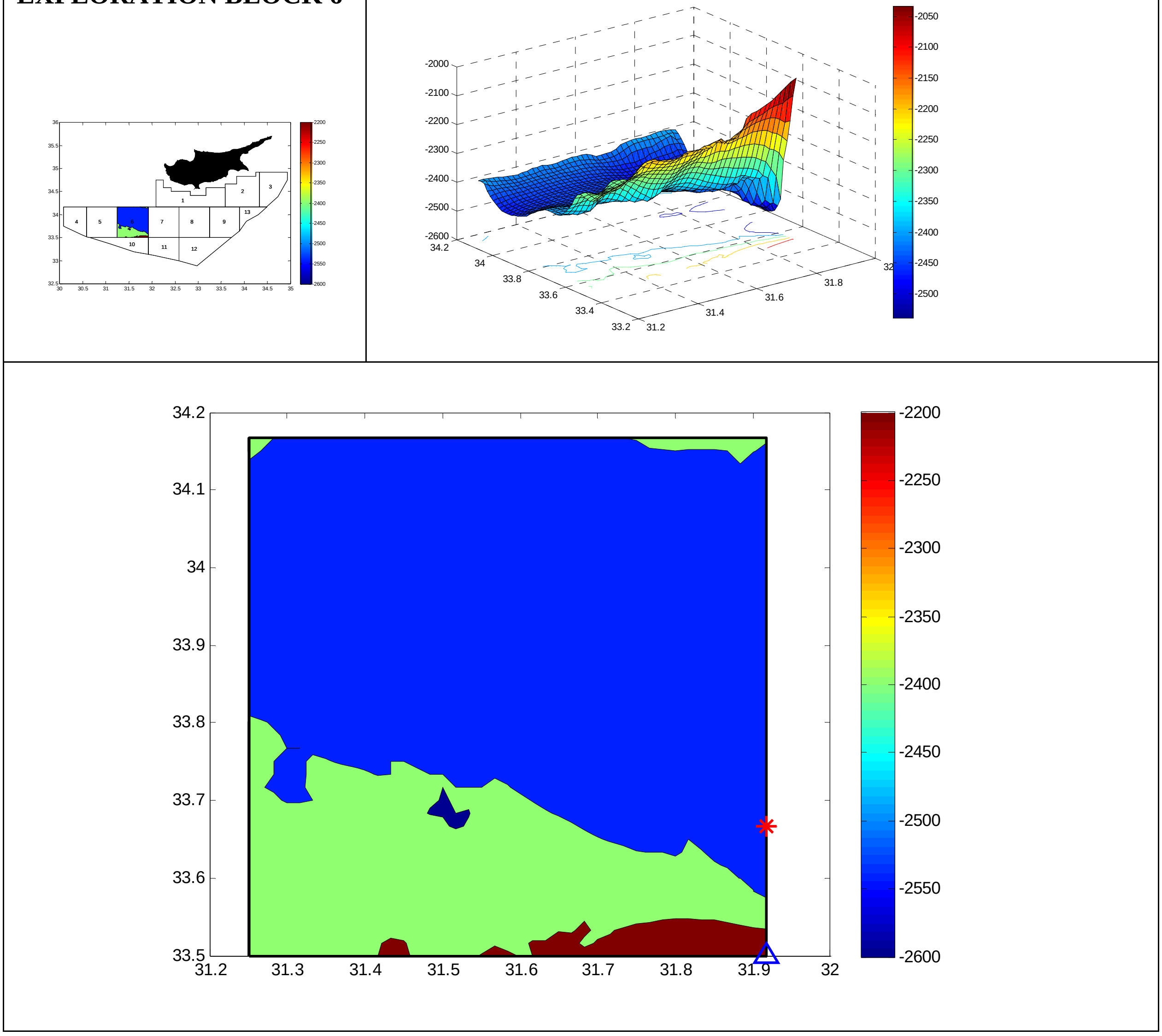


Figure C.6. Bathymetry of Exploration Block 6 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. It should be noted that the axes in the 3D plot are not in scale. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2539 m at (31.916667, 33.666667) and minimum depth is 2033 m at (31.916667, 33.5). The average depth is 2401 m.

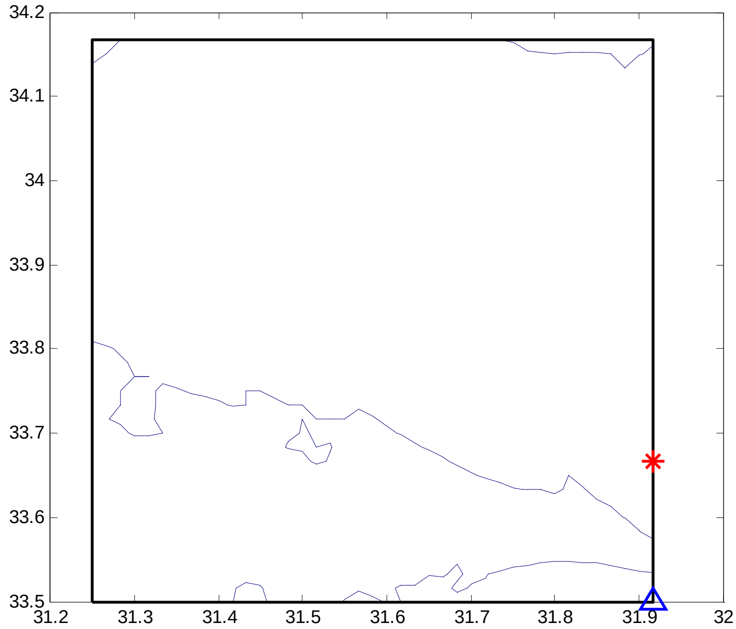
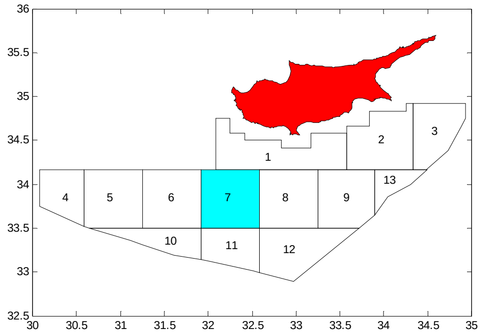
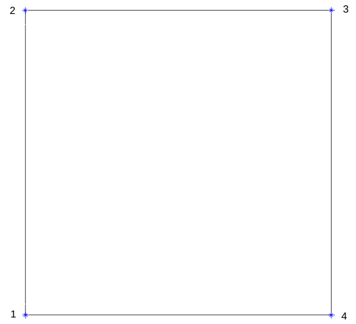


Figure C.6a. Bathymetry of Exploration Block 6 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2539 m at (31.916667, 33.666667) and minimum depth is 2033 m at (31.916667, 33.5). The average depth is 2401 m.

Table C.7. Useful data for Exploration Block 7.

EXPLORATION BLOCK 7





GENERAL INFORMATION	
Longitude range	31.916667 – 32.583333
Latitude range	33.500000 - 34.166667
Area	4554.8 km^2
Minimum depth	786 m at (32.583333, 33.633333)
Maximum depth	2703 m at (32.583333, 34.133333)
Average depth	2262.6 m

VERTEX COORDINATES		
n	**Longitude**	**Latitude**
1	31.916667	33.500000
2	31.916667	34.166667
3	32.583333	34.166667
4	32.583333	33.500000

EXPLORATION BLOCK 7

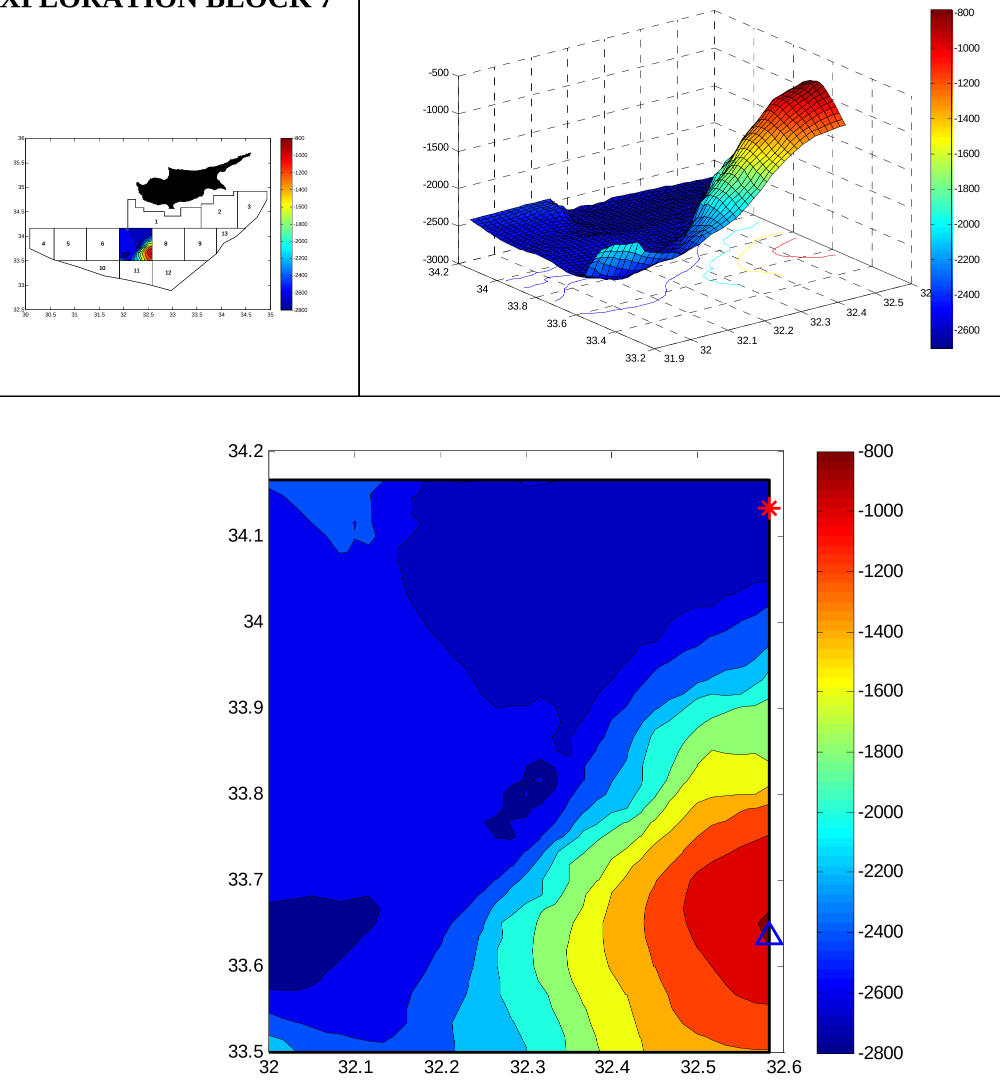


Figure C.7. Bathymetry of Exploration Block 7 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. It should be noted that the axes in the 3D plot are not in scale. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2703 m at (32.583333, 34.133333) and minimum depth is 786 m at (32.583333, 33.633333). The average depth is 2263 m.

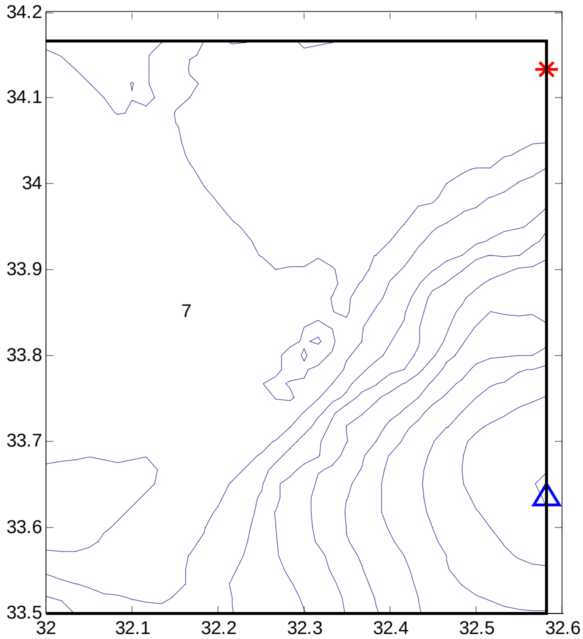
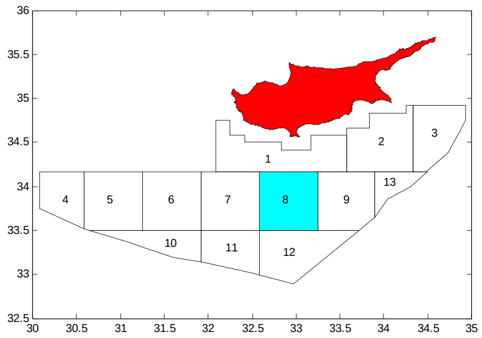
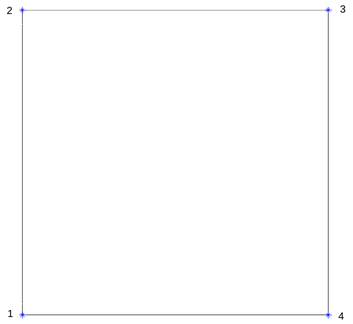


Figure C.7a. Bathymetry of Exploration Block 7 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2703 m at (32.583333, 34.133333) and minimum depth is 786 m at (32.583333, 33.633333). The average depth is 2263 m.

Table C.8. Useful data for Exploration Block 8.

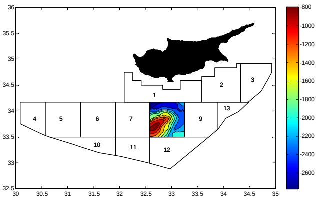
EXPLORATION BLOCK 8

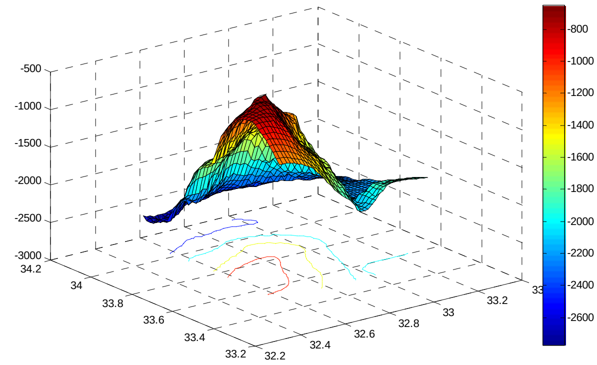




GENERAL INFORMATION		**VERTEX COORDINATES**		
		n	**Longitude**	**Latitude**
Longitude range	32.583333 – 33.250000	1	32.583333	33.500000
Latitude range	33.500000 - 34.166667	2	32.583333	34.166667
Area	4554.8 km^2	3	33.250000	34.166667
Minimum depth	654 m at (32.733333, 33.733333)	4	33.250000	33.500000
Maximum depth	2771 m at (32.65, 34.15)			
Average depth	1829.8 m			

EXPLORATION BLOCK 8





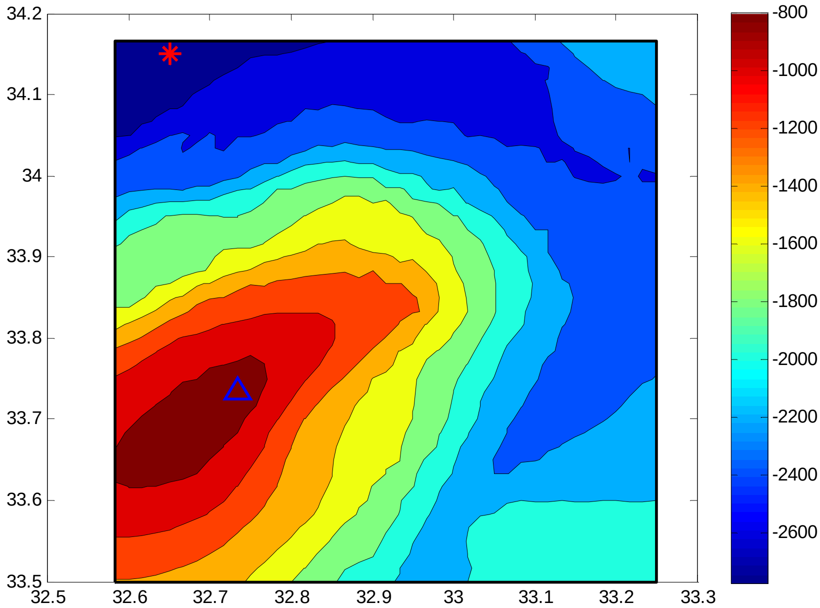


Figure C.8. Bathymetry of Exploration Block 8 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. It should be noted that the axes in the 3D plot are not in scale. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2771 m at (32.65, 34.15) and minimum depth is 654 m at (32.733333, 33.733333). The average depth is 1830 m.

,

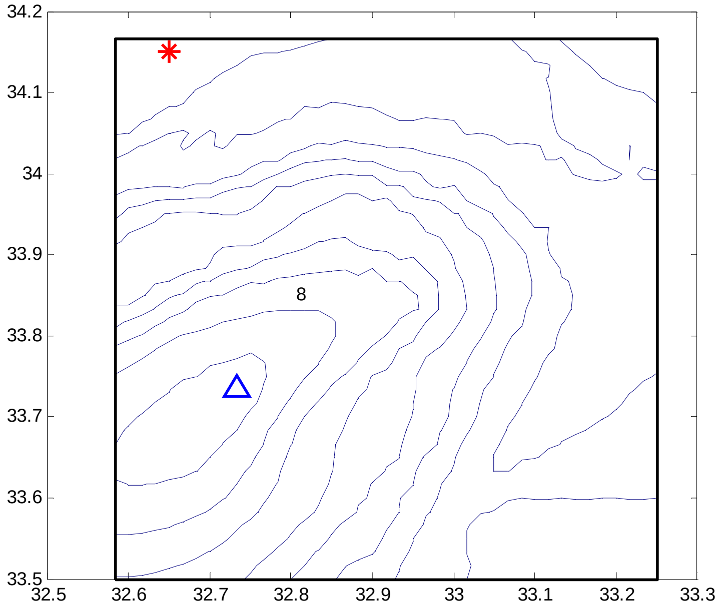
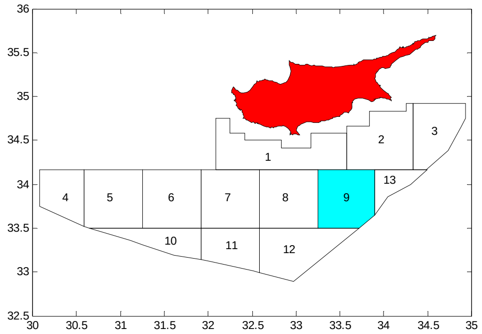
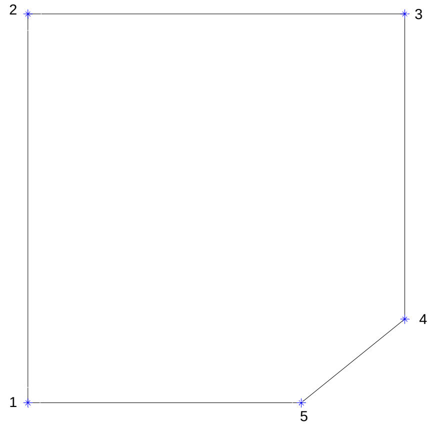


Figure C.8a. Bathymetry of Exploration Block 8 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2771 m at (32.65, 34.15) and minimum depth is 654 m at (32.733333, 33.733333). The average depth is 1830 m.

Table C.9. Useful data for Exploration Block 9.

EXPLORATION BLOCK 9





GENERAL INFORMATION	
Longitude range	33.250000 – 33.894444
Latitude range	33.500000 - 34.166667
Area	4271.9 km^2
Minimum depth	1871 m at (33.25, 33.5)
Maximum depth	2403 m at (33.25, 34.0)
Average depth	2121.6 m

VERTEX COORDINATES		
n	**Longitude**	**Latitude**
1	33.250000	33.500000
2	33.250000	34.166667
3	33.894444	34.166667
4	33.894444	33.644444
5	33.718056	33.500000

EXPLORATION BLOCK 9

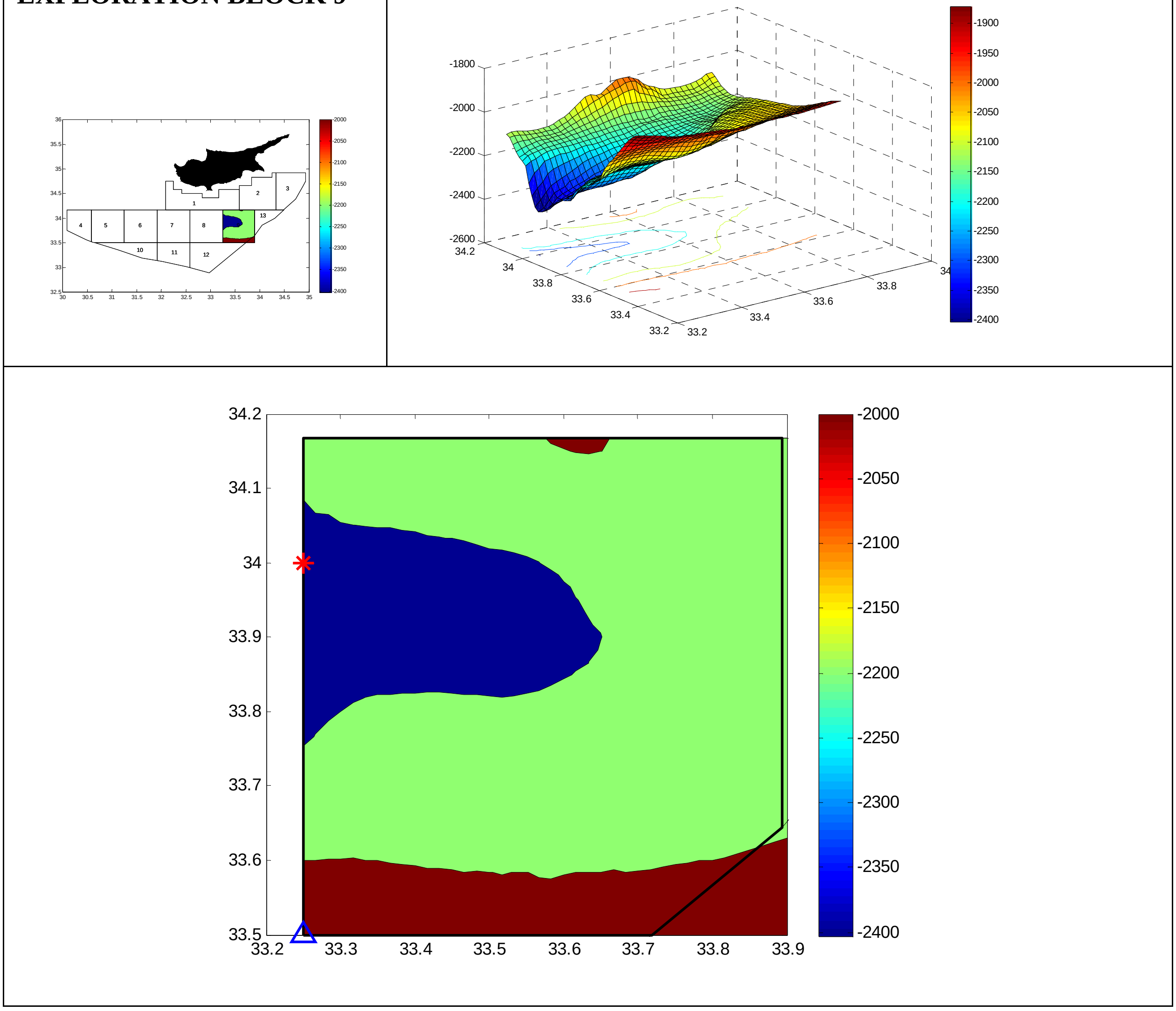


Figure C.9. Bathymetry of Exploration Block 9 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. It should be noted that the axes in the 3D plot are not in scale. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2403 m at (33.25, 34) and minimum depth is 1871 m at (33.25, 33.5). The average depth is 2122 m.

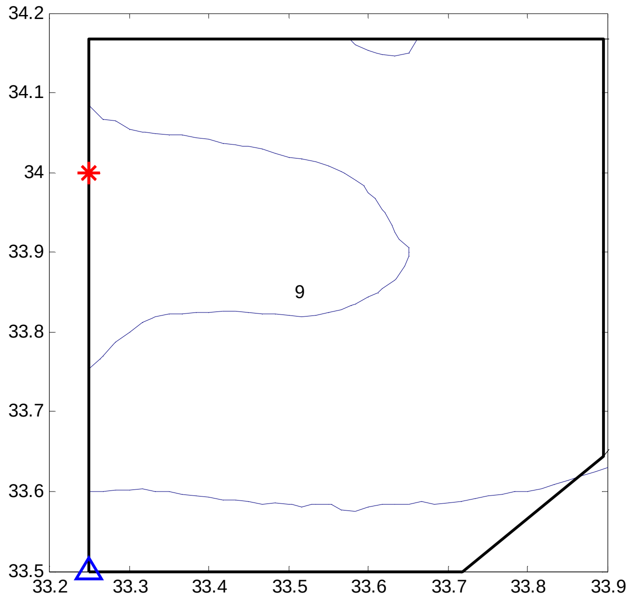
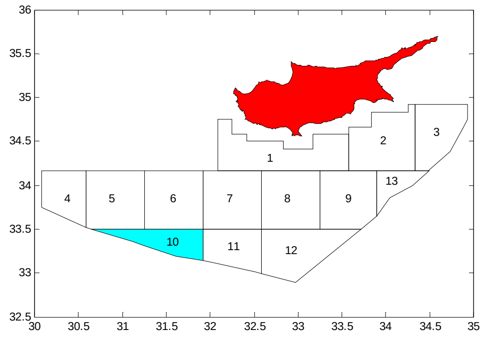
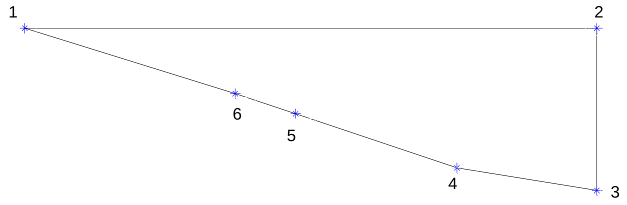


Figure C.9a. Bathymetry of Exploration Block 9 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2403 m at (33.25, 34) and minimum depth is 1871 m at (33.25, 33.5). The average depth is 2122 m.

Table C.10. Useful data for Exploration Block 10.

EXPLORATION BLOCK 10





GENERAL INFORMATION

Longitude range	30.650556 – 31.916667
Latitude range	33.140000 - 33.500000
Area	2555.1 km^2
Minimum depth	1671 m at (31.916667, 33.2)
Maximum depth	2515 m at (30.7, 33.5)
Average depth	2075.0 m

VERTEX COORDINATES

n	Longitude	Latitude
1	30.650556	33.500000
2	31.916667	33.500000
3	31.916667	33.140000
4	31.608333	33.191667
5	31.250000	33.311111
6	31.116667	33.355556

EXPLORATION BLOCK 10

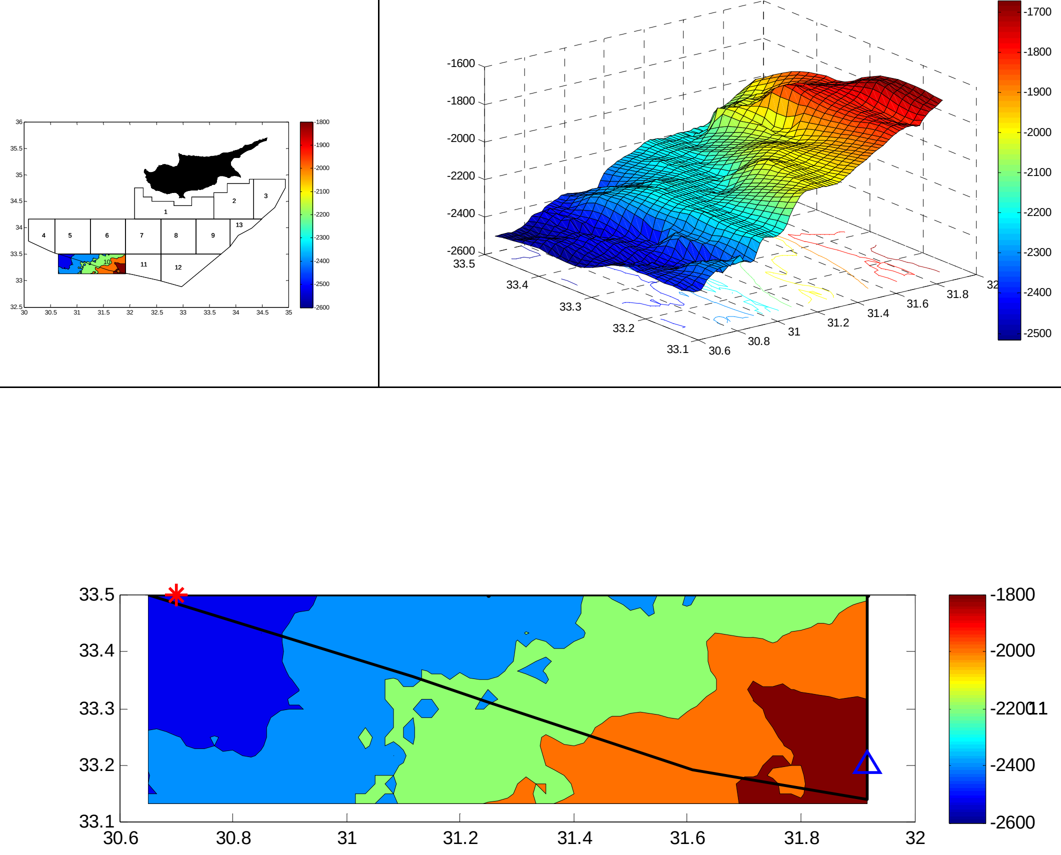


Figure C.10. Bathymetry of Exploration Block 10 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. It should be noted that the axes in the 3D plot are not in scale. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2515 m at (30.7, 33.5) and minimum depth is 1671 m at (31.916667, 33.2). The average depth is 2075 m.

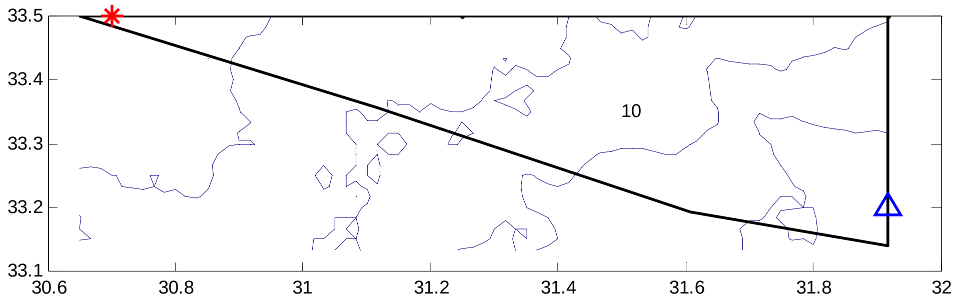
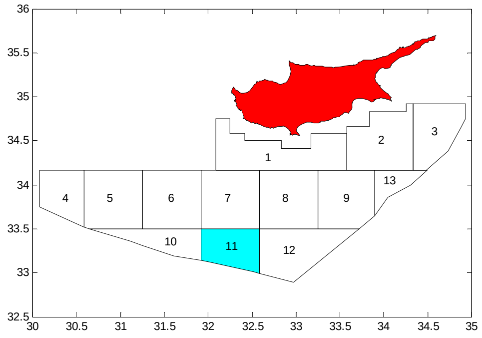
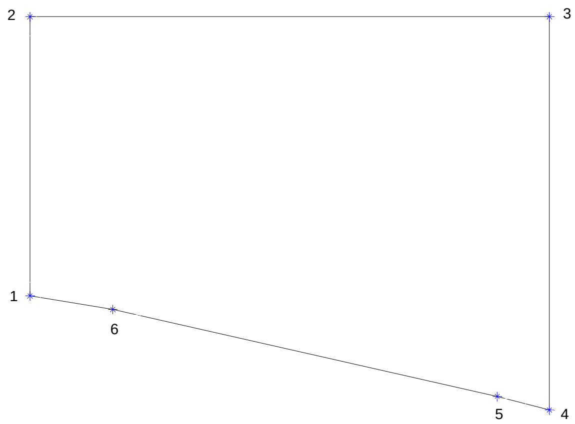


Figure C.10a. Bathymetry of Exploration Block 10 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2515 m at (30.7, 33.5) and minimum depth is 1671 m at (31.916667, 33.2). The average depth is 2075 m.

Table C.11. Useful data for Exploration Block 11.

EXPLORATION BLOCK 11





GENERAL INFORMATION	
Longitude range	31.916667 – 32.583333
Latitude range	32.993056 – 33.500000
Area	2953.8 km^2
Minimum depth	1207 m at (32.566667, 33.5)
Maximum depth	2366 m at (32.133333, 33.5)
Average depth	1674.7 m

VERTEX COORDINATES		
n	**Longitude**	**Latitude**
1	31.916667	33.140000
2	31.916667	33.500000
3	32.583333	33.500000
4	32.583333	32.993056
5	32.516667	33.011111
6	32.022222	33.122222

EXPLORATION BLOCK 11

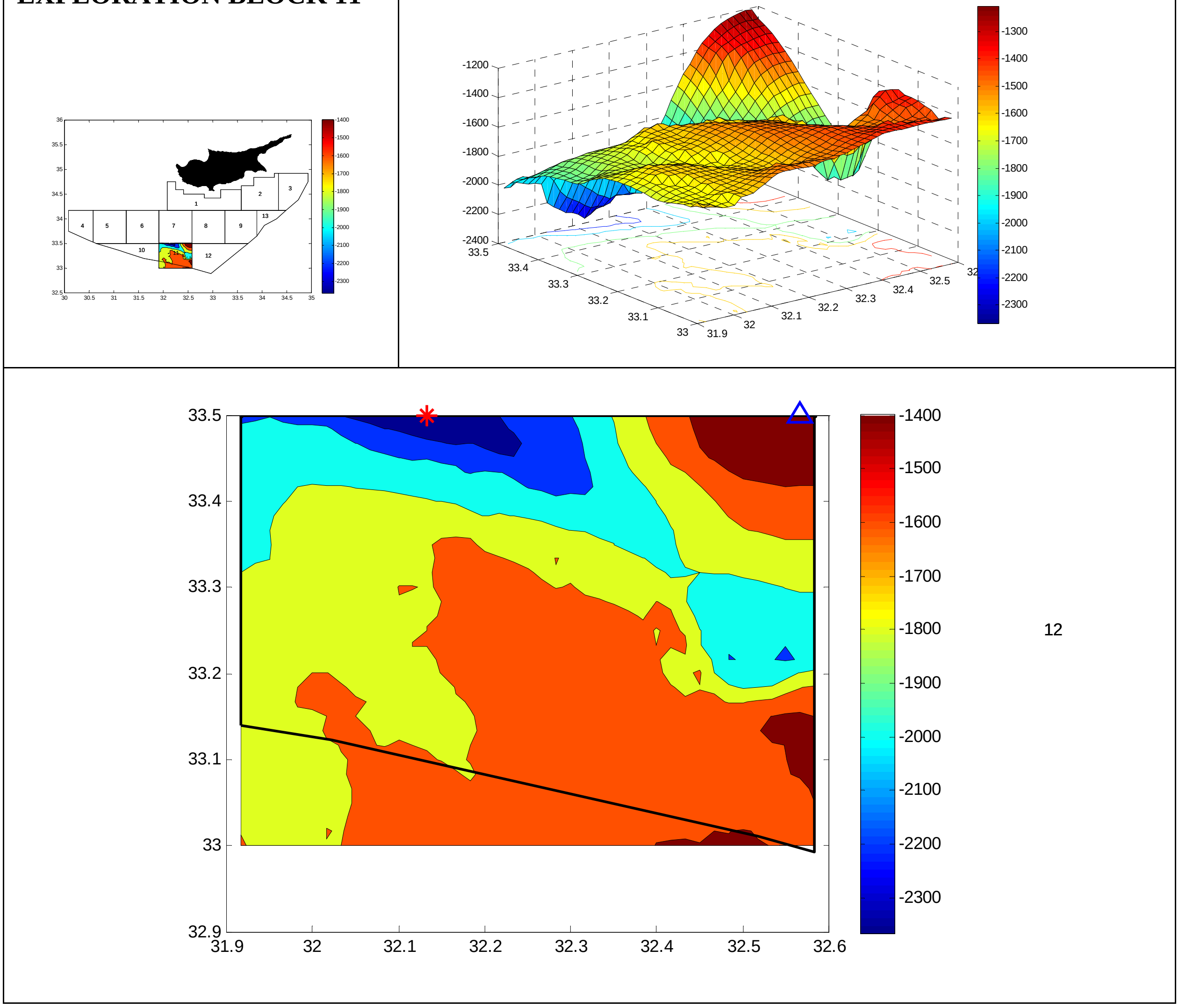


Figure C.11. Bathymetry of Exploration Block 11 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. It should be noted that the axes in the 3D plot are not in scale. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2366 m at (32.133333, 33.5) and minimum depth is 1207 m at (32.566667, 33.5). The average depth is 1675 m.

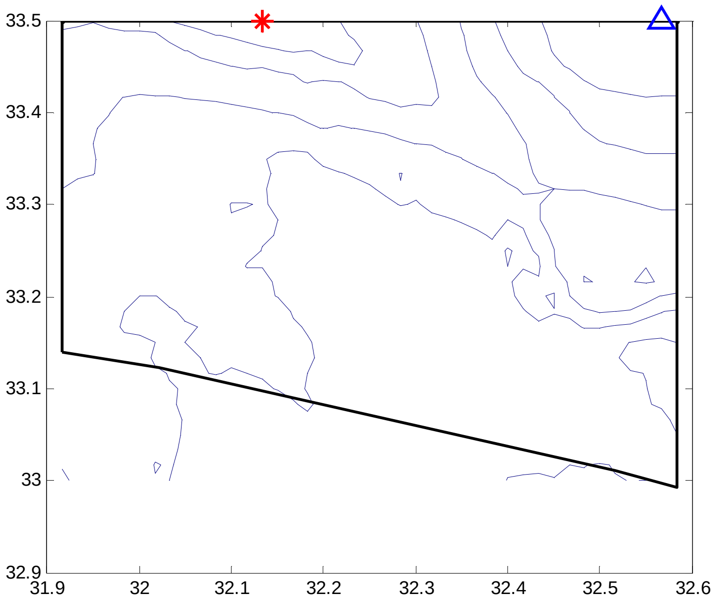
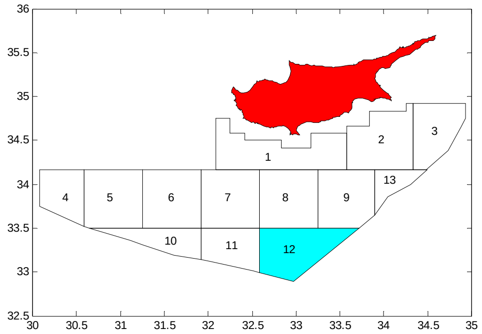
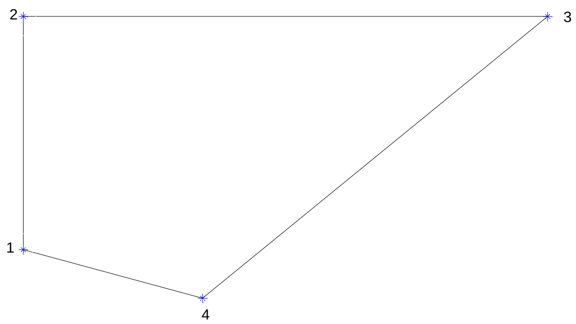


Figure C.11a. Bathymetry of Exploration Block 11 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200m. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2366 m at (32.133333, 33.5) and minimum depth is 1207 m at (32.566667, 33.5). The average depth is 1675 m.

Table C.12. Useful data for Exploration Block 12.

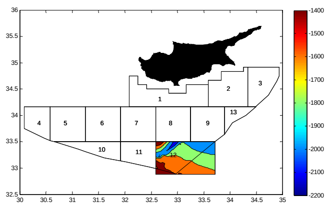
EXPLORATION BLOCK 12

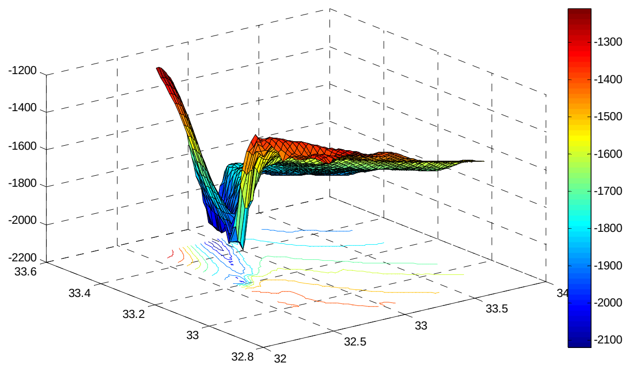




GENERAL INFORMATION		VERTEX COORDINATES		
		n	**Longitude**	**Latitude**
Longitude range	32.583333 – 33.718056	1	32.583333	32.993056
Latitude range	32.888889 - 33.5	2	32.583333	33.500000
Area	4605.3 km^2	3	33.718056	33.500000
Minimum depth	1208 m at (32.583333, 33.5)	4	32.972222	32.888889
Maximum depth	2119 m at (32.95, 33.466667)			
Average depth	1669.8 m			

EXPLORATION BLOCK 12





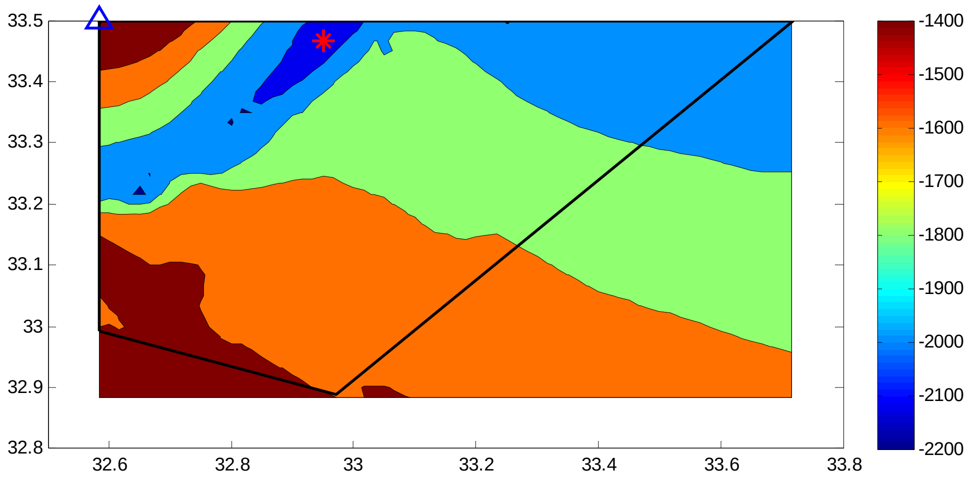


Figure C.12. Bathymetry of Exploration Block 12 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. It should be noted that the axes in the 3D plot are not in scale. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2119 m at (32.95, 33.466667) and minimum depth is 1208 m at (32.583333, 33.5). The average depth is 1670 m.

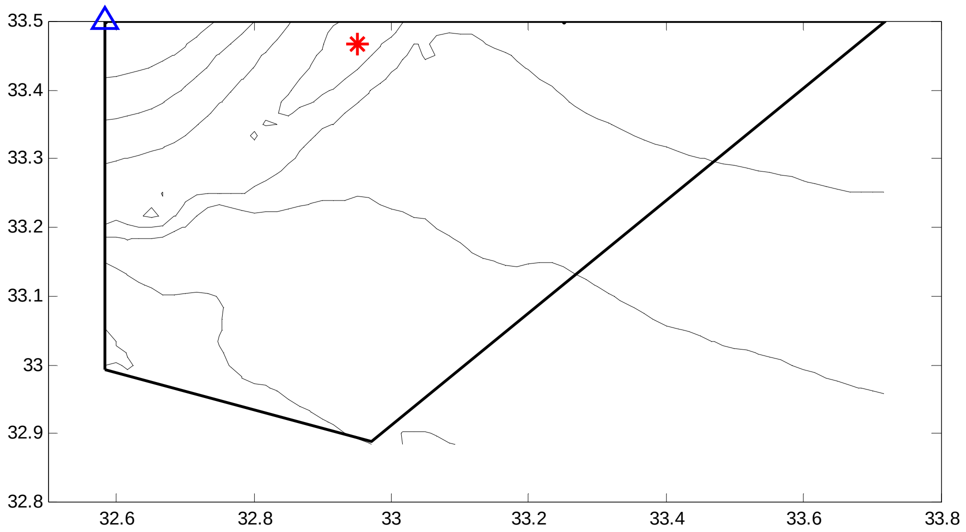
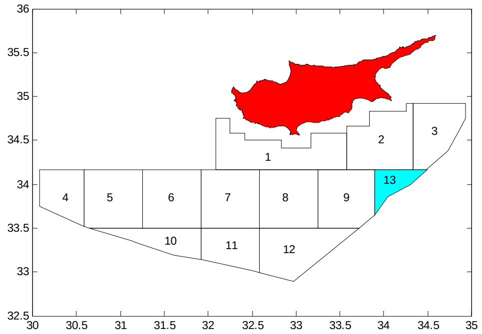
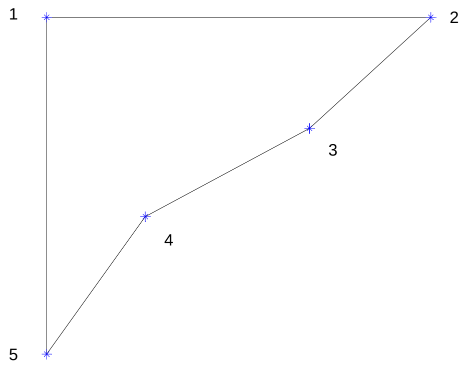


Figure C.12a. Bathymetry of Exploration Block 12 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. It should be noted that the axes in the 3D plot are not in scale. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2119 m at (32.95, 33.466667) and minimum depth is 1208 m at (32.583333, 33.5). The average depth is 1670 m.

Table C.13. Useful data for Exploration Block 13.

EXPLORATION BLOCK 13





GENERAL INFORMATION	
Longitude range	33.894444 – 34.488889
Latitude range	33.644444 - 34.166667
Area	1436 km^2
Minimum depth	2020 m at (33.9, 33.666667)
Maximum depth	2117 m at (33.9, 34.05)
Average depth	2061.9 m

VERTEX COORDINATES		
n	**Longitude**	**Latitude**
1	33.894444	34.166667
2	34.488889	34.166667
3	34.300000	33.994444
4	34.047222	33.858333
5	33.894444	33.644444

EXPLORATION BLOCK 13

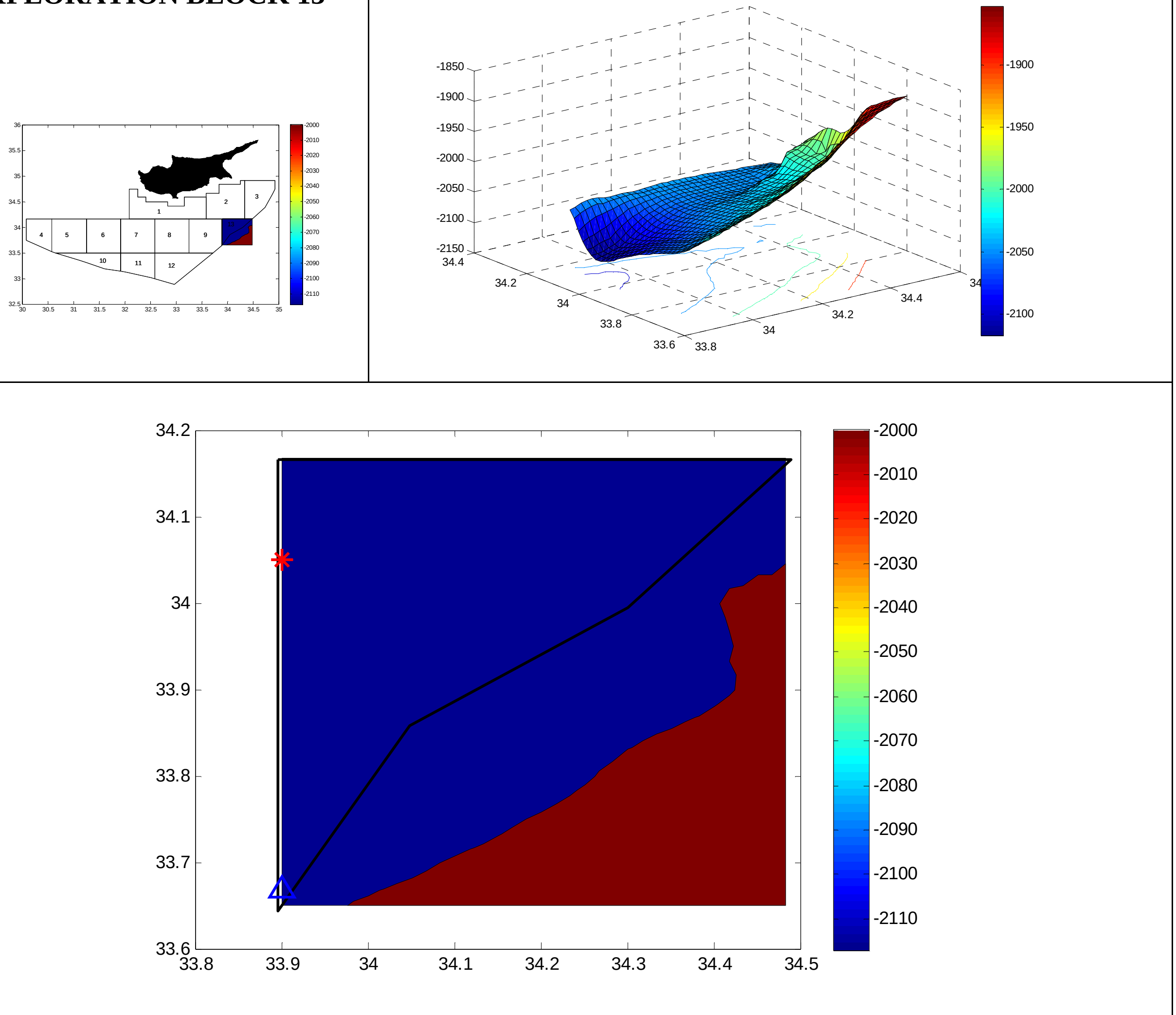


Figure C.13. Bathymetry of Exploration Block 13 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. It should be noted that the axes in the 3D plot are not in scale. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2117 m at (33.9, 34.05) and minimum depth is 2020 m at (33.9, 33.666667). The average depth is 2062 m.

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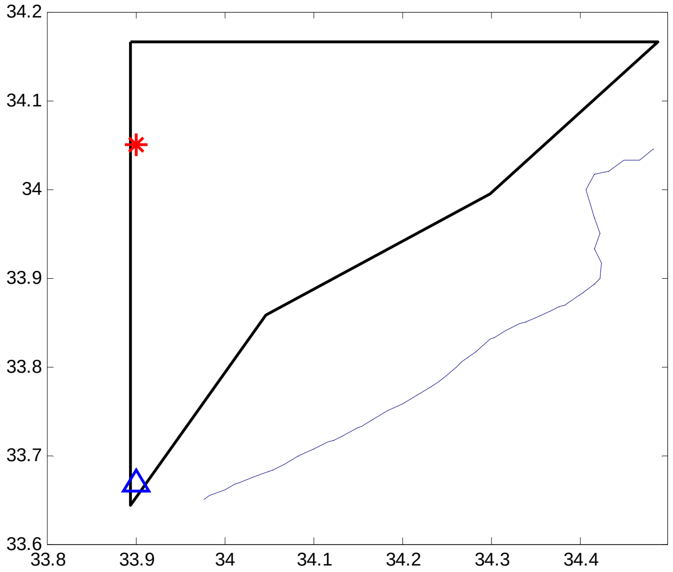

Figure C.13a. Bathymetry of Exploration Block 13 based on the GEBCO 1-min data. The contours correspond to isobaths with a step of 200 m. The star (*) indicates the maximum depth position and the triangle (Δ) the position of minimum depth. Maximum depth is 2117 m at (33.9, 34.05) and minimum depth is 2020 m at (33.9, 33.666667). The average depth is 2062 m.

Appendix D

The MEDSLIK Oil Spill Trajectory Model

The risk from oil spill pollution in the Mediterranean Sea is high due to the heavy traffic of merchant vessels for transporting oil and gas and from the many coastal and offshore installations related to the oil industry (**Figure D.1**). The Mediterranean countries are organised and prepared for operational response to accidental marine pollution, particularly with the assistance of REMPEC (Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea). The basic response to an oil spill includes different measures and equipment, such as booms and skimmers or sprays of chemicals. It is possible to make optimal use of such devices by using the Mediterranean oil spill and trajectory model known as MEDSLIK (Lardner et al. 1998; Zodiatis et al., 2005a,b; Zodiatis et al., 2007), developed in order to provide predictions of the movement and weathering of the oil, as well the trajectory of drifting floating objects on regional, sub-regional, coastal and local scales in any part of the Mediterranean. Initially, the MEDSLIK model was developed in late 1990s to suit the needs of the sub-regional contingency plan for preparedness and response to major oil pollution incidents in the Mediterranean, between Cyprus, Egypt and Israel, in the framework of a European Union LIFE project. In the last five years, MEDSLIK has been constantly upgraded following the request of its major end-users, such as REMPEC and the European Maritime Safety Agency (EMSA). MEDSLIK is coupled with operational meteorological and oceanographic (met-ocean) forecasting data for near real-time use, in order to suit the needs of several European Union projects related to the scopes and objectives of the Global Monitoring for Environment and Security (GMES) initiative. Within these European Union activities, MEDSLIK became the official oil spill model for the Eastern Mediterranean Levantine Basin, including the Cyprus EEZ. Moreover, within the framework of Italian and Maltese activities related to the preparedness and response to major oil spill pollution incidents in the Adriatic and the Tyrrhenian seas and the broader sea area of the Sicily Strait, MEDSLIK also became the official oil spill model for these sea areas in the Central and western Mediterranean (PRIMI project, 2008; De Dominicis et al., 2008; Glyptou et al., 2005).

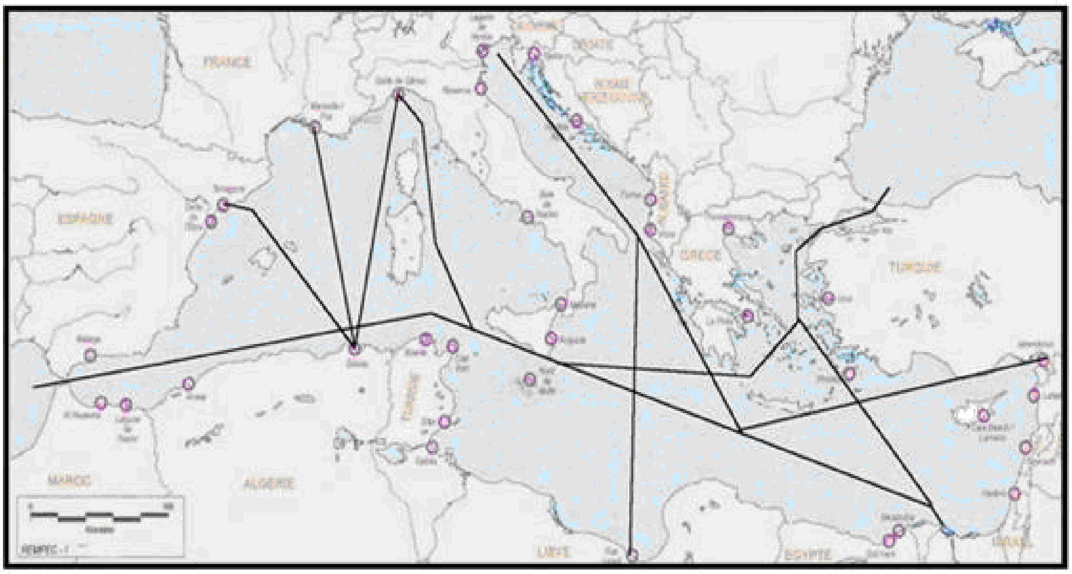

Figure D.1. Map showing the main tanker routes and the major coastal installations related to oil industry in the Mediterranean.

MEDSLIK is coupled with high-frequency wind and high-resolution ocean data from several operational ocean forecasting systems in the Mediterranean, due to the fact that MEDSLIK is used by response agencies from Italy, Malta, Syria, Israel and Cyprus, as well REMPEC, in cases of major oil spill incidents (Zodiatis et al. (2005a, 2005b). For the Eastern Mediterranean Levantine Basin, including the Cyprus EEZ, MEDSLIK is coupled with the CYCOFOS (Cyprus Coastal

Ocean Forecasting and Observing System) of the Cyprus Oceanography Center and SKIRON (University of Athens), respectively for ocean and wind forecasting data.

MEDSLIK was applied successfully during the Lebanese oil pollution crisis in summer 2006, considered the biggest so far oil pollution incident in the Eastern Mediterranean. Assistance was provided daily, upon request to the response agencies in the European Union, the United Nations and the Eastern Mediterranean countries (Lardner et al., 2006; Zodiatis et al, 2007; World Bank, 2007; De Dominicis et al., 2008). The MEDSLIK predictions during the Lebanese oil pollution crisis (**Figure D.2**) were verified by satellite remote sensing images, using MODIS and SAR data processed by the Cyprus Oceanography Center and the Joint Resent Centre if the EU at Ispra, as well by local observations of the Lebanese Ministry of Environment. The MEDSLIK results contributed also to drawn up the International Action Plan for the Clean up Operations of the oil spills in Lebanon.

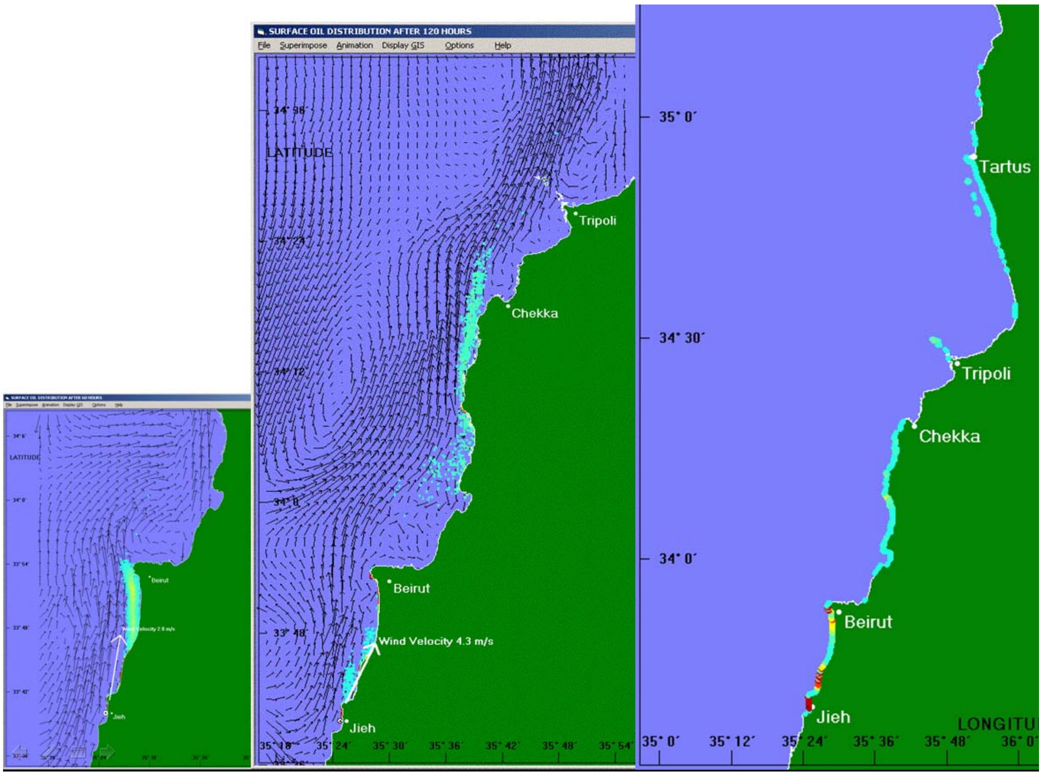

Figure D.2. MEDSLIK predictions during the Lebanese oil spill crisis in summer 2006: a) after 2.5 days; b) after 5 days; and c) oil permanent stack on the Lebanese coast.

MEDSLIK, following an EMSA-European Maritime Safety Agency request, is coupled with satellite data (synthetic aperture radar, SAR), used to detect oil spills at sea, in order to provide forecasts and hind-cast in the Eastern Mediterranean Levantine Basin, including the Cyprus EEZ (**Figure D.3**).

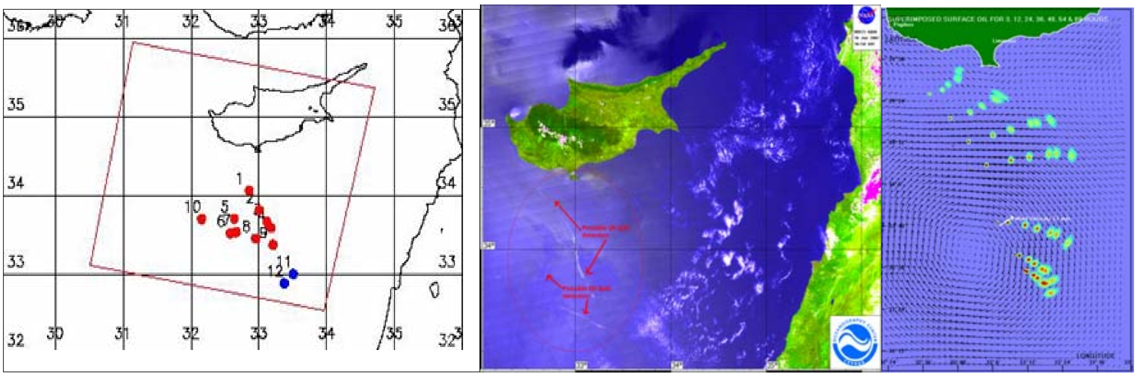

Figure D.3. Example of MEDSLIK oil spill predictions after an EMSA warning report for oil slicks released by two moving ships south of Cyprus, June 2007.

An oil spill incident could occur during oil and gas exploration or exploitation activities in the EEZ of Cyprus. Therefore, for oil risk map analysis and for contributing to the future contingency planning of the Cyprus response agencies, MEDSLIK was first applied by the Cyprus Oceanography Center, in order to define the most vulnerable coastal areas of Cyprus. **Figure D.4** shows the results from this pilot study using summer meteorological and oceanographic data.

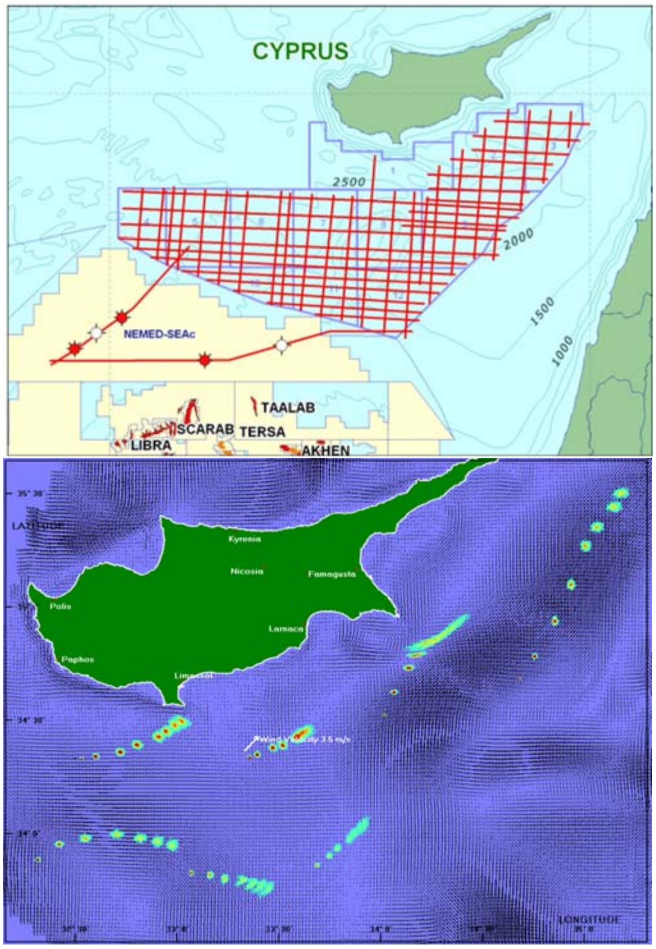

Figure D.4. (a) Map of the Cyprus EEZ indicating the areas for oil and gas exploration; (b) an example of the MEDSLIK oil spill predictions from an experiment carried out by the Cyprus Oceanography Centre, using summer meteorological and oceanographic data.

MEDSLIK as been integrated with the met-ocean forcing data of CYCOFOS, MFS, ALERMO and SKIRON, is fully operational. The met-ocean forcing data are archived daily to the servers of the Cyprus Oceanography Center, so upon a request by email message, or call or fax from the major or local or sub-regional end users, such as the Cyprus Department of Merchant Shipping, the MEDSLIK runs using the oil spill data provided by the end users. The results of MEDSLIK may put on Google Earth Map for easy and fast access by the end users.

MEDSLIK is a drifting model with transformation processes representation for oil in the water to simulate the fate and dispersal of oil slicks. MEDSLIK predicts the oil fate, that represents how much has evaporated, the degree of emulsification, how much is dispersed as fine droplets throughout the water column, and the oil dispersal. On the basis of the simulation of the fate and dispersal of the oil, it is possible to predict which and how extensively resources will be threatened. Oil spill models require as input data the type of oil and its characteristics, the wind field, the sea surface temperature and the three-dimensional sea currents. MEDSLIK is a 3-dimensional oil spill transport and fate model that represents the spill with a certain number of particles for each point-like release. At each time step, an advective (coming from the eulerian velocity field) and a diffusive (random walk) displacement is considered for each parcel. The oil is considered to consist of a light evaporative component and a heavy non-evaporative component. The emulsification is also simulated, and the viscosity changes of the oil are computed according to the amounts of emulsification and evaporation of the oil. Other fate processes included in the model are evaporation of the lighter oil fractions, mixing into the water column by wave action, emulsification and beaching on the coast.

In MEDSLIK the transport of the surface slick is governed by both water currents and by direct wind forcing, the diffusion of the slick is modelled by a random walk (Monte Carlo) model, the oil may be dispersed into the water column by wave action (Mackay et al., 1979; Buist, 1979), the dispersed oil is moved by currents only and the mechanical spreading of the initial slick is included (Fay, 1969, 1971). The fate processes included in MEDSLIK are evaporation of the lighter oil fractions (Mackay et al., 1979), mixing into the water column by wave action (Mackay et al., 1979; Buist, 1979), emulsification (Mackay and Leinonen, 1977; Mackay et al., 1980), oil viscosity changes, beaching on the coast and absorption depending on the coastal type (Shen et al., 1987) (**Figure D.5**). A detailed of the MEDSLIK fate model is given in Lardner (2004).

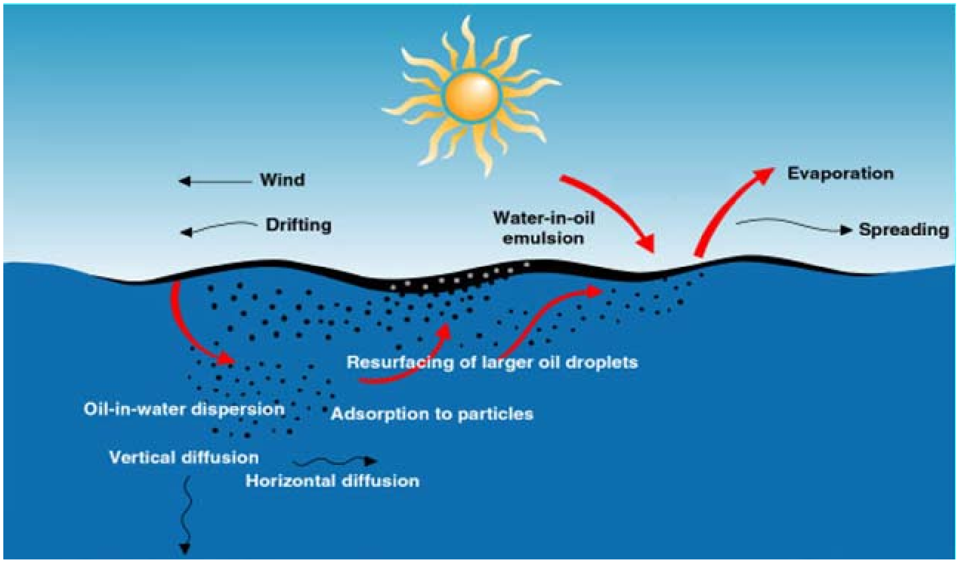

Figure D.5. The Mackay et al. (1979, 1980) schematic model of fate processes (evaporation, dispersion and emulsification).

Other major features of MEDSLIK includes: REMPEC database of the physical properties of over 220 oil types that are the most common in the Mediterranean, allows to switch from coarse to high resolution forecasting ocean data, when the oil slick passes from a coarse to a higher resolution domain, allows spill predictions to be corrected by subsequent slick observations, the effect of deployed of oil booms can be examined, simultaneous oil spills from moving or drifting ships whose slicks can be merge modelled together, hind-cast (backward) simulations for tracking the source of pollution, a simple GIS to allow information on coastal and open sea resources.

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Appendix E

Public Disclosure Report

PUBLIC DISCLOSURE SUMMARY

1. INTRODUCTION

Following the completion of the Strategic Environmental Assessment (SEA) concerning the Hydrocarbon Activities within the Exclusive Economic Zone of the Republic of Cyprus, a formal public disclosure meeting was held in Nicosia on 31st October 2008, in order to present the key findings and receive feedback.

In order to encourage participation, the public meeting was:

- Well advertised;
- Held in the Greek language (with simultaneous translation facilities available for the foreign language speaking participants)
- Held in an accessible location (Dimosigrafiki Estia-Press Club, 12 PIK Avenue, 2120 Aglantzia, Nicosia) in close proximity to Nicosia city center;
- Held at appropriate time of the day to encourage attendance of representatives from a wide range of interest/community groups (Friday 31 October, 17:00 – 20:00);
- Tailored to all participants information and dialogue needs; and
- Flexibly scheduled over the course of the consultation.

The meeting was organised in an “open house” style forum in which the MCIT (Energy Service) and the Consortium representatives, disclosed the findings of the SEA, gathered further stakeholder concerns and received feedback on the project.

The date, time and location of this meeting were advertised in the local press, the official gazette of the Republic of Cyprus, as well as the web site of the MCIT (http://www.mcit.gov.cy/) allowing for a period of thirty (30) days notice (see **APPENDIX E**1). At the meetings, stakeholders (**APPENDIX E**2) were invited to submit their comments, provide their feedback, and receive answers.

2. RESOURCES AND IMPLEMENTATION

The Energy Service of the MCIT had the responsibility for the organization of the public consultation meeting, whereas the Consortium team specialists had the responsibility for the preparation and presentation of the SEA findings and recommendations. The members of the Consortium team present at the meeting were:

1. Dr Luis Lagera – Principal Consultant (CSA International Inc)
2. Dr. Ioannis P. Glekas – Principal Consultant (AEOLIKI Ltd.)
3. Dr. Dimitris. Glekas – Principal Consultant (AEOLIKI Ltd.)
4. Dr George Zodiatis (Oceanographic Centre, UoC)
5. Dr Kostas Xenofontos (AEOLIKI Ltd)
6. Mr. A. Demetropoulos (AEOLIKI Ltd)

During the public consultation presentation, MCIT representatives were present, including:

1. Mr Solon Kassinis – Director
2. Dr Stelios Nicolaides
3. Mr Demetris Faklaris
4. Mrs Dora Antoniou

Two oral presentations were also prepared, presenting:

- An overview of the Hydrocarbon Activities within the Exclusive Economic Zone of the Republic of Cyprus, presented by Mr Solon Kassinis, Director of the Energy Service, as well as
- The methodology, findings and recommendations of the Strategic Environmental Assessment, presented by Dr Luis Lagera, Principal Consultant of CSA International Inc. This presentation was prepared in the English as well as Greek language

3. PUBLIC CONSULTATION MEETING

The Public Consultation Meeting Agenda included:

ORAL PRESENTATION SESSION

1. Address on behalf of Energy Service, MCIT (Mr Solon Kassinis)
2. Oral presentation (15 minutes): "Hydrocarbon Activities within the Exclusive Economic Zone of the Republic of Cyprus", presented by Mr Solon Kassinis (see APPENDIX E3);
3. Oral presentation (55 minutes): "Environmental Report - Strategic Environmental Assessment (SEA) Concerning Hydrocarbon Activities within the Exclusive Economic Zone of the Republic of Cyprus" (prepared and presented by Dr. Luis Lagera – CSA International Inc, on behalf of the Consortium team of experts) (see APPENDIX E4);

DISCUSSION

4. KEY ISSUES REGISTER

Table 1 below present the key issues raised by stakeholders during the formal public consultation meeting.

Table 1: Public Consultation Meeting: Issues/Comments and Responses

ISSUE / COMMENT	STAKEHOLDER GROUP
Q: Request for clarifications with respect to the scope of licensing phases studied in the SEA (i.e. prospecting, exploration and exploitation) as well as the exploration techniques reviewed (i.e. smart wells) in the SEA	Mr. Michalis Michael
A: The SEA covered the impacts from all three licensing phases (i.e. prospecting, exploration and exploitation). The licensees will be committed to conduct a detailed EIA for every drilling well, taking into consideration the findings and recommendations of the SEA .	Mr Solon Kassinis (Director, Energy Service)
Q: Request for clarifications with respect to the number of exploration wells foreseen, number of people working at each exploration well, transportation arrangements to/from exploration wells	Mr. Charalambos Theopemptou (Environment Commissioner)
A: It is foreseen that within the next 7 years, 3-5 wells will be operational for 20-50 days per well. There will be approximately 40 people working per exploration well. .	Mr Solon Kassinis (Director, Energy Service)
Q: Request for clarifications with respect to the development of detailed environmental impact descriptions per licensing programme phase.	Mr. Leondios Leondiades (member of the Environmental Committee)
A: The study presented is a Strategic Environmental Assessment, and as such, identified the issues that have to be considered and provided general guidelines on mitigation measures. As it is stipulated in the contract that will be in force between the MCIT and the licensees, the findings and recommendations of the SEA will be taken into consideration when detailed environmental impact assessment studies are conducted before any (prospecting / exploration / exploitation) works will commence in the area.	Dr Ioannis Glekas (AEOLIKI Ltd)
Q: Request on clarifications with respect to oil spills trajectory monitoring	
A: Oil spills trajectory monitoring is already effective in the Eastern Mediterranean; the Oceanographic Centre is participating; The SEA provides recommendations with respect to this issue.	Dr Giorgos Zodiatis (Oceanographic Centre, University of Cyprus)
Q: Suggested that all relevant legislations and International Treaties adopted by the Republic of Cyprus should be applicable, including Air Quality Pollution and Monitoring, Chemical Substances classification and recording etc.	Leandros Nicolaides (Director, Department of Labour Inspection)
A: The study is a strategic environmental assessment, and aims at identifying possible causes of negative environmental impacts of the hydrocarbon licensing activities, and recommend appropriate mitigation measures. The quantification of the impacts (or hazards) caused by these activities is not within the scope of this study, and have to be addressed in the subsequent EIAs. However, it is essential that provisions are made, so that all identified gaps in the SEA are addressed by enhancing the relevant legislation, and in doing so, involve the corresponding governmental departments and organizations (having the required experience and expertise in their field) in supporting the Energy Service, which according to the legislation, is responsible for the implementation of the hydrocarbon activities in Cyprus. In general, the Environmental Committee which was presented with the findings and recommendations of the SEA on Friday morning, 31st October 2008, unanimously decided that the study is satisfactory, and shortly will forward its report to the competent authority (Energy Service, MCIT)	Kostas Papastavros (Environmental Service)

Table 1: Public Consultation Meeting: Issues/Comments and Responses (Cont.)

ISSUE / COMMENT	STAKEHOLDER GROUP
Q: (1) Request for clarifications with respect to the scope of licensing phases studied in the SEA (i.e. prospecting, exploration and exploitation) (2) Concern on the timing of the conducting of the SEA. It should have been available prior to the decision taking on whether to proceed with hydrocarbon activities or not. (3) Request for clarifications on whether the licensees will be bound by the findings and recommendations of the SEA (4) Request for clarifications with respect to the contract terms (addressing the environmental impact assessment issues) with the licensees, in view of the fact that the SEA recommendations have not yet been incorporated in the relevant legislations (5) Request for clarifications with respect to the status of the environmental impact assessment and monitoring, during the currently ongoing prospecting activities	Mr Giorgos Perdikis (Green Party), Member of the Parliament of the Republic of Cyprus
A: (On going activities) The recommendations of the SEA are already implemented in the ongoing prospecting activities, since they constitute basic principles and practices concerning the hydrocarbon survey activities. The contractor of the MCIT (PGS) is one of the leading contractors internationally, with long term experience and involvement in such surveying activities. The employed protocol for the conducting of the prospecting activities, adheres to the stricter international standards and procedures, and certainly is in line with the recommendations of the SEA. (Future activities) The licensees will be bound by the findings and recommendations of the SEA (this is a term in the contract that will be put into force) and the detailed EIA, (which they will be asked to conduct prior to the initiation of any prospecting /exploration / exploitation activity), will have to at least take these recommendations into consideration	Mr Solon Kassinis (Director, Energy Service)
Q: (1) Request for clarifications with respect to the timing of the conducting of a detailed environmental impact assessment study concerning the installation works of the required infrastructure on the sea floor. The rationale is that due to the particular characteristics of the area (with regards to the seismic activity), a detailed study of the possible impacts to the sea floor and possible oil spills, should be conducted well before any such installation activities are initiated. (2) Request for clarifications with respect to the conducting of similar impact assessment studies for the onshore construction works	Dr Polis Michael ides (Director, Geological Survey Department)
A: The determination of the environmental impacts will largely depend on the qualitative as well quantitative findings of the prospecting and exploration activities. Once these are defined, then the technical options will be assessed, and determined. Then, a detailed EIA study will be conducted, before the commencement of the construction works. This applies to both offshore as well on shore activities and works.	Mr Solon Kassinis (Director, Energy Service)

Table 1: Public Consultation Meeting: Issues/Comments and Responses (Cont.)

ISSUE / COMMENT	STAKEHOLDER GROUP
Q: (1) Concerns expressed that the SEA does not cover at a satisfactory depth, the environmental impacts from the exploitation activities. The rationale stems from the fact that the legislation provides that a detailed EIA is required for each exploration block, and does not stipulate that a SEA has to be implemented prior to the commencement of the exploitation activities (2) Request for clarifications (mainly from the Environmental Service representative) with respect to the option of amending the existing legislation so that it provides that preliminary EIAs will be required for prospecting and exploration surveys.	Mr Giorgos Perdikis (Green Party), Member of the Parliament of Republic of Cyprus
A: The SEA covers the environmental impacts from the exploitation activities, at a satisfactory (for such a study) level. Being an SEA, it provides the general guidelines and identifies in a satisfactory extent the possible impacts from all three licensing activities (exploitation activities included). The detailed analysis and assessment of the environmental impacts from the exploitation activities will be conducted within the framework of the EIAs required (as stipulated in the relevant legislation, as well as the contract terms with the licensees) for every drilling location and exploration block, prior to the commencement of the exploration activities. Furthermore, the Consortium experts that conducted the SEA had held discussions with PGS consultants on the seismic survey protocol employed (which adheres to the suggestions and recommendations of the SEA). In addition, it is also stipulated in the service contract with PGS, that all International Treaty provisions have to be met, when conducting the prospecting surveys	Mr Solon Kassinis (Director, Energy Service)
A: There is no need for any amendment to the relevant legislation, since following this morning presentation of the SEA to the Environmental Committee, and the compilation of its reports with comments and recommendations, the competent authority (Energy Service, MCIT), will include the findings and recommendations of the SEA to any contract signed with prospect licensees. The specific mitigation measures concerning the environmental impact from the exploitation activities will be quantified once the outcomes of the exploration phase determine the actual qualitative and quantitative hydrocarbon characteristics. Hence, at this phase, the Energy Service will act accordingly, and will provide the terms to be included in the contracts to be signed regarding the exploitation activities. In order to safeguard the successful monitoring of the hydrocarbon activities development, the Environmental Committee will suggest (in its report to the competent authority), that the Monitoring Committee of the hydrocarbon activities, will closely and continuously monitor the developments of the activities (environmental issues will be covered as well).	Mr Kostas Papastavros (Environmental Service)
Q: Suggested that provisions should be made so that the findings and recommendations included in the SEA, be also included in the relevant legislation and regulations, so as to ensure their full and unconditional enforcement in the future	Mr Giorgos Perdikis (Green Party), Member of the Parliament of the Republic of Cyprus

Table 1: Public Consultation Meeting: Issues/Comments and Responses (Cont.)

ISSUE / COMMENT	STAKEHOLDER GROUP
Q: (1) Request for clarifications with respect to the legal framework (Cypriot or International) applicable in the area where the prospecting/exploration/exploitation activities will be implemented. (2) Request for clarifications regarding the control mechanism set up by the competent authority that will enable the close, efficient and timely monitoring of the development of all three licensing activities, according to the agreed principles and protocols, as stipulated in the contracts signed. The focus should be put on the environmental impacts on the ecosystems in the area, and the mitigation measures adopted. **A:** The Cyprus legislation is applicable and enforced in the Cyprus EEZ. The same applies to the relevant International Treaties, adopted by the Republic of Cyprus. In case of unavailability of relevant Cyprus legislation, provisions have been included in the contracts, that Best International Practices must be adopted and implemented. **A:** There is limited information available, at the moment, regarding the ecosystems in the area under investigation. The survey activities in the area will provide a unique opportunity to the scientific community in Cyprus, to expand its knowledge of these ecosystems. This has to be taken into account, and corresponding provisions must be made, when defining the terms and conditions of the contracts to be signed with the licensees. According to the Cyprus legislation, the competent authority which has the responsibility of monitoring the development of the hydrocarbon activities in Cyprus is the Energy Service. Its task can be assisted and scientifically supported by a Committee consisting of representatives from governmental departments (i.e. Fisheries Department, Department of Labour Inspection, Geological Survey Department, etc) which have the expertise and the scientific knowledge in the relevant fields.	Mr. Charalambos Theopemptou (Environment Commissioner) Mr Solon Kassinis (Director, Energy Service) Mrs Marina Argyrou (Department of Fisheries and Marine Research)
Q: Commented on the findings and recommendations included in the SEA, and reiterated that the study, being a Strategic Environmental Assessment of the Hydrocarbon Activities, provides the guidelines on impacts and mitigations measures, and cannot be assumed as a detailed EIA. In view of the future activities, she suggested that the government should provide adequate human as well as technical resources to the government departments and organizations which will be involved in the monitoring of these activities, so as to enable them to perform their tasks in an efficient way.	Mrs Toulla Onoufriou (Cyprus University of Technology)

APPENDIX E-1

(Newspaper Announcements)

Αριθμός 7105

ΓΝΩΣΤΟΠΟΙΗΣΗ

Η Κεντρική Τράπεζα της Κύπρου γνωστοποιεί ότι προτίθεται να εκδώσει σε τριάντα ημέρες από σήμερα και αφού εξετάσει οποιαδήποτε σχετική ένσταση που θα μπορούσε να υποβληθεί, αντίγραφο ήδη εκδοθέντος πιστοποιητικού για €39.297,83 (Τριάντα εννέα χιλιάδες, διακόσια ενενήντα επτά ευρώ και 83 σεντ μόνο) ονομαστική αξία στην έκδοση 4,25% Κρατικά Ονομαστικά Χρεόγραφα Αναπτύξεως 2η Σειρά 2005 Λήξης 2008 σε αντικατάσταση του πιστοποιητικού αρ. 440 που δηλώθηκε ως απολεσθέν.

Αριθμός 7106

ΓΝΩΣΤΟΠΟΙΗΣΗ

Από το Επαρχιακό Γραφείο του Ταμείου Θήρας Λάρνακας – Αμμοχώστου ανακοινώνεται ότι επιμορφωτικά μαθήματα για απόκτηση πρώτης άδειας κυνηγίου, για το 2008, θα διεξαχθούν όπως φαίνεται πιο κάτω:

Λάρνακα:

Χώρος: Οίκημα Κ.Ο.Κ. και Δ.Α.Ζ. Λάρνακας.

Ημέρες: 21 Οκτωβρίου 2008 και 22 Οκτωβρίου 2008.

Ώρες διεξαγωγής μαθημάτων: 19.00 – 22.00.

Αμμόχωστος:

Χώρος: Δημαρχείο Δερύνειας, Αίθουσα Βιβλιοθήκης.

Ημέρες: 21 Οκτωβρίου 2008 και 23 Οκτωβρίου 2008.

Ώρες διεξαγωγής μαθημάτων: 19.00 – 22.00.

Αριθμός 7107

ΓΝΩΣΤΟΠΟΙΗΣΗ

Από το Επαρχιακό Γραφείο του Ταμείου Θήρας Πάφου ανακοινώνεται ότι επιμορφωτικά μαθήματα για απόκτηση πρώτης άδειας κυνηγίου, για το 2008, θα διεξαχθούν όπως φαίνεται πιο κάτω:

Χώρος: Αίθουσα πολιτιστικών εκδηλώσεων Τράπεζας Κύπρου.

Ημέρες: 20 Οκτωβρίου 2008, 21 Οκτωβρίου 2008 και 22 Οκτωβρίου 2008.

Ώρες διεξαγωγής μαθημάτων: 19.00 – 22.00.

Αριθμός 7108

Ο ΠΕΡΙ ΤΗΣ ΕΚΤΙΜΗΣΗΣ ΤΩΝ ΕΠΙΠΤΩΣΕΩΝ ΣΤΟ ΠΕΡΙΒΑΛΛΟΝ
ΑΠΟ ΟΡΙΣΜΕΝΑ ΣΧΕΔΙΑ ΚΑΙ/Η ΠΡΟΓΡΑΜΜΑΤΑ ΝΟΜΟΣ
(ΝΟΜΟΣ 102(Ι) ΤΟΥ 2005)

Γνωστοποίηση δυνάμει του άρθρου 13

Δίδεται ειδοποίηση σύμφωνα με το άρθρο 13 του περί της Εκτίμησης των Επιπτώσεων στο Περιβάλλον από Ορισμένα Σχέδια και/ή Προγράμματα Νόμου ότι στις 30 Σεπτεμβρίου 2008 η Υπηρεσία Ενέργειας του Υπουργείου Εμπορίου, Βιομηχανίας και Τουρισμού υπέβαλε στην Υπηρεσία Περιβάλλοντος του Υπουργείου Γεωργίας, Φυσικών Πόρων και Περιβάλλοντος, Στρατηγική Περιβαλλοντική Μελέτη αναφορικά με τις δραστηριότητες Υδρογονανθράκων εντός της Αποκλειστικής Οικονομικής Ζώνης της Κυπριακής Δημοκρατίας.

2. Η μελέτη μπορεί να τύχει επιθεώρησης κατά τις εργάσιμες ημέρες και ώρες στα Γραφεία της Υπηρεσίας Περιβάλλοντος (28ης Οκτωβρίου 20–22, Έγκωμη) ή στα Γραφεία της Υπηρεσίας Ενέργειας (Ανδρέα Αραούζου 13–15, Λευκωσία).

3. Οποιοδήποτε πρόσωπο μπορεί να υποβάλει στην Υπηρεσία Περιβάλλοντος απόψεις ή παραστάσεις αναφορικά με το περιεχόμενο της μελέτης ή τις επιπτώσεις που ενδέχεται να επιφέρει στο περιβάλλον η έγκριση του σχεδίου και/ή προγράμματος εντός 35 ημερών από την ημερομηνία δημοσίευσης της γνωστοποίησης αυτής.

4. Το Υπουργείο Εμπορίου, Βιομηχανίας και Τουρισμού διοργανώνει δημόσια παρουσίαση και συζήτηση της Στρατηγικής Περιβαλλοντικής Μελέτης την Παρασκευή, 31 Οκτωβρίου 2008, μεταξύ των ωρών 5 μ.μ. και 8 μ.μ. στη Δημοσιογραφική Εστία (Λεωφόρος ΡΙΚ 12, 2120 Αγλαντζιά, Λευκωσία), όπου το κοινό θα έχει την ευκαιρία να παραθέσει τις απόψεις του επί της μελέτης.

Αριθμός 7109

Ο ΠΕΡΙ ΣΥΝΕΡΓΑΤΙΚΩΝ ΕΤΑΙΡΕΙΩΝ ΝΟΜΟΣ
(ΝΟΜΟΙ ΤΟΥ 1985 ΜΕΧΡΙ 2007)

Διάταγμα Ακυρώσεως Εγγραφής δυνάμει του άρθρου 48

Επειδή δυνάμει διατάγματος που εκδόθηκε από τον Έφορο Υπηρεσίας Εποπτείας και Ανάπτυξης Συνεργατικών Εταιρειών στις 8 Ιουνίου 2006, το οποίο δημοσιεύτηκε στην Επίσημη Εφημερίδα της Δημοκρατίας στις 23 Ιουνίου 2006 με αριθμό γνωστοποιήσεως 3989, διατάχθηκε η εκκαθάριση της Συνεργατικής Εταιρείας Διαθέσεως Γεωργικών Προϊόντων «Ασπρόκρεμμος» Λτδ.

Επειδή διορίστηκε εκκαθαριστής δυνάμει γνωστοποιήσεως ημερομηνίας 8 Ιουνίου 2006, η οποία δημοσιεύτηκε στην Επίσημη Εφημερίδα της Δημοκρατίας ημερομηνίας 23 Ιουνίου 2006, με αριθμό γνωστοποιήσεως 3990, και

Επειδή έχει ολοκληρωθεί η εκκαθάριση της πιο πάνω Συνεργατικής Εταιρείας, ο Έφορος Υπηρεσίας Εποπτείας και Ανάπτυξης Συνεργατικών Εταιρειών, με βάση τις εξουσίες που του παρέχονται από το άρθρο 48 του πιο πάνω

ΑΛΗΘΕΙΑ
Πέμπτη 23 Οκτωβρίου 2008

Ο ΠΕΡΙ ΤΗΣ ΕΚΤΙΜΗΣΗΣ ΤΩΝ ΕΠΙΠΤΩΣΕΩΝ ΣΤΟ ΠΕΡΙΒΑΛΛΟΝ ΑΠΟ ΟΡΙΣΜΕΝΑ ΣΧΕΔΙΑ ΚΑΙ/Η ΠΡΟΓΡΑΜΜΑΤΑ ΝΟΜΟΣ (Ν.102(1)/2005)

Γνωστοποίηση δυνάμει του άρθρου 13 του Νόμου 102(1)/2005

Δίδεται ειδοποίηση σύμφωνα με το άρθρο 13 του περί της Εκτίμησης των Επιπτώσεων στο Περιβάλλον από Ορισμένα Σχέδια και/ή Προγράμματα Νόμου ότι στις 30 Σεπεμβρίου 2008 η Υπηρεσία Ενέργειας του Υπουργείου Εμπορίου, Βιομηχανίας και Τουρισμού υπέβαλε στην Υπηρεσία Περιβάλλοντος του Υπουργείου Γεωργίας, Φυσικών Πόρων και Περιβάλλοντος, Στρατηγική Μελέτη αναφορικά με τις δραστηριότητες υδρογονανθράκων εντός της Αποκλειστικής Οικονομικής ζώνης της Κυπριακής Δημοκρατίας.

Η μελέτη μπορεί να τύχει επιθεώρησης κατά τις εργάσιμες ημέρες και ώρες στα γραφεία της Υπηρεσίας Περιβάλλοντος (28ης Οκτωβρίου 20-22, Έγκωμη) ή στα γραφεία της Υπηρεσίας Ενέργειας (Ανδρέα Αραούζου 13-15, Λευκωσία).

Οποιοδήποτε πρόσωπο μπορεί να υποβάλει στην Υπηρεσία Περιβάλλοντος απόψεις ή παραστάσεις αναφορικά με το περιεχόμενο της μελέτης ή τις επιπτώσεις που ενδέχεται να επιφέρει στο περιβάλλον η έγκριση του σχεδίου και/ή προγράμματος εντός 35 ημερών από την ημερομηνία δημοσίευσης της γνωστοποίησης αυτής.

Το Υπουργείο Εμπορίου, Βιομηχανίας και Τουρισμού, διοργανώνει δημόσια παρουσίαση και συζήτηση Στρατηγικής Περιβαλλοντικής Μελέτης την Παρασκευή, 31 Οκτωβρίου 2008, μεταξύ 17.00 και 20.00 στη Δημοσιογραφική Εστία (Λεωφόρος ΡΙΚ 12, 2120 Αγλαντζιά, Λευκωσία), όπου το κοινό θα έχει την ευκαιρία να παραθέσει τις απόψεις του επί της μελέτης.

ΥΠΗΡΕΣΙΑ ΕΝΕΡΓΕΙΑΣ
Υπουργείο Εμπορίου, Βιομηχανίας και Τουρισμού

ΧΑΡΑΥΓΗ

ΤΡΙΤΗ 14 ΟΚΤΩΒΡΙΟΥ 2008

Ο ΠΕΡΙ ΤΗΣ ΕΚΤΙΜΗΣΗΣ ΤΩΝ ΕΠΙΠΤΩΣΕΩΝ ΣΤΟ ΠΕΡΙΒΑΛΛΟΝ ΑΠΟ ΟΡΙΣΜΕΝΑ ΣΧΕΔΙΑ ΚΑΙ/Η ΠΡΟΓΡΑΜΜΑΤΑ ΝΟΜΟΣ (Ν. 102(ΙV2005)

Γνωστοποίηση δυνάμει του άρθρου 13 του Νόμου 102(Ι)2005

Δίδεται ειδοποίηση σύμφωνα με το άρθρο 13 του περί της Εκτίμησης των Επιπτώσεων στο Περιβάλλον από Ορισμένα Σχέδια και/ή Προγράμματα Νόμου ότι στις 30 Σεπτεμβρίου 2008 η Υπηρεσία Ενέργειας του Υπουργείου Εμπορίου, Βιομηχανίας και Τουρισμού υπέβαλε στην Υπηρεσία Περιβάλλοντος του Υπουργείου Γεωργίας, Φυσικών Πόρων και Περιβάλλοντος, Στρατηγική Περιβαλλοντική Μελέτη αναφορικά με τις δραστηριότητες υδρογονανθράκων εντός της Αποκλειστικής Οικονομικής Ζώνης της Κυπριακής Δημοκρατίας.

Η μελέτη μπορεί να τύχει επιθεώρησης κατά τις εργάσιμες ημέρες και ώρες στα γραφεία της Υπηρεσίας Περιβάλλοντος (28η Οκτωβρίου 20-22, Έγκωμη) ή στα γραφεία της Υπηρεσίας Ενέργειας (Ανδρέα Αραούζου 13-15, Λευκωσία).

Οποιοδήποτε πρόσωπο μπορεί να υποβάλει στην Υπηρεσία Περιβάλλοντος απόψεις ή παραστάσεις αναφορικά με το περιεχόμενο της μελέτης ή τις επιπτώσεις που ενδέχεται να επιφέρει στο περιβάλλον η έγκριση του σχεδίου και/ή προγράμματος εντός 35 ημερών από την ημερομηνία δημοσίευσης της γνωστοποίησης αυτής.

Το Υπουργείο Εμπορίου, Βιομηχανίας και Τουρισμού διοργανώνει δημόσια παρουσίαση και συζήτηση της Στρατηγικής Περιβαλλοντικής Μελέτης την Παρασκευή, 31 Οκτωβρίου 2008, μεταξύ 17:00 και 20:00 στη Δημοσιογραφική Εστία (Λεωφόρος ΡΙΚ 12, 2120 Αγλαντζιά, Λευκωσία), όπου το κοινό θα έχει την ευκαιρία να παραθέσει τις απόψεις του επί της μελέτης.

Υπηρεσία Ενέργειας
Υπουργείο Εμπορίου, Βιομηχανίας και Τουρισμού.

APPENDIX E-2

Stakeholders List and Photos

	NAME	ORGANISATION	TELEPHONE No	FAX No	e-mail
1	Solon Kassinis	Energy Service, MCIT	22409303	22304964	pkoulermou @mcit.gov.cy
2	Stelios Nicolaides	Energy Service	22409344	22304759	snicolaides@mcit.gov.cy
3	Dora Antoniou	Energy Service	22409341	22304759	
4	Demetris Faklaris	Energy Service	22409346	22304759	
5	Ioannis Glekas	AEOLIKI Ltd	22875707	22757778	iglekas@aeoliki.com
6	Demetris Glekas	AEOLIKI Ltd	22875707	22757778	dglekas@aeoliki.com
7	Leondios Leondiades	Member of the Environmental Committee	22358191	22840951	
8	Louis Lagera	CSA International Inc			
9	Michael Michael	-	99227836		michaelntua@hotmail.com
10	Vasilis Papamichalis	AEOLIKI Ltd	22875707	22757778	vpapamichalis@aeoliki@aeoiliki.com
11	Cecelia Hannides	AEOLIKI Ltd	22208625		c.hannides@cyi.ac.cy
12	Toulla Onoufriou	Cyprus University of Technology	25002597		t.onoufriou@cut.ac.cy
13	Leandros Nikolaides	Labour Inspection Department	22405623	22661696	director@dli.mlsi.gov.cy
14	George Zodiatis	Oceanographic Centre, University of Cyprus	22892576	22892575	gzodiac@ucy.ac.cy

	NAME	ORGANISATION	TELEPHONME No	FAX No	e-mail
15	Katerina Damianou	AEOLIKI Ltd	22875707	22757778	kdamianou@aeoliki.com
16	Giorgos Perdikis	Green Party	22518787	22512710	greenprs@cytanet.com.cy
17	Eleni Morisso	Geological Survey Department	22409217		emorisseau@gsd.moa.gov.cy
18	Stella Michaelidou	State General Laboratory	22809111		stellam@spidernet.com.cy
19	Polis Michaelides	Geological Survey Department	22409213		
20	Kostas Xenofondos	AEOLIKI Ltd	22370118		cosxen@spidernet.com.cy
21	Angelos Hannitis	Department of Fisheries and Marine Research	22807811	22775955	hannides@gmail.com
22	Marina Argyrou	Department of Fisheries and Marine Research	22807852	22775955	margyrou@demr.moa.gov.cy
23	Charalambos Theopemptou	Environment Commissioner	22803460	22803464	ctheopemptou@ec.gov.cy
24	A. Demetropoulos	AEOLIKI Ltd			
25	M. Hadjichristopoulos	Department of Fisheries and Marine Research	22805585		
26	Maria Alevraki	State General Laboratory	22809127		
27	Maro Christidoulidou	State General Laboratory	22809143		
28	Miroula Hadjichristoforou	Department of Fisheries and Marine Research			
29	Kostas Papastavros	Environment Service	22408949	22774945	


Νομοθετικό πλαίσιο
Οδηγία 2001/42/ΕΚ του Ευρωπαϊκού Κοινοβουλίου και του Συμβουλίου της 27ης Ιουνίου 2001 σχετικά με την εκτίμηση των περιβαλλοντικών επιπτώσεων ορισμένων σχεδίων και προγραμμάτων (οδηγία για τη Στρατηγική Περιβαλλοντική Εκτίμηση)
– τέθηκε σε ισχύ από την 21η Ιουλίου 2001
Ο περί της Εκτίμησης των Επιπτώσεων στο Περιβάλλον από Ορισμένα Σχέδια και/ή Προγράμματα Νόμος του 2005 (Ν. 102(Ι)/2005)
– τέθηκε σε ισχύ από την 29η Ιουλίου 2005
31 10 2008


31 10 2008


31 10 2008


Environmental Report
31 10 2008


Public Presentation
Environmental Report
Strategic Environmental Assessment (SEA)
Concerning Hydrocarbon Activities within the
Exclusive Economic Zone of the Republic of Cyprus
Environmental Report
31 10 2008


Recommended Additional Control,
Management, and Monitoring
velop discharge requirements for drilling fluid
d cuttings, produced water, and other effluents
nsider Barcelona Convention offshore protocol
the OSPAR Convention offshore oil and gas
ustry strategy as sources of guidance
iew Barcelona Convention offshore protocol to
ure that hydrocarbons activities are consistent
protocol requirements
31 10 2008

APPENDIX E-3

Oral presentation – Hydrocarbon Activities within the Exclusive Economic Zone of the Republic of Cyprus

Στρατηγική Περιβαλλοντική Μελέτη

Δημόσια Παρουσίαση

Σόλων Κασίνης
Διευθυντής Υπηρεσίας Ενέργειας

Δημοσιογραφική Εστία
Λευκωσία, 31 Οκτωβρίου 2008

Νομοθετικό πλαίσιο

- Οδηγία 2001/42/ΕΚ του Ευρωπαϊκού Κοινοβουλίου και του Συμβουλίου της $27^{ης}$ Ιουνίου 2001 σχετικά με την εκτίμηση των περιβαλλοντικών επιπτώσεων ορισμένων σχεδίων και προγραμμάτων (οδηγία για τη Στρατηγική Περιβαλλοντική Εκτίμηση)
  - τέθηκε σε ισχύ από την $21^{η}$ Ιουλίου 2001
- Ο περί της Εκτίμησης των Επιπτώσεων στο Περιβάλλον από Ορισμένα Σχέδια και/ή Προγράμματα Νόμος του 2005 (Ν. 102(Ι)/2005)
  - τέθηκε σε ισχύ από την $29^{η}$ Ιουλίου 2005

Οδηγία 2001/42/ΕΚ

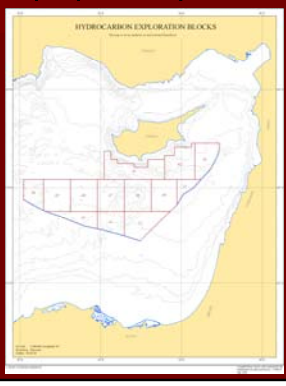
- Το άρθρο 1 της Οδηγίας θεσπίζει δύο στόχους για την εκτέλεση εκτίμησης περιβαλλοντικών επιπτώσεων
  - την υψηλού επιπέδου προστασία του περιβάλλοντος
  - την ενσωμάτωση περιβαλλοντικών θεωρήσεων στην προετοιμασία και υιοθέτηση σχεδίων και προγραμμάτων με σκοπό την προώθηση βιώσιμης ανάπτυξης
- Ως σχέδια και προγράμματα νοούνται εκείνα που
  - εκπονούνται ή/και εγκρίνονται από μια αρχή σε εθνικό, περιφερειακό ή τοπικό επίπεδο και
  - που απαιτούνται βάσει νομοθετικών, κανονιστικών ή διοικητικών διατάξεων

Στρατηγική Περιβαλλοντική Μελέτη

- Η Κυπριακή Δημοκρατία είναι το μόνο κράτος μέλος της Ευρωπαϊκής Ένωσης, εκτός του Ηνωμένου Βασιλείου, που προχώρησε σε εκπόνηση Στρατηγικής Περιβαλλοντικής Εκτίμησης αναφορικά με τις δραστηριότητες έρευνας και εκμετάλλευσης υδρογονανθράκων
- Η μελέτη αποσκοπεί στον εντοπισμό, περιγραφή και αξιολόγηση των ενδεχόμενων σημαντικών επιπτώσεων που θα έχει στο περιβάλλον η εκτέλεση των δραστηριοτήτων έρευνας και εκμετάλλευσης υδρογονανθράκων εντός της Αποκλειστικής Οικονομικής Ζώνης της Κυπριακής Δημοκρατίας

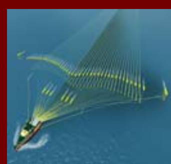
Δραστηριότητες Υδρογονανθράκων

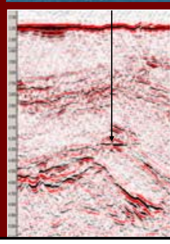
- Διεξάγονται εντός της Αποκλειστικής Οικονομικής Ζώνης της Δημοκρατίας (13 Ερευνητικά Τεμάχια)
- Διέπονται από τον περί Υδρογονανθράκων (Αναζήτηση, Έρευνα και Εκμετάλλευση) Νόμο του 2007 (Ν. 4(Ι)/2007) και τους σχετικούς Κανονισμούς του 2007 (Κ.Δ.Π. 51/2007)
- Περιλαμβάνουν γεωλογικές, γεωφυσικές, γεωχημικές και γεωτρητικές εργασίες, αναλόγως του τύπου της άδειας



Τύποι Αδειών

- Άδεια Αναζήτησης Υδρογονανθράκων
  - Χορηγείται για περίοδο που δεν υπερβαίνει το ένα έτος
  - Περιλαμβάνει κυρίως γεωφυσικές έρευνες, δεν περιλαμβάνει γεωτρήσεις
- Άδεια Έρευνας Υδρογονανθράκων
  - Χορηγείται για αρχική περίοδο που δεν υπερβαίνει τα 3 έτη, με δυνατότητα δύο ανανεώσεων για 2 έτη κάθε φορά (μέγιστο 7 έτη)
  - Σε κάθε ανανέωση ο αδειούχος αποδεσμεύει τουλάχιστον 25% της αρχικής επιφάνειας
  - Περιλαμβάνει γεωλογικές, γεωφυσικές, γεωχημικές και ερευνητικές γεωτρητικές εργασίες





- Άδεια Εκμετάλλευσης Υδρογονανθράκων
  - Χορηγείται για αρχική περίοδο 25 ετών, με δυνατότητα ανανέωσης 10 ετών
  - Περιλαμβάνει γεωτρητικές εργασίες ανάπτυξης και παραγωγής και εγκατάσταση έργων υποδομής
  - Ετοιμασία και υποβολή από τους αιτητές πλήρους Μελέτης Εκτίμησης των Επιπτώσεων στο Περιβάλλον

1ος Γύρος Αδειοδοτήσεων

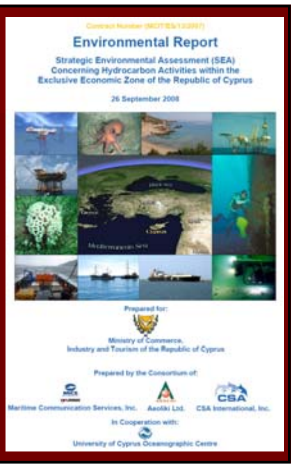
- Υποβλήθηκαν τρεις αιτήσεις
  - Ερευνητικά Τεμάχια 6, 11 και 12
- Προχωρημένο στάδιο εξέτασης της μίας αίτησης και διαπραγματεύσεις των άλλων δύο
- Πρόνοια για ετοιμασία λεπτομερούς Μελέτης Εκτίμησης των Επιπτώσεων στο Περιβάλλον

Ενέργειες Υπουργείου

- Προκήρυξη δημόσιου διαγωνισμού για ετοιμασία Στρατηγικής Περιβαλλοντικής Μελέτης (22 Ιουνίου 2007)
- Υποβλήθηκαν τέσσερις προσφορές
- Ακύρωση του διαγωνισμού λόγω μη συμμόρφωσης των προσφορών προς όλους τους όρους, προϋποθέσεις και προδιαγραφές των Εγγράφων του Διαγωνισμού
- Προκήρυξη δεύτερου δημόσιου διαγωνισμού (21 Δεκεμβρίου 2007)
- Υποβλήθηκαν τέσσερις προσφορές
- Κατακύρωση της μελέτης στην κοινοπραξία Maritime Communication Services (MCS) – Aeoliki – CSA International

- Η Επιτροπή Αξιολόγησης των προσφορών, καθώς και η Επιτροπή Παρακολούθησης της μελέτης απαρτίζεται από
  - χημικούς μηχανικούς (Υπηρεσία Ενέργειας)
  - γεωλόγο (Υπηρεσία Ενέργειας)
  - περιβαλλοντολόγο (Υπηρεσία Περιβάλλοντος)
  - θαλάσσιο βιολόγο (Τμήμα Αλιείας και Θαλασσίων Ερευνών)
- Η Περιβαλλοντική Έκθεση υποβλήθηκε στις 30 Σεπτεμβρίου 2008 στην Υπηρεσία Περιβάλλοντος για εξέταση της από την αρμόδια επιτροπή, δυνάμει του άρθρου 17 του Νόμου 102(Ι)/2005
- Δημοσίευση σχετικής γνωστοποίησης, δυνάμει του άρθρου 13 του Νόμου 102(Ι)/2005
- Οργάνωση σημερινής δημόσιας παρουσίασης και συζήτησης της Περιβαλλοντικής Έκθεσης, όπως προνοείται από την Οδηγία και τον Νόμο

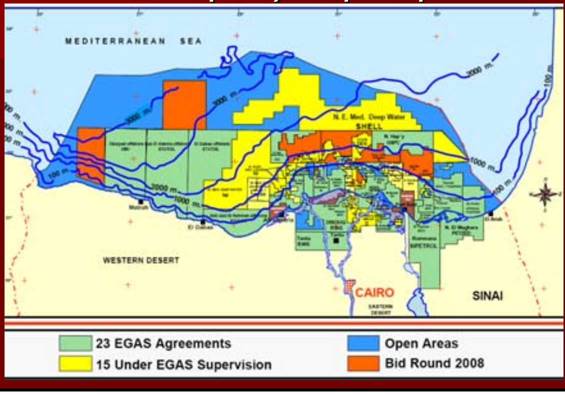
- Οι απόψεις του κοινού θα περιληφθούν στην τελική Περιβαλλοντική Έκθεση
- Τα πορίσματα και οι προτάσεις της μελέτης δεσμεύουν τους αδειούχους (σχετική πρόνοια στο Συμβόλαιο)
- Η μελέτη βρίσκεται στην ιστοσελίδα του Υπουργείου Εμπορίου, Βιομηχανίας και Τουρισμού www.mcit.gov.cy (Υπηρεσία Ενέργειας → Έρευνες Υδρογονανθράκων → Στρατηγική Περιβαλλοντική Μελέτη)



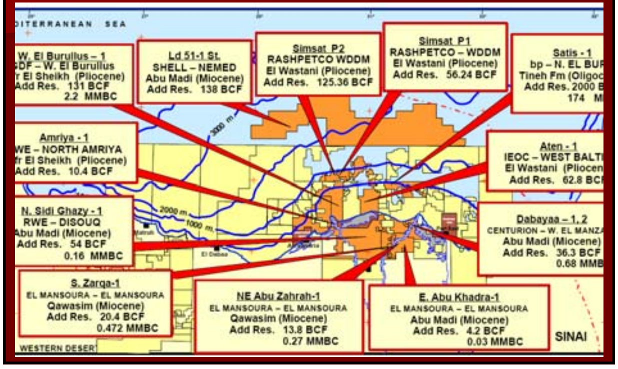
Δομή-Περιεχόμενα της Έκθεσης

- Σύνοψη (στην Ελληνική και Αγγλική)
- Εισαγωγή
  - Σκοπός και αντικείμενο της μελέτης
  - Διαδικασία και μεθοδολογία Στρατηγικής Περιβαλλοντικής Εκτίμησης
- Περιγραφή των δραστηριοτήτων υδρογονανθράκων και του νομικού πλαισίου
- Συλλογή περιβαλλοντικών πληροφοριών
  - Φυσικό περιβάλλον
  - Βιολογικό περιβάλλον
  - Κοινωνικο-οικονομικό περιβάλλον
- Εκτίμηση επιπτώσεων από δραστηριότητες
  - **Αναζήτησης** (σεισμικές, γεωλογικές, γεωχημικές και ηλεκτρομαγνητικές διασκοπήσεις και τηλεπισκοπήσεις)
  - **Έρευνας** (σεισμικές, γεωλογικές, γεωχημικές και ηλεκτρομαγνητικές διασκοπήσεις, τηλεπισκοπήσεις και ανόρυξη ερευνητικών γεωτρήσεων)
  - **Εκμετάλλευσης** (ανόρυξη γεωτρήσεων ανάπτυξης και παραγωγής, εγκατάσταση υποδομής παραγωγής, συνήθης λειτουργία και τερματισμός)
- Συμπεράσματα και Εισηγήσεις

Αδειοδοτήσεις στην Αίγυπτο



Ανακαλύψεις στην Αίγυπτο Ιούλιος 2007-Ιούνιος 2008 (4 TCF)



Ευχαριστώ για την προσοχή σας

APPENDIX E-4

Oral presentation – Environmental Report - Strategic Environmental Assessment (SEA) Concerning Hydrocarbon Activities within the Exclusive Economic Zone of the Republic of Cyprus

(ENGLISH VERSION)

Environmental Report

Public Presentation

Environmental Report

Strategic Environmental Assessment (SEA)
Concerning Hydrocarbon Activities within the
Exclusive Economic Zone of the Republic of Cyprus

Contract Number (MCIT/ES/13/2007)

Environmental Report

Strategic Environmental Assessment (SEA)
Concerning Hydrocarbon Activities within the
Exclusive Economic Zone of the Republic of Cyprus

26 September 2008

Introduction

- Purpose of the Public Presentation
- Purpose of SEA
- Objectives of the SEA
- SEA Process
- Project Team

Purpose of the Public Presentation

- Under the EIA Law, SEA subject to public consultation
- To present the findings and recommendations
- Public and relevant authorities invited to hear the outcome of the study and express opinions
- Responses incorporated into the Final Environmental Report

Purpose of the SEA

- To identify, describe, and evaluate the likely significant environmental effects of implementing the plan or programme, and reasonable alternatives
- To evaluate the likely significant environmental effects of implementing the hydrocarbon licensing programme in the Cyprus EEZ

Objectives of the SEA

- Describe hydrocarbon activities
- Describe existing control measures
- Summarise existing environmental information
- Describe the baseline environment
- Identify potential environmental effects and evaluate their significance
- Recommend additional management and monitoring
- Identify data gaps

SEA Process

- Develop a detailed outline for the Environmental Report
- Prepare a review of the legal and regulatory context
- Conduct a literature search and review
- Prepare a description of likely hydrocarbons activities
- Identify potential environmental effects and evaluating those identified as potentially significant
- Develop recommendations for additional management and monitoring measures

Ministry of Commerce,
Industry and Tourism of the Republic of Cyprus

Project Team

Maritime Communication Services, Inc.

Aeoliki Ltd.

CSA International, Inc.

University of Cyprus Oceanographic Centre

Licensing Programme and Regulatory Context

- Important Applicable Legislation
- Licences
- International Conventions and Protocols

Laws and Regulations

- The Hydrocarbons (Prospecting, Exploration, and Exploitation) Law, No. 4(I) of 2007
- The Hydrocarbons (Prospecting, Exploration, and Exploitation) Regulations of 2007
- Other related laws and agreements
  - Contiguous Zone Law (63(I) of 2004)
  - Exclusive Economic Zone Law (64(I) of 2004)
  - Bilateral agreements with Egypt (2003) and Lebanon (2007) delimiting the EEZ between these countries

The Council of Ministers, represented by the Ministry of Commerce, Industry and Tourism is the competent authority for granting hydrocarbon licences

Hydrocarbon Licences

- Prospecting
  - For evaluation of hydrocarbons potential
  - Includes gravity and magnetic surveys as well as seismic surveys; no drilling
- Exploration
  - For locating hydrocarbon resources
  - Includes gravity and magnetic surveys, seismic surveys, and exploration drilling
- Exploitation
  - For developing and producing hydrocarbon resources
  - Granted for an initial period of up to 25 years after the approval of a development and production plan; possibility for one renewal of up to 10 years

Hydrocarbons Regulations

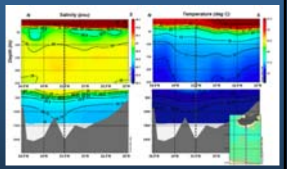
- Applications
- Work practices
- Protection of the environment
- Contingency plan
- Drilling practices
- Abandonment
- Well abandonment
- Construction and maintenance of installations, pipelines, and related facilities

International Conventions and Protocols

- MARPOL (International Convention for the Prevention of Pollution from Ships)
  - Drainage water, sewage discharge, accidental oil discharge
  - Garbage and food waste
  - Air pollutant emissions
- Barcelona Convention
  - prevent, abate, combat, and eliminate pollution
  - protect and enhance the marine environment
- Other International Agreements
  - Migratory Species and Biological Diversity
  - Law of the Sea Convention
  - Protection of the Ozone Layer
  - Climate Change
  - Agenda 21
  - Kyoto Protocol

Affected Environment

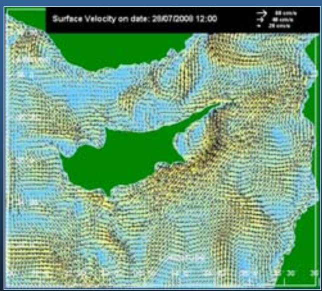
- Physical Environment
  - Climate
  - Currents and hydrography
  - Geology
  - Noise



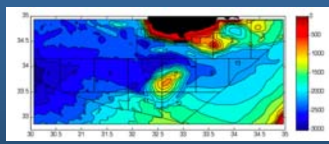
- Biological Environment
  - Water column
  - Sea floor
  - Sea birds
  - Protected and endangered species
  - Areas of special concern
- Socioeconomic Environment

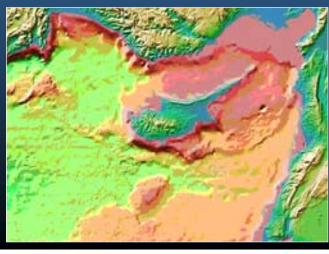
Physical Environment

- Climate
- Currents and hydrography
- Geology
- Noise



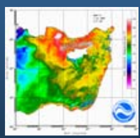
Bathymetry and Sea Floor Features

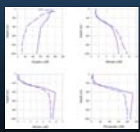




Environmental Baseline Summary

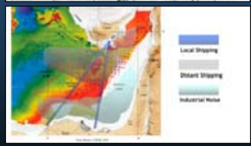
- Climate
  - cold period (December – March)
  - warm period (June – September)
- Air quality – affected by the long-range transport of air pollutants
  - anthropogenic
  - natural origin
- Currents
  - permanent, recurrent, and transient circulation features
  - rich, interacting mesoscale eddy field
  - coastal upwelling feature south of Cyprus
- Hydrography
  - pronounced thermocline
  - very warm, salty surface layer during the summer,
  - surface waters more homogeneous to greater depths during winter





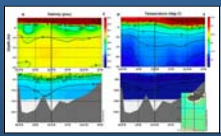
Environmental Baseline Summary

- Water Quality
  - high oxygen levels throughout the water column
  - extremely low concentrations of nutrients in surface waters
- Geology
  - Eastern Mediterranean shaped by the interactions of the African, Arabian, and Eurasian plates
  - Eratosthenes Seamount is a continental fragment about 1500 m high and 150 to 200 km wide with a flat top some 700 m below sea level
- Noise
  - natural and anthropogenic sources of noise
  - dominant noise source will be distant shipping, in the absence of wind and precipitation



Biological Environment

- Water column
- Sea Floor
- Sea birds
- Protected and endangered species
- Areas of special concern



Environmental Baseline Summary

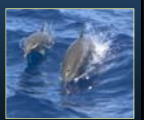
- Water column
  - low phytoplankton biomass and productivity
  - zooplankton biodiversity extremely high
  - large variety of species of marine life found in relatively small quantities
  - fisheries depend on a very large variety of fish (80-plus species)

- Seafloor
  - deep-sea fauna extremely impoverished in terms of species numbers
  - very little known about the biological communities inhabiting the Eratosthenes Seamount region.
  - presence of benthopelagic, commercially-important fish populations is highly likely

Environmental Baseline Summary

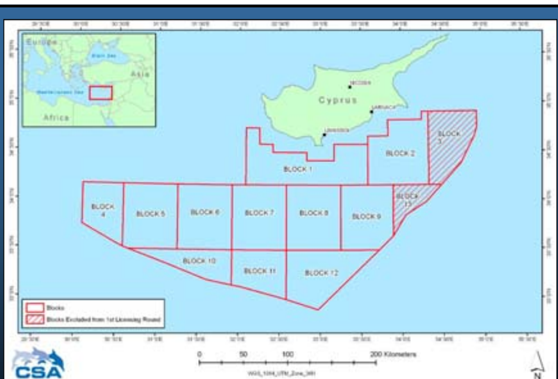
- Seabirds
  - seabirds noted in the Barcelona Convention and protected by Cypriot laws

- Protected and Endangered Species
  - diverse marine mammal fauna, including several species listed as endangered or vulnerable
    - rare, critically endangered Mediterranean monk seal may be present in nearshore Cyprus waters
    - all cetacean species are protected
  - three sea turtle species occur in the Mediterranean: green, leatherback, and loggerhead
  - green and loggerhead turtles are endangered
  - leatherback turtle is critically endangered
  - loggerhead and green turtle nesting on several beaches
- Areas of Special Concern
  - Pelagic Fish Habitats
  - Benthic Fish Habitats
  - Marine Protected Areas
  - Seamounts
  - Chemosynthetic Communities



Socioeconomic Environment

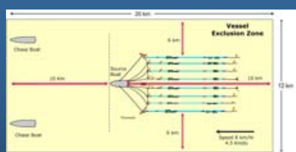
- Commercial and recreational fisheries
- Aquaculture
- Shipping and marine operations including ports and oil terminals
- Telecommunications
- Recreation and tourism
- Archaeological resources, antiquities, and cultural heritage

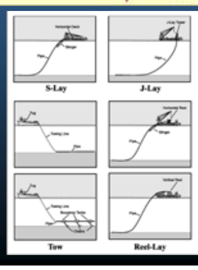


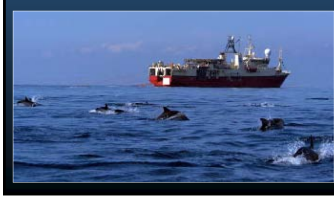
Offshore Licence Blocks

Description of Hydrocarbons Activities

- Prospecting
- Exploration
- Exploitation
  - Decommissioning





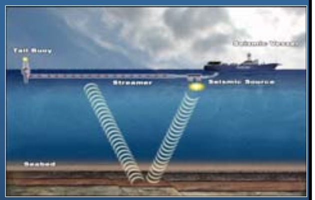


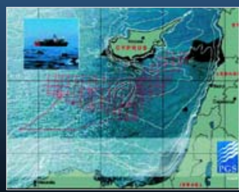
Prospecting

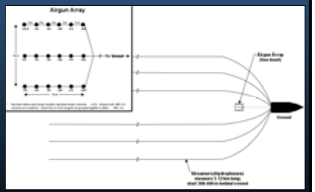
- Activities to locate hydrocarbons and/or evaluate hydrocarbon potential by methods other than drilling
  - seismic surveys
  - geological and geochemical sampling
  - electromagnetic surveys
  - remote sensing

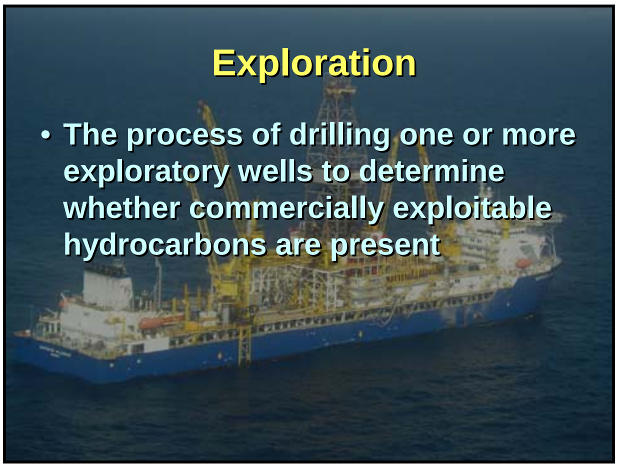
Seismic Surveys

- 2D streamer surveys
- 3D streamer surveys
- High-resolution site surveys
- Ocean bottom cable surveys
- Vertical cable surveys
- Vertical seismic profile









Exploration

- The process of drilling one or more exploratory wells to determine whether commercially exploitable hydrocarbons are present

Drilling Platforms

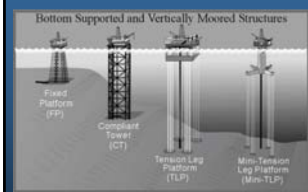
Semi-submersible

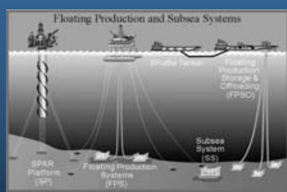
Drillship

Exploitation
(Development and Production)

- The process of exploiting commercial quantities of hydrocarbons
- Key activities
  - drilling of development wells
  - installation of production facilities
  - installation of export facilities such as pipelines and terminals
  - routine operation of these systems

Examples of Deepwater Facilities





Decommissioning

- Dismantling production and transportation facilities and restoration of depleted producing areas
- Licencees are required to
  - Remove all equipment and installations, structures, plants, appliances, and pipelines from the relinquished
  - Perform all necessary site restoration activities in accordance with good international petroleum industry practice

Impact Assessment

- Significance Criteria
- Impacts, Controls, and Mitigation
  - Prospecting
  - Exploration
  - Exploitation (Development and Production)
  - Decommissioning
  - Accidents

Significance Criteria

- Violation of air or water quality standards or limits
- Persistent contamination of water or sediments
- Damage to, or contamination of, sensitive or protected habitats and resources
- Damage to marine or coastal habitats
- Death, injury, disruption of critical activities, or damage to critical habitat of listed/protected species
- Frequent or continual interference with other marine uses
- Damage to or contamination of socio-culturally important sites on land or in the sea
- A threat to public health or public safety

Impacts from Prospecting

Impact Factor: *Airgun noise*

Potentially Significant Effects: *Auditory trauma to marine mammals and sea turtles (including endangered, critically endangered, and vulnerable species)*

Impact Factor: *Vessel traffic and towed streamers*

Potentially Significant Effects: *Potential conflicts with fishing or shipping activities (e.g., temporary exclusion from certain areas, gear damage, or entanglement)*

Impacts from Exploration

Impact Factor: *Drilling rig installation and removal*

Potentially Significant Effects: *Physical damage to deepwater corals (e.g., Eratosthenes Seamount), chemosynthetic communities, or historic shipwrecks due to placement of structures and/or anchors*

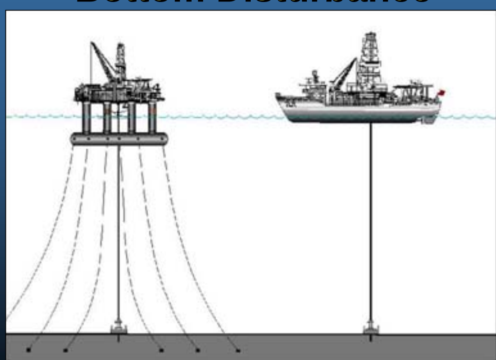
Impact Factor: *Drilling discharges*

Potentially Significant Effects: *Burial and anoxic effects on deepwater corals (e.g., Eratosthenes Seamount) or chemosynthetic communities if present within 500 m*

Impact Factor: *Marine debris*

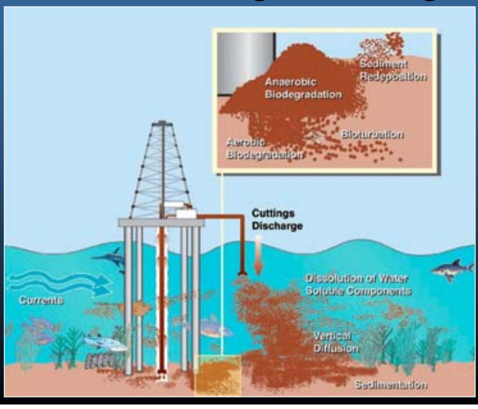
Potentially Significant Effects: *Risk of death or injury to marine mammals, sea turtles, or birds due to ingestion of or entanglement with accidentally discarded debris*

Bottom Disturbance



Semi-submersible Drillship

Fate of Drilling Discharges



Impacts from Exploration

Impact Factor: *Well testing*

Potentially Significant Effects: *Fallout of oil droplets due to incomplete combustion could produce a sheen on sea surface*

Impact Factor: *Support activities*

Potentially Significant Effects: *Helicopters flying over Important Bird Areas (IBAs) could disturb coastal birds*

Impacts from Exploitation

Impact Factor: *Facility installation*

Potentially Significant Effects: *Physical damage to deepwater corals (Eratosthenes Seamount), chemosynthetic communities, or historic shipwrecks due to placement of structures and/or anchors*

Impact Factor: *Drilling discharges*

Potentially Significant Effects: *Burial and anoxic effects on deepwater corals (Eratosthenes Seamount) or chemosynthetic communities if present within 500 m*

Impact Factor: *Structure removal*

Potentially Significant Effects: *Potential death or injury of a marine mammal or turtle (including endangered, critically endangered, or vulnerable species) if explosives are used*

Impacts from Accidents

Impact Factor: *Oil spills including*
- Crude oil spill from a blowout
- Diesel fuel spill
- Drilling fluid base oil spill
- Streamer cable fluid leak or spill

Potentially Significant Effects: *Depending on size and nature of spill, effects could include violation of water quality standards; contamination of sediments; death or injury of marine mammals, turtles, and birds; contamination of coastal habitats including beaches; and interference with fishing, shipping, recreation, and tourism during response and cleanup operations*

Impact Factor: *Hydrogen sulfide (H_2S) release*

Potentially Significant Effects: *Violation of air quality standards; potential death or injury of humans on offshore facilities and adjacent waters; potential death or injury of wildlife including birds*

Recommendations

- Issue #1 – Sea Floor Disturbances and Drilling Discharges on Deepwater Corals (Eratosthenes Seamount)
  - Licensees required to use high resolution seismic survey data and any other pertinent information available to identify hard bottom areas
  - Licensees required to conduct muds and cuttings discharge modelling to establish a separation distance
- Issue #2 – Sea Floor Disturbances and Drilling Discharges on Chemosynthetic Communities
  - Licensees required to use high-resolution seismic survey data and any other pertinent information available, to identify features that could support high density chemosynthetic communities.
  - Licensees required to maintain separation distances:
    - at least 500 m from each proposed drilling fluid and cuttings discharge location, and
    - at least 100 m from the location of all other proposed sea floor disturbances

Recommendations

- Issue #3 – Sea Floor Disturbances on Shipwrecks and Submerged Archaeological Resources
  - Licensees required to conduct a remote sensing survey of the sea floor to evaluate the potential for shipwrecks and other submerged archaeological resources.
  - Licensees required to submit an archaeological assessment report by a qualified marine archaeologist to include any identified archaeological resources and recommendations for avoidance or further investigation.
  - Based on the report, the Ministry could require avoidance or other protective measures.

Recommendations

- Issue #4 – Airgun Noise on Marine Mammals and Sea Turtles

  Licensees required to implement a protocol to reduce the risk of auditory trauma to marine mammals and sea turtles.
  - Soft start to allow time for marine mammals and turtles to move away
  - Visual monitoring of a safety (exclusion) zone of 500 m radius around the source vessel
  - Shutdown of the array if a whale, monk seal, or sea turtle enters the safety zone during visual monitoring.
- Issue #5 – Seismic Survey Vessels and Towed Streamers on Fishing and Shipping
  - Licensees required to consult with stakeholders prior to conducting streamer surveys

Recommendations

- Issue #6 – Well Testing on Air and Water Quality
  - During well testing, licensees required to
    - use a high efficiency burner
    - monitor the sea surface for visible sheen
- Issue #7 – Helicopter Traffic on Important Bird Area
  - Licensees advised that helicopters should avoid flying over SPAs and IBAs.
  - A map of SPAs and IBAs provided for this purpose.

Recommendations

- Issue #8 – Structure Removals on Marine Mammals and Sea Turtles
  - Licensees required to follow international best practice for safe structure removal during decommissioning.
  - decommissioning plan should be prepared that includes monitoring for the presence of marine mammals and sea turtles to avoid effects of underwater detonations.
- Issue #9 – Oil Spills on the Marine Environment
  - Use trajectory modelling in contingency planning.
  - Additional modelling of trajectories over multiple seasons and spill sites to aid in
    - predicting the fate of an oil spill in the licence area,
    - identifying potentially affected environmental resources, and
    - determining minimum response times for contingency planning

Recommended Additional Control, Management, and Monitoring

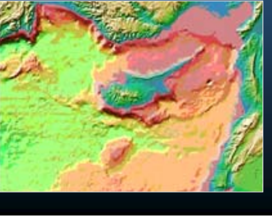
- Develop discharge requirements for drilling fluid and cuttings, produced water, and other effluents
- Consider Barcelona Convention offshore protocol and the OSPAR Convention offshore oil and gas industry strategy as sources of guidance
- Review Barcelona Convention offshore protocol to ensure that hydrocarbons activities are consistent with protocol requirements

Data Gaps

- Assessment of Eratosthenes Seamount ecology including deepwater corals
- Measurements of hydrocarbons and trace metal concentrations in sea floor sediments to provide a useful baseline for detecting future changes
- Increase resolution of existing ocean flow models to improve accuracy and reliability of oil spill trajectory modeling
- Collection of additional subsurface current, temperature, and salinity data at sufficiently high temporal and/or spatial resolution

Thank You

- Ministry of Commerce, Industry and Tourism of the Republic of Cyprus
- Aeoliki
- Maritime Communications Services
- CSA International Inc.
- Oceanography Center, University of Cyprus



Oral presentation – Environmental Report - Strategic Environmental Assessment (SEA) Concerning Hydrocarbon Activities within the Exclusive Economic Zone of the Republic of Cyprus

(GREEK VERSION)

Περιβαλλοντική Μελέτη

Περιβαλλοντική Μελέτη

Στρατηγική Περιβαλλοντική Μελέτη Αναφορικά με τις Δραστηριότητες Υδρογονανθράκων εντός της Αποκλειστικής Οικονομικής Ζώνης της Κυπριακής Δημοκρατίας

Αριθμός Συμβολαίου (MCIT/ES/13/2007)

Υπουργείο Εμπορίου , Βιομηχανίας και Τουρισμού

26 Σεπτεμβρίου 2008

Εισαγωγή

- Σκοπός της Στρατηγικής Περιβαλλοντικής Μελέτης (ΣΠΜ)
- Στόχοι της ΣΠΜ
- Διαδικασία ΣΠΜ
- Ομάδα Εργασίας
- Περιγραφή Περιβάλλοντος
- Περιγραφή των Εγκαταστάσεων
- Περιβαλλοντικές Επιπτώσεις
- Μέτρα Αντιμετώπισης

Σκοπός της ΣΠΜ

- Εντοπισμός, περιγραφή και αξιολόγηση των «πιθανών» περιβαλλοντικών επιπτώσεων που μπορεί να προκύψουν από την υλοποίηση των σχεδίων ή/και των προγραμμάτων.
- Αξιολόγηση των πιο σημαντικών περιβαλλοντικών επιπτώσεων που θα προκύψουν από το πρόγραμμα αδειοδότησης συμπεριλαμβανομένων των προοπτικών έρευνας και εκμετάλλευσης υδρογονανθράκων εντός της Αποκλειστικής Οικονομικής Ζώνης της Κυπριακής Δημοκρατίας
- Λεπτομερείς περιβαλλοντικές μελέτες θα εκπονηθούν για κάθε σχέδιο έρευνας των υδρογονανθράκων

Στόχοι της ΣΠΜ

- Περιγραφή του συνόλου των δραστηριοτήτων που αφορούν στην έρευνα και εκμετάλλευση υδρογονανθράκων
- Περιγραφή των υφισταμένων μέτρων ελέγχου των δραστηριοτήτων έρευνας και εκμετάλλευσης υδρογονανθράκων
- Περίληψη των διαθέσιμων περιβαλλοντικών πληροφοριών
- Περιγραφή του περιβάλλοντος της περιοχής μελέτης
- Προσδιορισμός των πιθανών περιβαλλοντικών επιπτώσεων και αξιολόγηση της σημαντικότητας τους
- Εισηγήσεις για επιπρόσθετα διαχειριστικά μέτρα και μέτρα παρακολούθησης με σκοπό την διασφάλιση της προστασίας του περιβάλλοντος και την ορθολογιστική χρήση των φυσικών πόρων,
- Εντοπισμός των πιθανόν ελλείψεων σε στοιχεία ή/και ανακριβειών των υφισταμένων πληροφοριών τα οποία μπορούν να συμπληρωθούν στα πλαίσια επιπρόσθετων μελετών

Διαδικασία Εκπόνησης ΣΠΜ

- Εκτενής περιγραφή του περιβάλλοντος της περιοχής μελέτης
- Ανασκόπηση των σχετικών νομοθετικών και κανονιστικών διατάξεων
- Βιβλιογραφική επισκόπηση όλων των περιβαλλοντικών δεδομένων που περιγράφουν την υφιστάμενη κατάσταση του περιβάλλοντος
- Αξιολόγηση των πιθανών δραστηριοτήτων έρευνας και εκμετάλλευσης υδρογονανθράκων
- Προσδιορισμός και ανάλυση των πιθανώς σημαντικών περιβαλλοντικών επιπτώσεων
- Εισηγήσεις για την διαχείριση και την παρακολούθηση των δραστηριοτήτων έρευνας και εκμετάλλευσης υδρογονανθράκων

Υπουργείο Εμπορίου
Βιομηχανίας και Τουρισμού της Κυπριακής Δημοκρατίας

Ομάδα Εργασίας

Maritime Communication Services, Inc.

Aeoliki Ltd.

CSA International, Inc.

Ωκεανογραφικό Κέντρο Πανεπιστημίου Κύπρου

Πρόγραμμα Αδειοδότησης και Νομοθετικό Πλαίσιο

- Εφαρμοζόμενη Νομοθεσία
- Αδειοδότηση
- Διεθνείς Συμβάσεις και Πρωτόκολλα

Νόμοι και Κανονισμοί

- Ο περί Υδρογονανθράκων (Αναζήτηση, Έρευνα και Εκμετάλλευση) Νόμος Ν.4(Ι)/2007 – γνωστός ως ο περί Υδρογονανθράκων Νόμος του 2007
- Οι περί Υδρογονανθράκων (Αναζήτηση, Έρευνα και Εκμετάλλευση) Κανονισμοί του 2007 – γνωστοί ως οι περί Υδρογονανθράκων Κανονισμοί του 2007
- Άλλες Νομοθετικές Πράξεις και Συμφωνίες
  - Ο Περί της Συνορεύουσας Ζώνης Νόμος (63(Ι)2004)
  - Ο Περί της Αποκλειστικής Οικονομικής Ζώνης Νόμος(64(Ι)2004)
  - Διμερείς Συμφωνίες με την Αίγυπτο (2003) και το Λίβανο (2007)) για τον προσδιορισμό των συνόρων αποκλειστικής οικονομικής ζώνης μεταξύ των εν λόγω χωρών

Αρμόδια Αρχή για την έκδοση αδειών εκμετάλλευσης υδρογονανθράκων είναι το Υπουργικό Συμβούλιο, που εκπροσωπείται από το ΥΕΒΤ

Είδη Αδειοδότησης

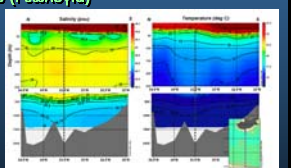
- Αναζήτηση
  - Αφορά στην αξιολόγηση του πετρελαϊκού δυναμικού στην βάση του εντοπισμού γεωλογικών χαρακτηριστικών της περιοχής ενδιαφέροντος
  - Συμπεριλαμβάνει βαρυτομετρικές, μαγνητικές και σεισμικές επισκοπήσεις. Δεν περιλαμβάνει γεωτρήσεις
- Έρευνα
  - Αφορά στον εντοπισμό υδρογονανθράκων
  - Συμπεριλαμβάνει, βαρυτομετρικές, μαγνητικές και σεισμικές επισκοπήσεις, καθώς επίσης και γεωτρήσεις
- Εκμετάλλευση
  - Αφορά στην εξόρυξη και εκμετάλλευση υδρογονανθράκων
  - Εκδίδεται για αρχική περίοδο μέχρι 25 ετών, αφού προηγηθεί η έγκριση του σχεδίου παραγωγής υδρογονανθράκων, και ανανεώνεται για ακόμη 10 έτη

International Conventions and Protocols

- MARPOL (International Convention for the Prevention of Pollution from Ships)
  - Υγρά αστικά απόβλητα, διαρροές πετρελαιοειδών
  - Στερεά απόβλητα
  - Αέριες εκπομπές
- Barcelona Convention
  - Πρόληψη, μείωση, αντιμετώπιση, εξάλειψη της ρύπανσης
  - Προστασία του θαλάσσιου περιβάλλοντος
- Other International Agreements
  - Αποδημητικά είδη και Βιοποικιλότητα
  - Προστασία της στοιβάδας του όζοντος
  - Κλιματικές αλλαγές
  - Agenda 21
  - Kyoto Protocol

Επηρεαζόμενο Περιβάλλον

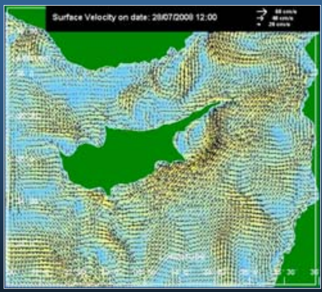
- Φυσικό Περιβάλλον
  - Μετεωρολογικές Συνθήκες
  - Ωκεανογραφικές Συνθήκες
  - Χαρακτηριστικά Θαλάσσιου Βυθού (Γεωλογία)
  - Περιβάλλον Θορύβου



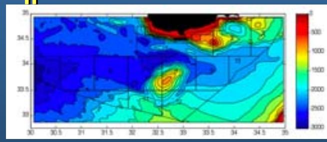
Βιολογικό Περιβάλλον
  - Θαλάσσιο Πλαγκτόν
  - Νηκτόν
  - Βένθος
  - Θαλάσσια Πτηνά
  - Προστατευόμενα και Υπό Εξάλειψη Είδη
  - Περιοχές Ειδικού Ενδιαφέροντος
- Κοινω-οικονομικό Περιβάλλον

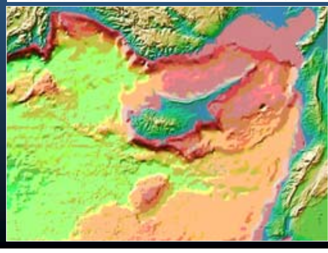
Φυσικό Περιβάλλον

- Μετεωρολογικές Συνθήκες
- Θαλάσσια Ρεύματα και Υδρογραφία
- Γεωλογία
- Θόρυβος



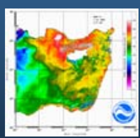
Μορφο-Βαθυμετρία και Χαρακτηριστικά Θαλάσσιου Βυθού

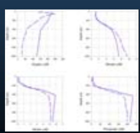




Συνοπτική Περιγραφή του Περιβάλλοντος της Περιοχής Μελέτης

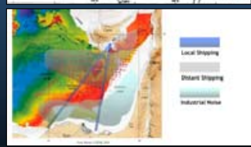
- Μετεωρολογικά Χαρακτηριστικά
  - ψυχρή υγρή περίοδος (Δεκέμβριος – Μάρτιος)
  - θερμή ξηρή περίοδος (Ιούνιος – Σεπτέμβριος)
- Ποιότητα Αέρα – επηρεαζόμενη από τη μεταφορά αέριων ρύπων
  - Ανθρωπογενή αίτια (transboundary)
  - φυσικά αίτια (σκόνη από την Σαχάρα)
- Θαλάσσια Ρεύματα
- Υδρογραφία
  - Χαρακτηριστικό θερμοκλινές
  - Πολύ θερμό υψηλής αλατότητας επιφανειακό στρώμα το καλοκαίρι,
  - Επιφανειακά νερά με ομοιόμορφη θερμοκρασία και αλατότητα σε μεγαλύτερο βάθος τον χειμώνα





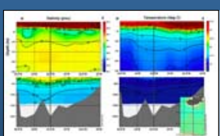
Συνοπτική Περιγραφή του Περιβάλλοντος της Περιοχής Μελέτης

- Ποιότητα Υδάτων
  - Υψηλή περιεκτικότητα σε οξυγόνο
  - Χαμηλή συγκέντρωση θρεπτικών ουσιών
- Γεωλογία
  - Η Ανατολική Μεσόγειος σχηματίστηκε από την αλληλεπίδραση της Αφρικανικής, Αραβικής και Ευρω-ασιατικής πλάκας
  - Το υποθαλάσσιο βουνό Ερατοσθένης έχει ύψος περίπου 1500 μέτρων και πλάτος 150 to 200 km με την κορυφή του να βρίσκεται σε βάθος περίπου 700 μέτρων από την επιφάνεια της θάλασσας
- Θόρυβος
  - Φυσικές και ανθρωπογενείς πηγές θορύβου
  - Κύρια πηγή θορύβου η ναυτιλιακή κίνηση στην περιοχή, στην απουσία ανέμων και βροχόπτωσης



Βιολογικό Περιβάλλον

- Θαλάσσιο Πλαγκτόν
- Βένθος
- Νηκτόν
- Θαλάσσια είδη πτηνών
- Θαλάσσια θηλαστικά, χελώνες, προστατευόμενα και απειλούμενα είδη
- Περιοχές ειδικού ενδιαφέροντος



Συνοπτική Περιγραφή του Περιβάλλοντος της Περιοχής Μελέτης

- Υδάτινη Στήλη
  - Χαμηλή βιομάζα φυτοπλαγκτού και χαμηλή παραγωγικότητα
  - Εξαιρετικά ψηλή βιοποικιλότητα ζωοπλαγκτού
  - Μεγάλη ποικιλία θαλασσίων ειδών που απαντάται σε σχετικά μικρές ποσότητες
  - Η αλιεία εξαρτάται από ένα μεγάλο αριθμό ειδών ψαριών (πέραν των 80)
- Βυθός
  - Η πανίδα των βαθέων υδάτων είναι εξαιρετικά φτωχή σε αριθμό ειδών
  - Πολύ λίγα είναι γνωστά για τις βιοκοινωνίες που υπάρχουν στη περιοχή του υποθαλάσσιου όρους Ερατοσθένης
  - Η παρουσία εμπορικά σημαντικών αποθεμάτων βενθοπελαγικών ψαριών είναι πολύ πιθανή

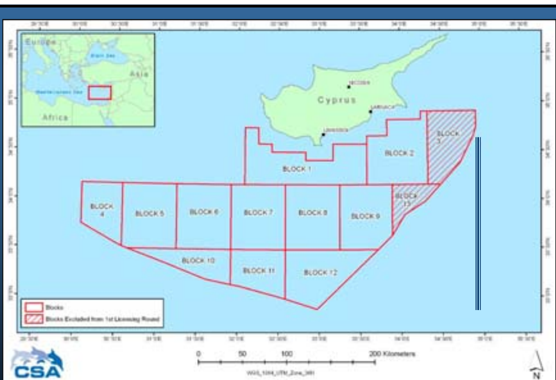
Συνοπτική Περιγραφή του Περιβάλλοντος της Περιοχής Μελέτης

- Θαλάσσια Είδη Πτηνών
  - Αναφέρονται στο Σχέδιο Δράσης της Σύμβασης της Βαρκελώνης και προστατεύονται από την Κυπριακή Νομοθεσία
- Προστατευόμενα και Απειλούμενα Είδη
  - Υπάρχει ποικιλία θαλάσσιων θηλαστικών, που περιλαμβάνει διάφορα κινδυνεύοντα ή απειλούμενα είδη
    - Η σπάνια και κρίσιμα απειλούμενη με εξαφάνιση (critically endangered) Μεσογειακή Φώκια, μπορεί να υπάρχει στα παράκτια νερά τη Κύπρου
    - Όλα τα κητώδη είναι προστατευόμενα είδη
  - τρία είδη θαλάσσιας χελώνας απατούνται στη Μεσόγειο: η Πράσινη χελώνα, η Δερμοχέλης και η Καρέττα-Καρέττα
  - η Πράσινη χελώνα και η Καρέττα-Καρέττα είναι κινδυνεύοντα είδη
  - η Δερμοχέλης είναι είδος κρίσιμα απειλούμενο με εξαφάνιση ((critically endang
  - η Πράσινη χελώνα και η Καρέττα-Καρέττα ωοτοκούν σε διάφορες παράλιες

- Περιοχές Ειδικού Ενδιαφέροντος
  - Πελαγικά ενδιαιτήματα ψαριών
  - Βενθικά ενδιαιτήματα ψαριών
  - Προστατευμένες θαλάσσιες περιοχές
  - Υποθαλάσσια Όρη
  - Χημοσυνθετικές Βιοκοινωνίες

Κοινω-οικονομικό Περιβάλλον

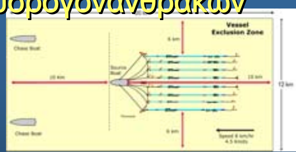
- Εμπορική Ναυτιλία και Ψυχαγωγική Ιστιοπλοΐα
- Ιχθυοκαλλιέργειες
- Ναυτιλία και παράκτιες δραστηριότητες (λιμάνια, σταθμοί αποθήκευσης πετρελαιοειδών)
- Τηλεπικοινωνίες (δίκτυο υποβρυχίων καλωδίων)
- Ψυχαγωγία και Τουρισμός
- Αρχαιολογικοί χώροι, αρχαία και πολιτιστική κληρονομιά

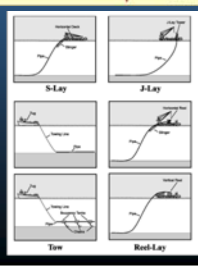


Ερευνητικά Τεμάχια

Περιγραφή Δραστηριοτήτων για έρευνα και εκμετάλλευση υδρογονανθράκων

- Αναζήτηση
- Έρευνα
- Εκμετάλλευση
  - Αποσυναρμολόγηση



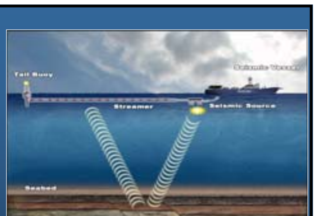


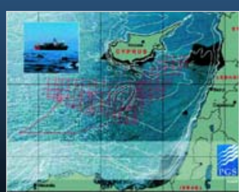
Αναζήτηση

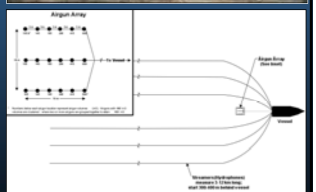
- Δραστηριότητες για τον εντοπισμό των υδρογονανθράκων ή/και αξιολόγηση της δυνατότητας εξεύρεσης υδρογονανθράκων με μεθόδους εκτός από αυτών των γεωτρήσεων
  - σεισμικές έρευνες
  - γεωλογικές και γεωχημικές δειγματοληψίες
  - ηλεκτρομαγνητικές έρευνες
  - τηλεπισκόπηση

Σεισμικές Έρευνες

- Έρευνες 2D
- Έρευνες 3D
- Έρευνες Υψηλής Ευκρίνειας
- Έρευνες με καλώδια βυθού
- Έρευνες με κάθετα καλώδια
- Κάθετο σεισμικό προφιλ







Έρευνα

- Διαδικασίες σε ένα ή περισσότερα διερευνητικά φρεάτια ανά αδειοδοτούμενο ερευνητικό τεμάχιο έτσι ώστε να καθοριστεί αν υπάρχουν εμπορικά εκμεταλλεύσιμες ποσότητες υδρογονανθράκων

Πλατφόρμες Γεώτρησης

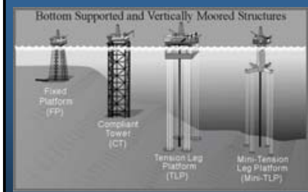
Ημι-βυθιζόμενη πλατφόρμα

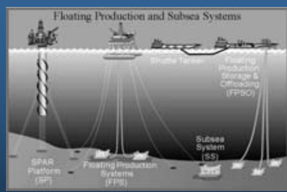
Πλατφόρμα σε πλοίο-φορέα

Εκμετάλλευση
(Ανάπτυξη και Παραγωγή)

- Διαδικασία για την εμπορική εκμετάλλευση των υδρογονανθράκων
- Βασικές Δραστηριότητες
  - διάνοιξη φρεατίων ανάπτυξης
  - δημιουργία εγκαταστάσεων παραγωγής
  - δημιουργία εγκαταστάσεων εξαγωγής (δίκτυο σωληνώσεων και τερματικοί σταθμοί)
  - λειτουργία συστημάτων

Παραδείγματα Εγκαταστάσεων Εκμετάλλευσης





Αποσυναρμολόγηση

- Αποσυναρμολόγηση των εγκαταστάσεων παραγωγής και μεταφοράς, και αποκατάσταση της περιοχής
- Απαίτηση (από τους κάτοχους αδειών) για
  - Απομάκρυνση του εξοπλισμού και εγκαταστάσεων
  - Υλοποίηση της αποσυναρμολόγησης και απομάκρυνσης των εγκαταστάσεων σύμφωνα με τις πρόνοιες της διεθνούς καλής πρακτικής

Εκτίμηση Επιπτώσεων

- Κριτήρια Σημαντικότητας
- Επιπτώσεις, Μέτρα Ελέγχου, και Μέτρα μετριασμού Επιπτώσεων
  - Αναζήτηση
  - Έρευνα
  - Εκμετάλλευση (Ανάπτυξη και Παραγωγή)
  - Αποσυναρμολόγηση
  - Ατυχήματα

Κριτήρια Σημαντικότητας

- Παραβίαση προτύπων ποιότητας του νερού
- Μόλυνση νερού ή ιζημάτων
- Πρόκληση βλάβης ή μόλυνσης σε ευαίσθητους ή προστατευόμενους βιοτόπους - Ρύπανση παράκτιων βιοτόπων
- Πρόκληση θανάτου ή βλάβης ή περιορισμό δραστηριοτήτων σε σημαντικούς βιοτόπους προστατευόμενων ειδών
- Συχνός ή συνεχής επηρεασμός άλλων θαλάσσιων δραστηριοτήτων
- Πρόκληση βλάβης ή μόλυνσης σημαντικών χώρων κοινω-οικονομικής δραστηριότητας στη θάλασσα ή στην ξηρά
- Κίνδυνος για τη δημόσια υγεία και ασφάλεια

Επιπτώσεις από τις δραστηριότητες Αναζήτησης

Πηγή: Θόρυβος (***Airgun*** *)*

Πιθανές Σημαντικές Επιπτώσεις: *Ακουστικό τραύμα στα θαλάσσια θηλαστικά και τις χελώνες (συμπεριλαμβανομένων των απειλούμενων, αυστηρά απειλούμενων και υπό εξαφάνιση ειδών)*

Πηγή: *Κυκλοφορία σκαφών και ρυμουλκούμενου εξοπλισμού*

Πιθανές Σημαντικές Επιπτώσεις: *Πιθανός επηρεασμός των αλιευτικών ή ναυτιλιακών δραστηριοτήτων (π.χ. προσωρινός αποκλεισμός από ορισμένες περιοχές, πρόκληση ζημίας σε εξοπλισμό αλιείας ή εμπλοκή)*

Επιπτώσεις από τις δραστηριότητες Έρευνας

Πηγή: *Δημιουργία και αποσυναρμολόγηση των εγκαταστάσεων των γεωτρήσεων*

Πιθανές Σημαντικές Επιπτώσεις: *Πρόκληση βλαβών στα κοράλλια (π.χ.,* ***Seamount Eratosthenes****), στις χημοσυνθετικές κοινότητες ή στα ιστορικά ναυάγια λόγω της τοποθέτησης των εγκαταστάσεων ή/και των αγκύρων*

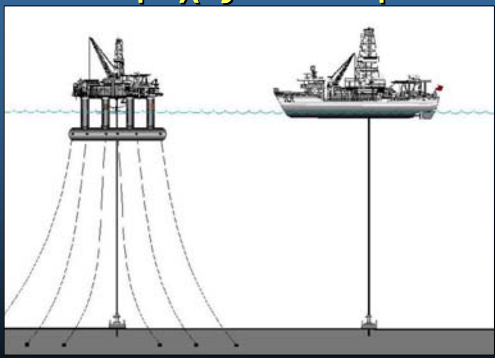
Πηγή: *Απόβλητα Γεωτρήσεων*

Πιθανές Σημαντικές Επιπτώσεις: *Αποτελέσματα επικάλυψης και ανοξίας σε κοράλλια (π.χ.,* ***Seamount Eratosthenes****) ή στις χημοσυνθετικές* ***(chemosynthetic)*** *κοινότητες που βρίσκονται σε βάθος* ***500m***

Πηγή: *Θαλάσσια Συντρίμμια*

Πιθανές Σημαντικές Επιπτώσεις: *Κίνδυνος θανάτου ή τραυματισμού των θαλάσσιων θηλαστικών, των χελωνών, ή και των πουλιών λόγω της πιθανής παγίδευσής τους στα απορριπτόμενα συντρίμμια*

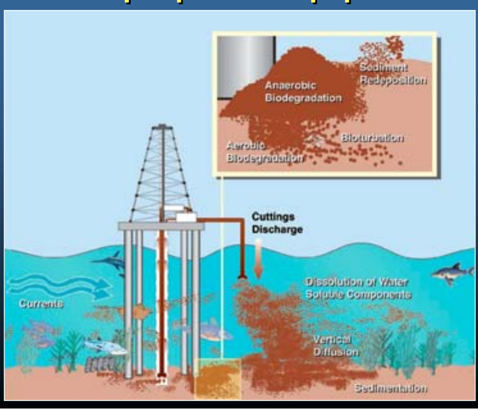
Διαταραχές του Πυθμένα



Ημι-βυθιζόμενη πλατφόρμα

Πλοίο-φορέας

Απόβλητα Γεωτρήσεων



Επιπτώσεις από τις δραστηριότητες Εκμετάλλευσης

Πηγή: *Δοκιμές Γεωτρήσεων*

Πιθανές Σημαντικές Επιπτώσεις: *Η λειτουργία του πυργού (****flare****) λόγω ελλιπούς καύσης προκαλέσει την δημιουργία φιλμ στην επιφάνεια της θάλασσας*

Πηγή: *Βοηθητικές Δραστηριότητες*

Πιθανές Σημαντικές Επιπτώσεις: *Ελικόπτερα που πετούν πάνω από τις Σημαντικές Περιοχές Πτηνών (ΣΠΠ) θα μπορούσαν να προκαλέσουν ενοχλήσεις στα παράκτια πουλιά*

Επιπτώσεις από τις δραστηριότητες Εκμετάλλευσης

Πηγή: *Αγκυροβόληση των Εγκαταστάσεων*

Πιθανές Σημαντικές Επιπτώσεις : *Πρόκληση βλαβών στα κοράλλια (π.χ.,* **Seamount Eratosthenes)**, *στις χημοσυνθετικές κοινότητες ή στα ιστορικά ναυάγια λόγω της τοποθέτησης των εγκαταστάσεων ή/και των αγκυρών*

Πηγή : *Απόβλητα γεωτρήσεων*

Πιθανές Σημαντικές Επιπτώσεις : *Αποτελέσματα επικάλυψης και ανοξίας σε κοράλλια (π.χ.,* **Seamount Eratosthenes)** *ή τις χημοσυνθετικές* **(chemosynthetic)** *κοινότητες που βρίσκονται σε βάθος* **500m**

Πηγή : *Αποσυναρμολόγηση και απομάκρυνση των Εγκαταστάσεων*

Πιθανές Σημαντικές Επιπτώσεις : *Πιθανός θάνατος ή πρόκληση βλάβης σε θαλάσσια θηλαστικά ή χελώνες (συμπεριλαμβανομένων των απειλούμενων, αυστηρά απειλούμενων, και υπό εξαφάνιση ειδών) από τη χρήση εκρηκτικών υλών*

Επιπτώσεις από Ατυχήματα

Πηγή: *Διαρροές πετρελαίου που περιλαμβάνουν*

– Διαρροή αργού πετρελαίου λόγω έκρηξης
– Διαρροή πετρελαίου diesel
– Διαρροή πετρελαίου από τα φρεάτια γεωτρήσεων
– Διαρροή υγρών από τον εξοπλισμό των καλωδίων

Πιθανές Σημαντικές Επιπτώσεις : *Ανάλογα με το μέγεθος και τη φύση των διαρροών, τα αποτελέσματα θα μπορούσαν να περιλάβουν την παραβίαση των προτύπων ποιότητας του νερού, τη μόλυνση των ιζημάτων, το θάνατο ή πρόκληση βλάβης των θαλασσίων θηλαστικών, των χελωνών, και των πουλιών, τη ρύπανση παράκτιων βιότοπων συμπεριλαμβανομένων και των παραλιών και τον περιορισμό δραστηριοτήτων αλιείας, ναυτιλίας, αναψυχής, και τουρισμού κατά τη διάρκεια των διαδικασιών καθαρισμού*

Πηγή: *Απελευθέρωση Υδρόθειου (H2S)*
Πιθανές Σημαντικές Επιπτώσεις : *Παραβίαση των προτύπων ποιότητας της ατμόσφαιρας Πιθανή πρόκληση θανάτου ή βλάβης σε ανθρώπινες ζωές στις υπεράκτιες εγκαταστάσεις και τα παρακείμενα ύδατα*
Πιθανή πρόκληση θανάτου ή βλάβης σε είδη της άγριας φύσης συμπεριλαμβανομένων των πτηνών

Εισηγήσεις

- Επίπτωση #1 – Επιπτώσεις στα κοράλλια (Eratosthenes Seamount) από τις διαταραχές στον πυθμένα της θάλασσας και τα απόβλητα των διατρήσεων)
  – οι κάτοχοι άδειας πρέπει να χρησιμοποιήσουν σεισμικά δεδομένα υψηλής ανάλυσης, τρισδιάστατα σεισμικά στοιχεία ερευνών, και οποιεσδήποτε άλλες διαθέσιμες πληροφορίες, έτσι ώστε να προσδιορίσουν τις περιοχές του πυθμένα που μπορούν να υποστηρίξουν κοινότητες κοραλλιών
  – οι κάτοχοι άδειας θα πρέπει να διεξαγάγουν προσομοιώσεις διασποράς της λάσπης και των αποβλήτων (muds and cuttings discharge modeling) ούτως ώστε να προσδιοριστεί η απόσταση ασφαλείας που θα προστατεύσει τις εν λόγω κοινότητες κοραλλιών
- Επίπτωση #2 – Επιπτώσεις στις Χημοσυνθετικές Κοινότητες (Chemosynthetic Communities) λόγω διαταράξεων του Θαλάσσιου Πυθμένα και απόρριψης αποβλήτων των Γεωτρήσεων
  – Οι κάτοχοι άδειας πρέπει να χρησιμοποιήσουν σεισμικά δεδομένα υψηλής ανάλυσης τρισδιάστατα σεισμικά στοιχεία ερευνών, και οποιεσδήποτε άλλες διαθέσιμες πληροφορίες, έτσι ώστε να προσδιορίσουν τα γεωλογικά χαρακτηριστικά τα οποία μπορούν να υποστηρίξουν μεγάλη ποικιλία χημοσυνθετικών κοινοτήτων .
  – οι κάτοχοι άδειας πρέπει να εφαρμόσουν αποστάσεις ασφαλείας :
    - τουλάχιστον 500m από κάθε προτεινόμενο σημείο γεώτρησης και σημείο απόρριψης αποβλήτων
    - Τουλάχιστον 100 m από κάθε άλλη πιθανή θέση διατάραξης του πυθμένα

Εισηγήσεις

- Επίπτωση #3 – Επιπτώσεις στα Ναυάγια και στους Υποβρυχίους Αρχαιολογικούς Χώρους λόγω Διαταράξεων του Πυθμένα
  – οι κάτοχοι άδειας θα πρέπει να εκπονήσουν έρευνες τηλεπισκόπησης (remote sensing survey) του πυθμένα για να αξιολογηθούν έτσι οι πιθανότητες να υπάρχουν σε αυτόν ναυάγια και αρχαιολογικοί χώροι
  – Οι κάτοχοι άδειας πρέπει να υποβάλουν αρχαιολογικές μελέτες (που εκπονούνται από ειδικούς αρχαιολόγους) οι οποίες να καταδεικνύουν την ύπαρξη ή μη αρχαιολογικών περιοχών, και να εισηγούνται μέτρα προστασίας αυτών
  – Με βάση αυτή την έκθεση το Υπουργείο μπορεί να απαιτήσει αποφυγή οποιασδήποτε επέμβασης ή άλλα μέτρα προστασίας των εν λόγω χώρων

Εισηγήσεις

- Επίπτωση #4 – Επιπτώσεις στα Θαλάσσια Θηλαστικά και Χελώνες από τον Θορύβου (Airgun)

  Οι κάτοχοι άδειας πρέπει να εφαρμόσουν ένα πρωτόκολλο για να μειώσουν τον κίνδυνο ακουστικού τραύματος στα θαλάσσια θηλαστικά και τις χελώνες. Το πρωτόκολλο πρέπει να περιλαμβάνει τουλάχιστον τα ακόλουθα
  – Ελεγχόμενη έναρξη για να δοθεί χρόνος στα θαλάσσια θηλαστικά και στις χελώνες να απομακρυνθούν
  – Οπτικός έλεγχος ζώνης «αποκλεισμού» ακτίνας 500 m radius γύρω από το ερευνητικό σκάφος
  – Απενεργοποίηση της ηχητικής πηγής (array) εάν διαπιστωθεί (κατά τη διάρκεια του οπτικού ελέγχου) ότι μια φάλαινα ή μια χελώνα εισέλθουν στη ζώνη αποκλεισμού
- Επίπτωση #5 – Επιπτώσεις στην αλιεία και τη ναυτιλία από την παρουσία των Σεισμικών Ερευνητικών Σκαφών και του ρυμουλκούμενου εξοπλισμού (streamers)
  – Οι κάτοχοι άδειας πρέπει να συνεργαστούν με τους ενδιαφερόμενους φορείς πριν την έναρξη των ερευνών,

Εισηγήσεις

- Επίπτωση #6 – Επιπτώσεις στην Ποιότητα του Αέρα και των Υδάτων από τις διαδικασίες δοκιμής των γεωτρήσεων
  – Κατά τη διάρκεια της δοκιμής της γεώτρησης, οι κάτοχοι άδειας θα πρέπει να
    - χρησιμοποιούν καυστήρες υψηλής απόδοσης για να ελαχιστοποιήσουν τις εκπομπές αέριων ρύπων καύσης
    - παρακολουθούν την επιφάνεια της θάλασσας για να διασφαλίσουν ότι δεν θα δημιουργεί φιλμ υδρογονανθράκων
- Επίπτωση #7 – Επιπτώσεις από την Κίνηση Ελικοπτέρων εντός Σημαντικών Περιοχών Πτηνών
  – Οι κάτοχοι άδειας πρέπει να αποφεύγουν τη πτήση ελικοπτέρων πάνω από Ειδικές Περιοχές Προστασίας (ΕΠΠ) και Σημαντικές Περιοχές Πτηνών (ΣΠΠ) όταν ταξιδεύουν προς και από τα σημεία των γεωτρήσεων
  – Χάρτες των περιοχών ΕΠΠ και ΣΠΠ πρέπει να κοινοποιούνται γι’ αυτό τον σκοπό

Εισηγήσεις

- Επίπτωση #8 – Επιπτώσεις στα Θαλάσσια Θηλαστικά και στις Χελώνες από τις εργασίες αποξήλωσης και απομάκρυνσης των εγκαταστάσεων
  - Οι κάτοχοι άδειας πρέπει να ακολουθούν τη διεθνή καλή πρακτική για την ασφαλή απομάκρυνση του εξοπλισμού κατά τη διάρκεια της αποσυναρμολόγησης των εγκαταστάσεων
  - Να απαιτείται η εκπόνηση πλάνου αποσυναρμολόγησης, το οποίο θα συμπεριλαμβάνει την παρακολούθηση και έλεγχο της παρουσίας των θαλάσσιων θηλαστικών και χελωνών με σκοπό την αποφυγή πιθανών επιπτώσεων που θα προκύψουνε από τις υποβρύχιες εκρήξεις
- Επίπτωση #9 – Επιπτώσεις στο Θαλάσσιο Περιβάλλον από τις διαρροές υδρογονανθράκων
  - Να χρησιμοποιηθεί προγνωστικό μοντέλο ροής (MEDSLIK) για τι διαμόρφωση σχεδίων αντιμετώπισης
  - Να χρησιμοποιηθεί προγνωστικό μοντέλο ροής (MEDSLIK) για να προσδιοριστούν οι πιθανές κατευθύνσεις των διαρροών στην περιοχή αδειοδότησης, για να καθοριστεί η πιθανή επίπτωση των διαρροών στην περιοχή, ενδεχομένως και των επηρεαζόμενων περιβαλλοντικών πόρων, και η εκτίμηση του χρόνου που χρειάζεται να φθάσουν οι εν λόγω διαρροές στις ακτές της Κύπρου και άλλων χωρών της ευρύτερης περιοχής

Εισηγήσεις για Επιπρόσθετο Έλεγχο, Διαχείριση και Παρακολούθηση

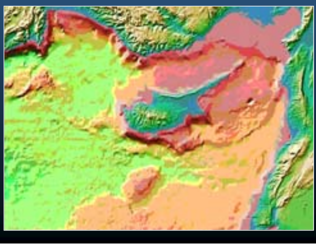
- Να καθοριστούν οι απαιτήσεις για τη διαχείριση των αποβλήτων των γεωτρήσεων, και των άλλων αποβλήτων που σχετίζονται με τις δραστηριότητες εκμετάλλευσης των υδρογονανθράκων στη περιοχή αδειοδότησης
- Να ληφθούν υπόψη οι σχετικές πρόνοιες της Σύμβασης της Βαρκελώνης και της Σύμβασης OSPAR
- Να γίνει λεπτομερής ανάλυση των προνοιών του πρωτοκόλλου υπεράκτιων δραστηριοτήτων της Σύμβασης της Βαρκελώνης και των Παραρτημάτων του έτσι ώστε να επιβεβαιωθεί ότι όλες οι δραστηριότητες έρευνας και εκμετάλλευσης υδρογονανθράκων στη περιοχή αδειοδότησης είναι σύμφωνες με τις απαιτήσεις του

Ελλείψεις Στοιχείων

- Αξιολόγηση της οικολογίας του υποθαλάσσιου όρους Ερατοσθένης (Eratosthenes) συμπεριλαμβανομένων των κοραλλιών
- Μετρήσεις των συγκεντρώσεων των υδρογονανθράκων και βαρέων μετάλλων στα ιζήματα του πυθμένα της θάλασσας στην περιοχή αδειοδότησης, ούτως ώστε να είναι δυνατή η εκτίμηση των επιπτώσεων και αλλαγών λόγω των δραστηριοτήτων έρευνας και εκμετάλλευσης των υδρογονανθράκων στην περιοχή
- Επέκταση ή αύξηση της ανάλυσης των υφιστάμενων ωκεάνιων προγνωστικών μοντέλων ροής προκειμένου να βελτιωθεί η ακρίβεια και η αξιοπιστία των προσομοιώσεων της διασποράς των διαρροών πετρελαίου
- Συλλογή επιπρόσθετων στοιχείων και δεδομένων σε σχέση με τα υπο-επιφανειακά ρεύματα, τη θερμοκρασία και την αλατότητα στην περιοχή αδειοδότησης

Ευχαριστούμε Πολύ

- Υπουργείο Εμπορίου, Βιομηχανίας και Τουρισμού
- **Aeoliki Ltd**
- **Maritime Communications Services**
- **CSA International Inc.**
- Ωκεανογραφικό Κέντρο, Πανεπιστήμιο Κύπρου



Appendix F

Non Technical Summary (Greek Translation)

Κεφάλαιο 1
Σύνοψη

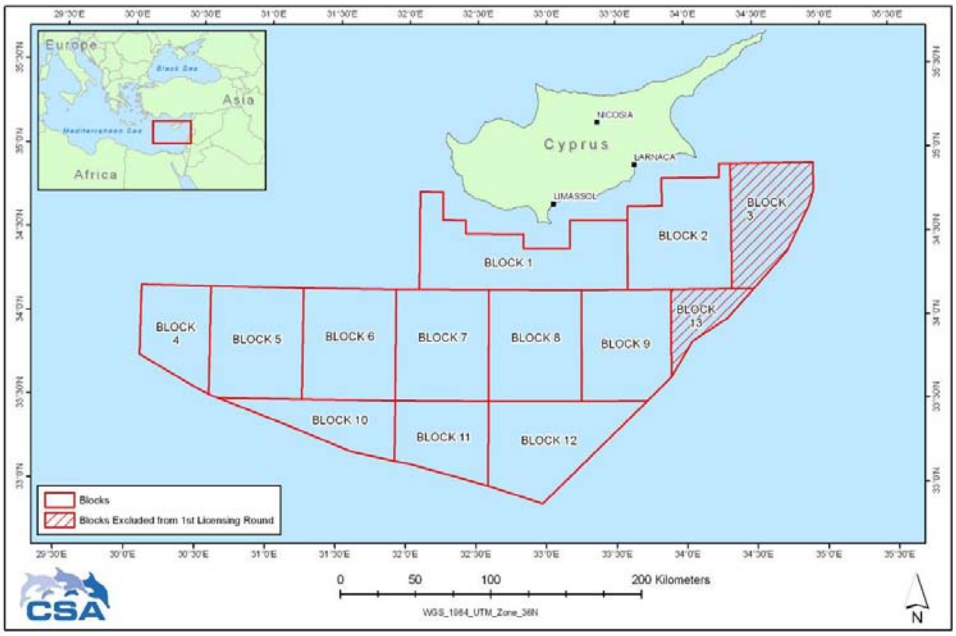
1.1 ΕΙΣΑΓΩΓΗ

Στην έκθεση αυτή παρουσιάζονται τα συμπεράσματα της Στρατηγικής Περιβαλλοντικής Μελέτης (ΣΠΜ) αναφορικά με τις δραστηριότητες αναζήτησης, έρευνας και εκμετάλλευσης των υδρογονανθράκων εντός της Αποκλειστικής Οικονομικής Ζώνης της Κυπριακής Δημοκρατίας.
Το Υπουργείο Εμπορίου , Βιομηχανίας και Τουρισμού με την εκπόνηση της ΣΠΜ στόχο έχει την προστασία του περιβάλλοντος και την αειφόρο ανάπτυξη της περιοχής. Η ΣΠΜ εκπονήθηκε σύμφωνα με τις απαιτήσεις του Νόμου Νο.102(Ι)/2005 για την αξιολόγηση των περιβαλλοντικών επιπτώσεων από ορισμένα σχέδια, πλάνα ή/και προγράμματα, ο οποίος εναρμόνισε την εθνική νομοθεσία στην Ευρωπαϊκή Οδηγία 2001/42/ΕΚ του Ευρωπαϊκού Κοινοβουλίου και του Συμβουλίου της Ευρώπης. Η ΣΠΜ εκπονήθηκε από την κοινοπραξία που απαρτίζεται από τις εταιρείες :

- Marine Communication Services, Inc. (MCI) από τις ΗΠΑ,
- AEOLIKI Ltd από την Κύπρο, και
- CSA International, Inc. (CSA) από τις ΗΠΑ

σε συνεργασία με το Ωκεανογραφικό Κέντρο του Πανεπιστημίου Κύπρου.

Η περιοχή αδειοδότησης που μελετήθηκε αποτελεί μέρος της ΑΟΖ της Κυπριακής Δημοκρατίας και αποτελείται από 13 ερευνητικά τεμάχια από τα οποία τα 11 συμπεριλαμβάνονται στον πρώτο γύρο αδειοδοτήσεων ο οποίος προκηρύχτηκε το 2007 (**Σχήμα 1.1**). Η περιοχή έχει έκταση περίπου 51,000 km^2. Τα ερευνητικά τεμάχια έχουν έκταση από 1,436 ως 5,728 km^2 και βρίσκονται σε απόσταση από τις ακτές της Κύπρου μεταξύ 11km ως 178 km. Το βάθος της θάλασσας κυμαίνεται από 248 m έως 2866 m.



Σχήμα 1.1. Γεωγραφική τοποθεσία της υπό μελέτης περιοχής αδειοδότησης έρευνας υδρογονανθράκων (τμήμα της Κυπριακής Αποκλειστικής Οικονομικής Ζώνης)

Σύμφωνα με την Οδηγία 2001/42/ΕΚ, ο σκοπός των ΣΠΜ είναι να εντοπίσουν, περιγράψουν και να αξιολογήσουν τις «πιθανές» περιβαλλοντικές επιπτώσεις που μπορεί να προκύψουν από την υλοποίηση των σχεδίων ή/και των προγραμμάτων λαμβάνοντας υπόψη τους σκοπούς και το γεωγραφικό πεδίο τέτοιων σχεδίων ή/και προγραμμάτων. Επειδή στην υπό μελέτη περιοχή δεν έχει προηγηθεί καμία δραστηριότητα αναζήτησης, έρευνας και εκμετάλλευσης υδρογονανθράκων, δεν υπάρχει συγκεκριμένο σενάριο ανάπτυξης της περιοχής. Έτσι η παρούσα ΣΠΜ επικεντρώνεται στις δραστηριότητες που είναι πιθανόν να προκύψουν από το Πρόγραμμα Αδειοδότησης, συμπεριλαμβανομένων των προοπτικών, έρευνας και εκμετάλλευσης. Αναμένεται ότι λεπτομερείς Περιβαλλοντικές Μελέτες θα εκπονηθούν για κάθε σχέδιο έρευνας των υδρογονανθράκων.

Οι συγκεκριμένοι οι στόχοι της ΣΠΜ περιλαμβάνουν:

- Περιγραφή του συνόλου των δραστηριοτήτων που αφορούν στην έρευνα και εκμετάλλευση υδρογονανθράκων που μπορεί λογικά να διεξαχθούν μέσα στα όρια της περιοχής αδειοδότησης,

- Περιγραφή των υφισταμένων μέτρων ελέγχου των δραστηριοτήτων έρευνας και εκμετάλλευσης υδρογονανθράκων,

- Περίληψη των διαθέσιμων περιβαλλοντικών πληροφοριών και περιγραφή του περιβάλλοντος της περιοχής μελέτης,

- Προσδιορισμός των πιθανών περιβαλλοντικών επιπτώσεων που θα προκύψουν από τις δραστηριότητες έρευνας και εκμετάλλευσης υδρογονανθράκων. Αξιολόγηση των πιο σημαντικών περιβαλλοντικών επιπτώσεων,

- Εισηγήσεις για επιπρόσθετα διαχειριστικά μέτρα και μέτρα παρακολούθησης με σκοπό την διασφάλιση της προστασίας του περιβάλλοντος και την ορθολογιστική χρήση των φυσικών πόρων,

- Εντοπισμός των πιθανόν ελλείψεων σε στοιχεία ή/και ανακριβειών των υφισταμένων πληροφοριών τα οποία μπορούν να συμπληρωθούν στα πλαίσια επιπρόσθετων μελετών.

Η διαδικασία εκπόνησης της ΣΠΜ συμπεριλάμβανε την ανασκόπηση των νομοθετικών και κανονιστικών διατάξεων που έχουν σχέση με την υπεράκτια δραστηριότητα της έρευνας και εκμετάλλευσης υδρογονανθράκων μέσα στη περιοχή αδειοδότησης της Κυπριακής Δημοκρατίας, την βιβλιογραφική επισκόπηση όλων των περιβαλλοντικών δεδομένων που περιγράφουν την υφιστάμενη κατάσταση του περιβάλλοντος, την αξιολόγηση των πιθανών δραστηριοτήτων έρευνας και εκμετάλλευσης υδρογονανθράκων με βάση την θέση, τα χαρακτηριστικά του περιβάλλοντος και τις υφιστάμενες κοντινές βιομηχανικές εγκαταστάσεις, την ανάλυση των πιθανών περιβαλλοντικών επιπτώσεων και την πρόταση εισηγήσεων για την διαχείριση και την παρακολούθηση των δραστηριοτήτων έρευνας και εκμετάλλευσης υδρογονανθράκων.

1.2 ΠΡΟΓΡΑΜΜΑ ΑΔΕΙΟΔΟΤΗΣΗΣ ΚΑΙ ΝΟΜΟΘΕΤΙΚΟ ΠΛΑΙΣΙΟ

Η Κυπριακή Δημοκρατία αναθεώρησε πρόσφατα το εθνικό νομοθετικό της πλαίσιο έτσι ώστε να εναρμονίζεται με την Οδηγία 94/22/ΕΚ του Ευρωπαϊκού Κοινοβουλίου και του Συμβουλίου της 30 Μαΐου 1994 που έχει σχέση με τις συνθήκες υιοθέτησης και χρήσης των εξουσιοδοτήσεων για την αναζήτηση, έρευνα, εκμετάλλευση και παραγωγή υδρογονανθράκων. Οι εν λόγω δραστηριότητες υδρογονανθράκων διέπονται από τις παρακάτω νομοθεσίες:

- Ο περί Υδρογονανθράκων (Αναζήτηση, Έρευνα και Εκμετάλλευση) Νόμος Ν.4(Ι)/2007 – γνωστός ως ο περί Υδρογονανθράκων Νόμος του 2007.

- Οι περί Υδρογονανθράκων (Αναζήτηση, Έρευνα και Εκμετάλλευση) Κανονισμοί του 2007 – γνωστοί ως οι περί Υδρογονανθράκων Κανονισμοί του 2007.

Ο περί Υδρογονανθράκων Νόμος του 2007 προβλέπει τριών τύπων αδειοδοτήσεις για την αναζήτηση, έρευνα και εκμετάλλευση υδρογονανθράκων όπως αυτοί παρουσιάζονται στον Πίνακα 1.1.

Πίνακας 1.1. Είδη αδειοδότησης για υπεράκτιες δραστηριότητες έρευνας και εκμετάλλευσης υδρογονανθράκων.

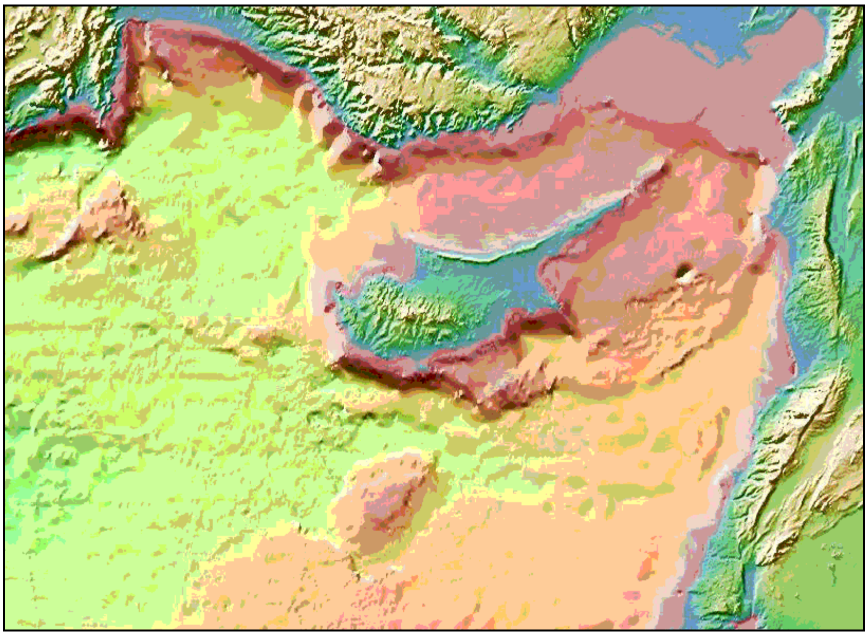
Είδος Αδειοδότησης	Πώς και Πότε εκδίδεται	Χαρακτηριστικά
Αναζήτηση	• Όπως αυτή προσδιορίζεται από το Υπουργείο Εμπορίου, Βιομηχανίας και Τουρισμού	• Εκδίδεται με διάρκεια μέχρι ένα χρόνο. • Αφορά την αξιολόγηση του πετρελαϊκού δυναμικού στην βάση του εντοπισμού γεωλογικών χαρακτηριστικών της περιοχής ενδιαφέροντος. • Συμπεριλαμβάνει βαρυτομετρικές, μαγνητικές και σεισμικές διασκορπίσεις. Δεν περιλαμβάνει γεωτρήσεις.
Έρευνα	• Μέσω προκηρύξεων αδειοδότησης ανοικτών προς όλους τους προσοντούχους διαγωνιζόμενους	• Εκδίδεται με διάρκεια τριών χρόνων με δυνατότητα δύο ανανεώσεων για δύο χρόνια η κάθε μια. • Συμπεριλαμβάνει, βαρυτομετρικές, μαγνητικές και σεισμικές διασκοπίσεις, καθώς επίσης και γεωτρήσεις. • Σε κάθε ανανέωση το 25% της αρχικής αδειοδοτημένης περιοχής εγκαταλείπεται
Εκμετάλλευση	• Στη περίπτωση ανακάλυψης υδρογονανθράκων, ο οργανισμός ο οποίος έχει αδειοδοτηθεί για έρευνα, έχει το δικαίωμα να λάβει άδεια και για την εκμετάλλευση των εν λόγω φυσικών πόρων	• Εκδίδεται για αρχική περίοδο μέχρι 25 ετών, αφού προηγηθεί η έγκριση του σχεδίου παραγωγής υδρογονανθράκων, και ανανεώνεται για ακόμη 10 έτη.

Άλλες νομοθετικές πράξεις συμπεριλαμβάνουν τον Περί της Συνορεύουσας Ζώνης Νόμο (63(Ι)2004) και τον Νόμο περί της Αποκλειστικής Οικονομικής Ζώνης (64(Ι)2004), οι οποίοι προσδιορίζουν τα σύνορα της Συνορεύουσας Ζώνης της δημοκρατίας και της οικονομικής της ζώνης. Επιπρόσθετα, η Κύπρος έχει υπογράψει διμερείς συμφωνίες με τη Αίγυπτο (2003) και τον Λίβανο (2007) προσδιορίζοντας τα σύνορα της αποκλειστικής οικονομικής ζώνης μεταξύ των εν λόγω χωρών. Η Κύπρος είναι μέλος διεθνών συμβάσεων και πρωτοκόλλων συμπεριλαμβανομένων της MARPOL και της Σύμβασης της Βαρκελώνης. Η Σύμβαση της Βαρκελώνης περιλαμβάνει και το πρωτόκολλο το οποίο προσδιορίζει τα μέτρα ελέγχου της έρευνας και εκμετάλλευσης υδρογονανθράκων. Το εν λόγω πρωτόκολλο έχει υιοθετηθεί στις 14 Οκτωβρίου 1994 στη Μαδρίτη. Μολονότι η Κύπρος υπέγραψε και επικύρωσε το εν λόγω πρωτόκολλο, δεν το έθεσε σε εφαρμογή αφού δεν έχει επικυρωθεί από τα απαιτούμενα ελάχιστα μέλη.

1.3 ΓΕΝΙΚΗ ΠΕΡΙΓΡΑΦΗ ΤΗΣ ΠΕΡΙΟΧΗΣ ΥΠΟ ΜΕΛΕΤΗ

Η παρούσα Περιβαλλοντική Έκθεση συμπεριλαμβάνει την περιγραφή της υφιστάμενης κατάστασης της περιοχής μελέτης που καλύπτει τον χώρο αδειοδότησης για την έρευνα και εκμετάλλευση υδρογονανθράκων. Οι επιπτώσεις στο περιβάλλον αναλύονται και μελετώνται ως επιπτώσεις στο φυσικό, βιολογικό, γεωλογικό και κοινωνικό-οικονομικό περιβάλλον της Κυπριακής Δημοκρατίας.

Το φυσικό περιβάλλον περιλαμβάνει τις μετεωρολογικές και ωκεανογραφικές συνθήκες της περιοχής, τα χαρακτηριστικά του θαλάσσιου βυθού **(Σχήμα 1.2**) και το υφιστάμενο περιβάλλον θορύβου.



Σχήμα 1.2. Μορφο-βαθυμετρία της Ανατολικής Μεσογείου συμπεριλαμβανομένων της Κύπρου και του Υποθαλάσσιου Όρους Ερατοσθένης (Scripps Institution of Oceanography, 2008).

Το βιολογικό περιβάλλον της περιοχής μελέτης περιλαμβάνει:

- Θαλάσσιο πλαγκτόν, το οποίο περιλαμβάνει το φυτοπλαγκτόν (χλωρίδα) το οποίο αποτελεί την βάση της τροφικής αλυσίδας και το ζωοπλαγκτόν (πανίδα) το οποίο λειτουργεί ως συνδετικός κρίκος μεταξύ του φυτικού κόσμου και της αναπαραγωγής των ψαριών,

- Βένθος, το οποίο συμπεριλαμβάνει την πανίδα (benthic fauna) και χλωρίδα που βρίσκεται στον πυθμένα της θάλασσας,

- Νηκτόν το οποίο περιλαμβάνει όλη την πανίδα αλλά κατ' εξοχήν τα μικρά είδη ψαριών που βρίσκονται στα νερά της περιοχής,

- Θαλάσσια είδη πτηνών και ειδικά αυτά τα είδη που αναφέρονται στο Σχέδιο Δράσης της Σύμβασης της Βαρκελώνης για την Προστασία Θαλάσσιων Πτηνών,

- Θαλάσσια θηλαστικά, χελώνες και άλλα προστατευμένα και απειλούμενα είδη,

- Περιοχές ειδικού ενδιαφέροντος όπως είναι Θαλάσσιες Προστατευμένες Περιοχές (Marine Protected Areas – MPA), το υποθαλάσσιο όρος Ερατοσθένης και πιθανές χημοσυνθετικές κοινότητες.

Τα σημαντικότερα θαλάσσια περιβαλλοντικά χαρακτηριστικά της περιοχής είναι η υψηλή αλατότητα των υδάτων και η υψηλή θερμοκρασία των επιφανειακών θαλάσσιων υδάτων σε σχέση με την υπόλοιπη Μεσόγειο, η χαμηλή συγκέντρωση θρεπτικών ουσιών και η χαμηλή παραγωγικότητα.

Το κοινωνικό-οικονομικό περιβάλλον αφορά στην γενική επισκόπηση των κυρίων κοινωνικό-οικονομικών χαρακτηριστικών σε σχέση με την παράκτια περιοχή της Κύπρου που μπορεί να επηρεαστεί από πιθανές δραστηριότητες για την έρευνα και εκμετάλλευση υδρογονανθράκων.

Οι οικονομικές δραστηριότητες που μελετήθηκαν περιλαμβάνουν:

- Την εμπορική αλιεία και την ψυχαγωγική ιστιοπλοΐα,
- Τις μονάδες ιχθυοκαλλιέργειας (Aquaculture),
- Την ναυτιλία και τις παράκτιες δραστηριότητες όπως είναι τα λιμάνια και οι σταθμοί αποθήκευσης πετρελαιοειδών (**Σχήμα 1.3**),
- Τις τηλεπικοινωνίες και ιδιαίτερα το υφιστάμενο και μελλοντικό δίκτυο υποβρυχίων καλωδίων,
- Την ψυχαγωγία και τον τουρισμό,
- Τους αρχαιολογικούς χώρους, και την αρχαία και πολιτιστική κληρονομιά.

Σχήμα 1.3. Κύρια Λιμάνια και Σταθμοί Αποθήκευσης Πετρελαιοειδών.

1.4 ΕΚΤΙΜΗΣΗ ΠΕΡΙΒΑΛΛΟΝΤΙΚΩΝ ΕΠΙΠΤΩΣΕΩΝ

Η αξιολόγηση των πιθανών περιβαλλοντικών επιπτώσεων αναφέρεται στις τρεις φάσεις υπεράκτιων δραστηριοτήτων για την έρευνα και εκμετάλλευση των υδρογονανθράκων:

- ***Αναζήτηση*** - δραστηριότητες για τον εντοπισμό των υδρογονανθράκων ή/και αξιολόγηση της δυνατότητας εξεύρεσης υδρογονανθράκων με μεθόδους εκτός από αυτών των γεωτρήσεων. Η εν λόγω έρευνα περιλαμβάνει την σεισμική, τη γεωλογική, την γεωχημική δειγματοληψία, την ηλεκτρομαγνητική έρευνα και την τηλεπισκόπηση,

- ***Έρευνα*** - διαδικασίες σε ένα ή περισσότερα διερευνητικά φρεάτια ανά αδειοτούμενο ερευνητικό τεμάχιο έτσι ώστε να καθοριστεί αν υπάρχουν εμπορικά εκμεταλλεύσιμες ποσότητες υδρογονανθράκων,

- ***Εκμετάλλευση*** (ανάπτυξη και παραγωγή) - διαδικασία για την εμπορική εκμετάλλευση των υδρογονανθράκων. Οι βασικές δραστηριότητες περιλαμβάνουν την διάνοιξη των φρεατίων ανάπτυξης, την δημιουργία των εγκαταστάσεων παραγωγής, την δημιουργία των εγκαταστάσεων εξαγωγής όπως το δίκτυο των σωληνώσεων, την λειτουργία αυτών των συστημάτων, και την τελική αποσυναρμολόγηση αυτών των εγκαταστάσεων.

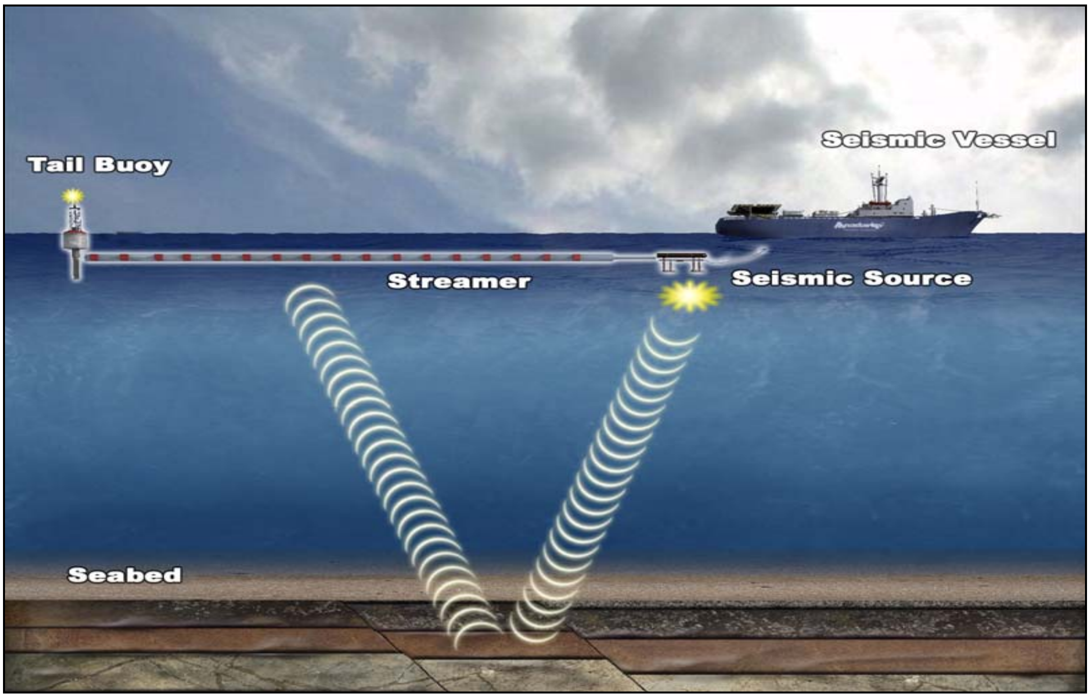
Οι περιβαλλοντικές επιπτώσεις εκτιμήθηκαν και αξιολογήθηκαν για κάθε μία από τις πιθανές πηγές περιβαλλοντικών προβλημάτων, που αναφέρονται ξεχωριστά στην κάθε φάση δραστηριοτήτων για την έρευνα και εκμετάλλευση των υδρογονανθράκων όπως παρουσιάζονται στον Πίνακα 1.2.

Πίνακας 1.2. Πηγές περιβαλλοντικών προβλημάτων για κάθε φάση των υπεράκτιων δραστηριοτήτων υδρογονανθράκων.

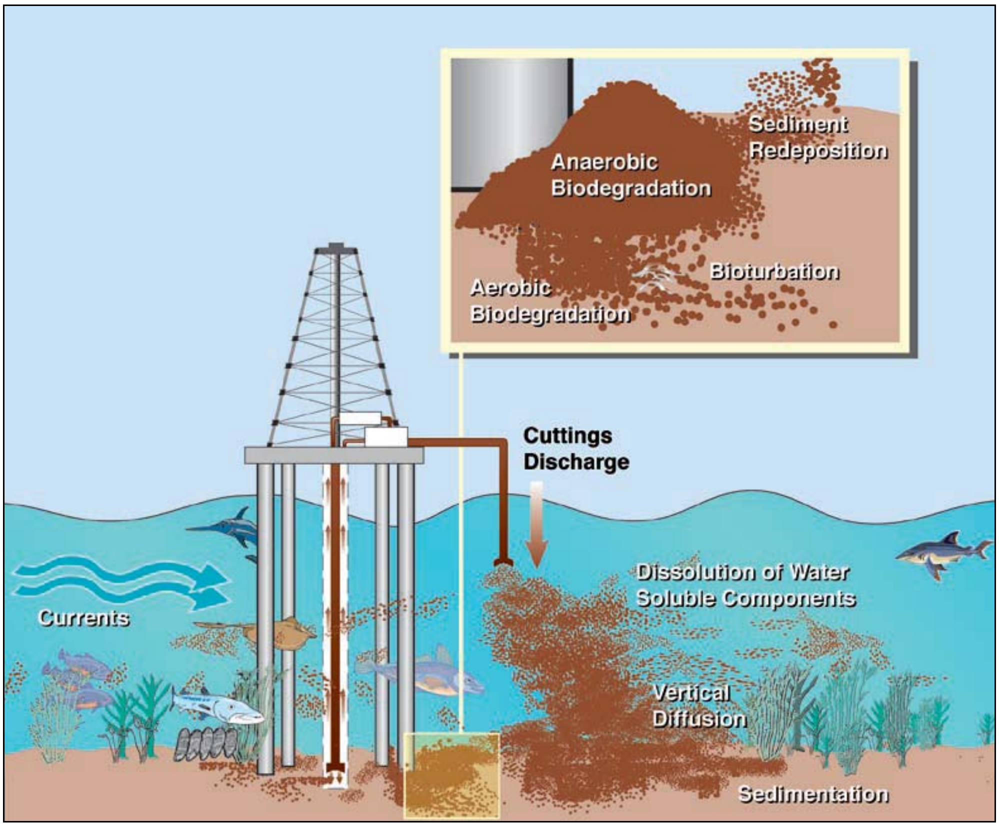
Αναζήτηση	**Έρευνα**	**Εκμετάλλευση**
• Θόρυβος • Κυκλοφορία σκαφών και ρυμουλκούμενος εξοπλισμός (towed streamers) • Απόρριψη αποβλήτων • Εκπομπές ατμοσφαιρικών ρυπών • Διαταραχή πυθμένα της θάλασσας	• Εργασίες εγκατάστασης και αποσυναρμολόγησης εξοπλισμού φρεατίων γεώτρησης • Φυσική παρουσία φρεατίων γεώτρησης • Απόρριψη αποβλήτων γεωτρήσεων • Απόρριψη άλλων αποβλήτων • Θαλάσσια συντρίμμια • Εκπομπές ατμοσφαιρικών ρύπων • Διεργασίες δοκιμής των γεωτρήσεων • Άλλες δραστηριότητες υποστήριξης	• Ανέγερση εγκαταστάσεων εκμετάλλευσης • Φυσική παρουσία εγκαταστάσεων εκμετάλλευσης • Απόρριψη αποβλήτων γεωτρήσεων • Απόρριψη αποβλήτων άλλων λειτουργικών δραστηριοτήτων • Θαλάσσια συντρίμμια • Εκπομπές ατμοσφαιρικών ρύπων • Δραστηριότητες υποστήριξης • Αποσυναρμολόγηση Κατασκευών

Ως παραδείγματα σημαντικών παραγόντων επίπτωσης στο περιβάλλον μπορούν να αναφερθούν η δημιουργία θορύβου κατά τη διάρκεια των σεισμικών ερευνών (Σχήμα 1.4), η δημιουργία και απόρριψη υγρών αποβλήτων κατά την διεξαγωγή των γεωτρήσεων και αποβλήτων εξόρυξης κατά τη διάρκεια της έρευνας και της εκμετάλλευσης (Σχήμα 1.5) αντίστοιχα, και τέλος η δημιουργία των εγκαταστάσεων παραγωγής στον πυθμένα θάλασσας (Σχήμα 1.6).

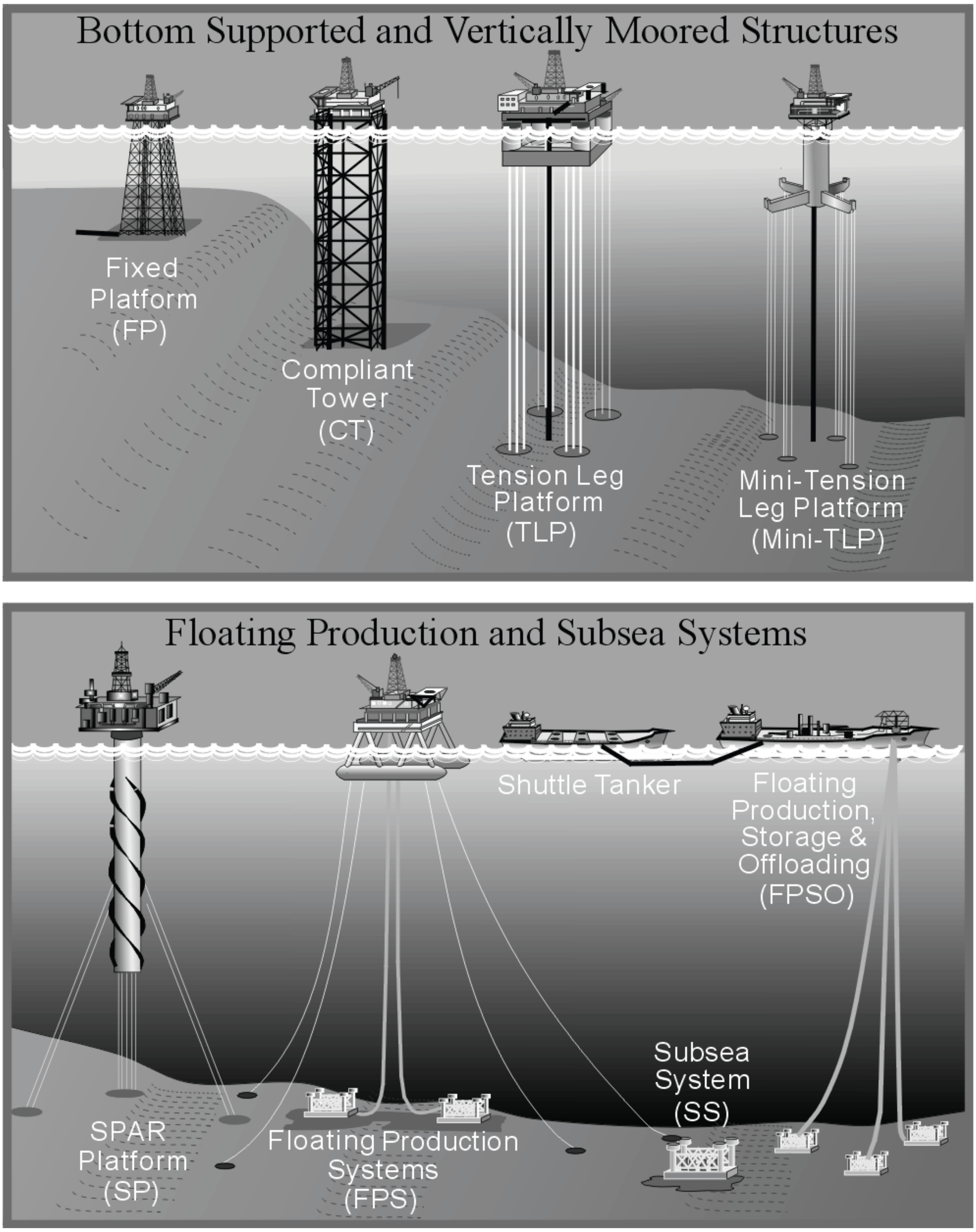
Ο Πίνακας 1.3 στην συνέχεια συνοψίζει τα πιθανά αποτελέσματα των υπεράκτιων δραστηριοτήτων της έρευνας και εκμετάλλευσης των υδρογονανθράκων στην περιοχή. Τα αποτελέσματα ομαδοποιούνται κατά φάση δραστηριότητας (αναζήτηση, έρευνα και εκμετάλλευση), και συνοδεύονται από μια χωριστή λίστα των πιθανών ατυχημάτων που μπορούν να συμβούν. Σε κάθε φάση, τα αποτελέσματα οργανώνονται με βάση τις πηγές των επιπτώσεων που αναφέρονται στην κάθε φάση. Ο πίνακας απαριθμεί επίσης τα αναγκαία μέτρα ελέγχου και μετριασμού των επιπτώσεων, ενώ για τις ενδεχομένως σημαντικές επιπτώσεις προτείνεται μια σειρά από πρόσθετα μέτρα μετριασμού.



Σχήμα 1.4. Απεικόνιση ενός σκάφους ερευνών που ρυμουλκεί μια σεισμική πηγή (airgun) και υποβρύχια υδρόφωνα. Ο ρυμουλκούμενος εξοπλισμός μπορεί να αναπτυχθεί σε απόσταση από 3 ως 12 χλμ πίσω από το σκάφος.



Σχήμα 1.5. Αποθέσεις αποβλήτων γεωτρήσεων κατά τη διάρκεια της έρευνας ή της εκμετάλλευσης (πηγή: Διεθνής Ένωση των Παραγωγών Πετρελαίου & Αερίου [OGP], 2003).



Σχήμα 1.6. Διαφορετικοί Τύποι Συστημάτων Εξόρυξης και Παραγωγής σε βαθιά νερά (Regg et al., 2000).

Πίνακας 1.3. Πιθανά αποτελέσματα από τις παράκτιες δραστηριότητες έρευνας και εκμετάλλευσης των υδρογονανθράκων στην περιοχή αδειοδότησης της Κυπριακής Δημοκρατίας.

Πηγή	Πιθανές Σημαντικές Επιπτώσεις	Μικρές ή αμελητέες επιπτώσεις	Υφιστάμενα Μέτρα Ελέγχου	Εισηγήσεις για Επιπρόσθετα Μέτρα Μετριασμού
Αναζήτηση				
Θόρυβος (Airgun)	Ακουστικό τραύμα στα θαλάσσια θηλαστικά και τις χελώνες (συμπεριλαμβανομένων των απειλούμενων, αυστηρά απειλούμενων και υπό εξαφάνιση ειδών)	Ενοχλήσεις των ψαριών, του πλαγκτόν και άλλων οργανισμών	Κανένα	Απαίτηση από τους κατόχους άδειας να εφαρμόσουν ένα πρωτόκολλο για την μείωση του κινδύνου πρόκλησης ακουστικού τραύματος στα θαλάσσια θηλαστικά και τις χελώνες. Το πρωτόκολλο πρέπει κατ' ελάχιστον να περιλαμβάνει πρόνοιες για ελεγχόμενη έναρξη (soft start), οπτικό έλεγχο (visual monitoring), και τερματισμό λειτουργίας (airgun shutdown).
Κυκλοφορία σκαφών και ρυμουλκούμενου εξοπλισμού (towed streamers)	Πιθανός επηρεασμός των αλιευτικών ή ναυτιλιακών δραστηριοτήτων (π.χ., προσωρινός αποκλεισμός από ορισμένες περιοχές, πρόκληση ζημίας σε εξοπλισμό αλιείας ή εμπλοκή)	Μικρός κίνδυνος συγκρούσεων σκαφών με θαλάσσια θηλαστικά ή χελώνες	Οι περί Υδρογονανθράκων Κανονισμοί του 2007 απαιτούν από τους κατόχους άδειας όπως εκτελούν τις εργασίες τους κατά τρόπο περιβαλλοντικά αποδεκτό και ασφαλή. Οι κάτοχοι άδειας πρέπει να ειδοποιούν τις θαλάσσιες αρχές της Κύπρου για τη θέση και το πρόγραμμα των ερευνών που διεξάγουν. Επίσης, τα ερευνητικά σκάφη πρέπει να χρησιμοποιούν τα κατάλληλα σήματα σύμφωνα με το διεθνές θαλάσσιο δίκαιο	Οι κάτοχοι άδειας θα πρέπει να συμβουλεύονται όλους όσους αφορά το ερευνητικό τους πρόγραμμα (stakeholders) έτσι ώστε να εξασφαλίζεται η αποφυγή επηρεασμού των αλιευτικών και ναυτιλιακών δραστηριοτήτων στην περιοχή διεξαγωγής των ερευνών.
Απόβλητα	Καμία	Μικρές επιπτώσεις στην ποιότητα των υδάτων όμοιες με αυτές που προκαλούνται από τα σκάφη που διακινούνται ήδη στην περιοχή	Συμμόρφωση με την MARPOL	Καμία
Ατμοσφαιρικοί ρύποι	Καμία	Μικρές επιπτώσεις στην ατμοσφαιρική ποιότητα όμοιες με αυτές που προκαλούνται από την υπάρχουσα κυκλοφορία σκαφών και αεροσκαφών στην περιοχή	Συμμόρφωση με την MARPOL	Καμία
Διαταραχή πυθμένα	Καμία	Μικρές διαταραχές του πυθμένα της θάλασσας λόγω της τοποθέτησης των καλωδίων ή των κιβωτίων δεκτών	Κανένα	Καμία

Πίνακας 1.3. (συνέχεια)

Πηγή	Πιθανές Σημαντικές Επιπτώσεις	Μικρές ή αμελητέες επιπτώσεις	Υφιστάμενα Μέτρα Ελέγχου	Εισηγήσεις για Επιπρόσθετα Μέτρα Μετριασμού
Έρευνα				
Δημιουργία και αποσυναρμολόγηση των εγκαταστάσεων των γεωτρήσεων	Πρόκληση βλαβών στα κοράλλια (π.χ., Seamount Eratosthenes), στις χημοσυνθετικές κοινότητες ή στα ιστορικά ναυάγια λόγω της τοποθέτησης των εγκαταστάσεων ή/και των αγκύρων	Πρόκληση βλάβης στο βένθος	Κανένα	Οι κάτοχοι άδειας πρέπει να αξιολογήσουν την περιοχή του προγράμματος για την παρουσία κοραλλιών των βαθιών νερών και χημοσυνθετικών (chemosynthetic) κοινοτήτων. Θα πρέπει να διατηρούν μια απόσταση ασφαλείας 100 m μεταξύ των σημείων παρουσίας των κοραλλιών ή των χημοσυνθετικών κοινοτήτων και της περιοχής δραστηριότητας που προκαλεί διαταραχές του πυθμένα της θάλασσας. Οι κάτοχοι θα πρέπει διαμέσου έρευνας τηλεπισκόπησης (remote sensing) να αξιολογήσουν τη περιοχή δραστηριότητας για παρουσία ναυαγίων και να υποβάλουν μια αρχαιολογική έκθεση αξιολόγησης από έναν καταρτισμένο θαλάσσιο αρχαιολόγο, συμπεριλαμβανομένων και των συστάσεων για περαιτέρω μελέτη
Παρουσία εγκαταστάσεων γεωτρήσεων (συμπεριλαμβανομένου του θορύβου και του φωτισμού)	Καμία	Οι εγκαταστάσεις γεωτρήσεων είναι πιθανόν να προσελκύσουν τα ψάρια και το πλαγκτόν. Ο θόρυβος μπορεί να αναγκάσει τα θαλάσσια θηλαστικά ή τις χελώνες να εγκαταλείψουν την περιοχή δραστηριότητας	Κανένα	Κανένα
Απόβλητα γεωτρήσεων	Αποτελέσματα επικάλυψης και ανοξίας σε κοράλλια (π.χ., Seamount Eratosthenes) ή στις χημοσυνθετικές (chemosynthetic) κοινότητες που βρίσκονται σε βάθος 500m	Αποτελέσματα επικάλυψης και ανοξίας στο μαλακό κατώτατο βένθος	Κανένα	Οι κάτοχοι άδειας θα πρέπει να αξιολογήσουν την περιοχή του προγράμματος τους για την πιθανή παρουσία κοραλλιών των βαθιών νερών και χημοσυνθετικών (chemosynthetic) κοινοτήτων, και να διατηρήσουν μια απόσταση ασφαλείας τουλάχιστον 500 m από οποιεσδήποτε γεωτρήσεις

Πίνακας 1.3. (συνέχεια)

Πηγή	Πιθανές Σημαντικές Επιπτώσεις	Μικρές ή αμελητέες επιπτώσεις	Υφιστάμενα Μέτρα Ελέγχου	Εισηγήσεις για Επιπρόσθετα Μέτρα Μετριασμού
Άλλα απόβλητα	Καμία	Μικρές επιπτώσεις στην ποιότητα των υδάτων πλησίον των εγκαταστάσεων των γεωτρήσεων, όμοιες με αυτές που προκαλούνται από την υφιστάμενη κυκλοφορία σκαφών στην περιοχή	Συμμόρφωση με την MARPOL	Καμία
Θαλάσσια συντρίμμια	Κίνδυνος θανάτου ή τραυματισμού των θαλάσσιων θηλαστικών, των χελωνών, ή και των πουλιών λόγω της πιθανής παγίδευσής τους στα απορριπτόμενα συντρίμμια	Επιδράσεις στην ποιότητα του νερού και των ακτών καθώς επίσης και του πυθμένα της θάλασσας	• Συμμόρφωση με την MARPOL • Οι περί Υδρογονανθράκων Κανονισμοί του 2007 απαιτούν όπως οι κάτοχοι άδειας εκτελέσουν τις δραστηριότητες αποκατάστασης περιοχών σύμφωνα με την ορθή διεθνή πρακτική της πετρελαϊκής βιομηχανίας	Καμία (θεωρείται ότι τα υφιστάμενα μέτρα είναι αποτελεσματικά για την αποφυγή σημαντικών επιπτώσεων)
Ατμοσφαιρικοί ρύποι	Καμία	Μικρές επιπτώσεις στην ατμοσφαιρική ποιότητα, παρόμοιες με αυτές που προκαλούνται από την υφιστάμενη κυκλοφορία σκαφών και αεροσκαφών στην περιοχή	Συμμόρφωση με την MARPOL	Καμία
Δοκιμές γεωτρήσεων	Η συγκέντρωση σταγονιδίων πετρελαίου λόγω ελλιπούς καύσης μπορεί να προκαλέσει την δημιουργία φιλμ στην επιφάνεια της θάλασσας	Μικρές επιπτώσεις στην ποιότητα του αέρα	Συμμόρφωση με την MARPOL	Οι κάτοχοι άδειας θα πρέπει να χρησιμοποιούν καυστήρες υψηλής απόδοσης για να ελαχιστοποιήσουν την δημιουργία αέριων εκπομπών, όπως επίσης και να παρακολουθούν και να ελέγχουν την δημιουργία φιλμ στην επιφάνεια της θάλασσας

Πίνακας 1.3. (συνέχεια)

Πηγή	Πιθανές Σημαντικές Επιπτώσεις	Μικρές ή αμελητέες επιπτώσεις	Υφιστάμενα Μέτρα Ελέγχου	Εισηγήσεις για Επιπρόσθετα Μέτρα Μετριασμού
Βοηθητικές δραστηριότητες	Ελικόπτερα που πετούν πάνω από τις Σημαντικές Περιοχές Πτηνών (IBAs) θα μπορούσαν να προκαλέσουν ενοχλήσεις στα παράκτια πουλιά	Ο κίνδυνος συγκρούσεων σκαφών με θαλάσσια θηλαστικά ή χελώνες είναι μικρός	Κανένα	Πρέπει να δίνονται οι απαραίτητες υποδείξεις στους κατόχους άδειας ώστε να αποφεύγονται οι πτήσεις πάνω από τις Σημαντικές Περιοχές Πτηνών (IBAs).
Εκμετάλλευση				
Ανέγερση Εγκαταστάσεων	Πρόκληση βλαβών στα κοράλλια (π.χ., Seamount Eratosthenes), στις χημοσυνθετικές κοινότητες ή στα ιστορικά ναυάγια λόγω της τοποθέτησης των εγκαταστάσεων ή/και των αγκύρων	Φυσική ζημιά στο βένθος	Κανένα	Οι κάτοχοι άδειας πρέπει να αξιολογήσουν την περιοχή της εκμετάλλευσης για την παρουσία κοραλλιών των βαθιών νερών και χημοσυνθετικών (chemosynthetic) κοινοτήτων. Θα πρέπει να διατηρούν μια απόσταση ασφαλείας 100 m μεταξύ των σημείων παρουσίας κοραλλιών ή χημοσυνθετικών κοινοτήτων και της περιοχής δραστηριότητας που προκαλεί διαταραχές του πυθμένα της θάλασσας (συμπεριλαμβανομένων των αγκυρώσεων, των εγκαταστάσεων στον πυθμένα και της κατασκευή του δικτύου των σωληνώσεων). Οι κάτοχοι θα πρέπει διαμέσου έρευνας τηλεπισκόπησης (remote sensing) να αξιολογήσουν τη περιοχή δραστηριότητας για παρουσία ναυαγίων και να υποβάλουν μια αρχαιολογική έκθεση αξιολόγησης από έναν καταρτισμένο θαλάσσιο αρχαιολόγο, συμπεριλαμβανομένων και των συστάσεων για περαιτέρω μελέτη
Παρουσία εγκαταστάσεων	Καμία	Οι εγκαταστάσεις γεωτρήσεων είναι πιθανόν να προσελκύσουν τα ψάρια και το πλαγκτόν. Ο θόρυβος μπορεί να αναγκάσει τα θαλάσσια θηλαστικά ή τις χελώνες να εγκαταλείψουν την περιοχή	Κανένα	Κανένα

Πίνακας 1.3. (συνέχεια)

Πηγή	Πιθανές Σημαντικές Επιπτώσεις	Μικρές ή αμελητέες επιπτώσεις	Υφιστάμενα Μέτρα Ελέγχου	Εισηγήσεις για Επιπρόσθετα Μέτρα Μετριασμού
Απόβλητα γεωτρήσεων	Αποτελέσματα επικάλυψης και ανοξίας σε κοράλλια (π.χ., Seamount Eratosthenes) ή τις χημοσυνθετικές (chemosynthetic) κοινότητες που βρίσκονται σε βάθος 500m	Αποτελέσματα επικάλυψης και ανοξίας στο μαλακό κατώτατο βένθος	Κανένα	Οι κάτοχοι άδειας θα πρέπει να αξιολογήσουν την περιοχή εκμετάλλευσης για την πιθανή παρουσία κοραλλιών των βαθιών νερών και χημοσυνθετικών (chemosynthetic) κοινοτήτων, και να διατηρήσουν μια απόσταση ασφαλείας τουλάχιστον 500 m από οποιεσδήποτε απόβλητα γεωτρήσεων
Απόβλητα κατά την διάρκεια λειτουργίας	Καμία	Μικρές επιπτώσεις στην ποιότητα του νερού που βρίσκεται κοντά στις εγκαταστάσεις, παρόμοιες με αυτές που προκαλούνται από την υφιστάμενη κυκλοφορία σκαφών στην περιοχή	Συμμόρφωση με την MARPOL	Κανένα
Θαλάσσια συντρίμμια	Κίνδυνος θανάτου ή τραυματισμού για τα θαλάσσια θηλαστικά, τις χελώνες, ή τα πουλιά λόγω της κατάποσης ή παγίδευσης τους σε συντρίμμια που μπορεί να έχουν απορριφθεί λόγω ατυχήματος ή μη σωστά εφαρμοζόμενων πρακτικών	Επιδράσεις στην ποιότητα του νερού, στις ακτές και τον πυθμένα της θάλασσας.	Συμμόρφωση με την MARPOL Οι περί Υδρογονανθράκων Κανονισμοί του 2007 απαιτούν όπως οι κάτοχοι άδειας εκτελέσουν τις δραστηριότητες αποκατάστασης περιοχών σύμφωνα με την ορθή διεθνή πρακτική της βιομηχανίας πετρελαίου	Καμία (θεωρείται ότι τα υφιστάμενα μέτρα είναι αποτελεσματικά για την αποφυγή σημαντικών επιπτώσεων)
Ατμοσφαιρικοί ρύποι	Καμία	Μικρές επιπτώσεις στην ατμοσφαιρική ποιότητα, παρόμοιες με αυτές που προκαλούνται από την κυκλοφορία σκαφών και αεροσκαφών στην περιοχή	Συμμόρφωση με την MARPOL	Κανένα
Βοηθητικές δραστηριότητες	Ελικόπτερα που πετούν πάνω από τις Σημαντικές Περιοχές Πτηνών (IBAs) θα μπορούσαν να προκαλέσουν ενοχλήσεις στα παράκτια πουλιά	Ο κίνδυνος συγκρούσεων σκαφών με θαλάσσια θηλαστικά ή χελώνες είναι μικρός	Κανένα	Πρέπει να δίνονται οι απαραίτητες υποδείξεις στους κατόχους άδειας ώστε να αποφεύγονται οι πτήσεις πάνω από τις Σημαντικές Περιοχές Πτηνών (IBAs).

Πίνακας 1.3. (συνέχεια)

Πηγή	Πιθανές Σημαντικές Επιπτώσεις	Μικρές ή αμελητέες επιπτώσεις	Υφιστάμενα Μέτρα Ελέγχου	Εισηγήσεις για Επιπρόσθετα Μέτρα Μετριασμού
Αποσυναρμολόγηση και απομάκρυνση των Εγκαταστάσεων	Πιθανός θάνατος ή πρόκληση βλάβης σε θαλάσσια θηλαστικά ή χελώνες (συμπεριλαμβανομένων των απειλούμενων, αυστηρά απειλούμενων, και υπό εξαφάνιση ειδών) από τη χρήση εκρηκτικών υλών	Θάνατος ή βλάβη σε ψάρια και άλλη θαλάσσια ζωή κοντά στις αποσυναρμολογούμενες εγκαταστάσεις	Κανένα	Θα πρέπει να εφαρμοστεί κατάλληλο πρωτόκολλο για την προστασία των θαλασσίων θηλαστικών και των χελωνών κατά τη διάρκεια της αποσυναρμολόγησης και απομάκρυνσης των εγκαταστάσεων σύμφωνα με τις πρόνοιες της διεθνούς καλής πρακτικής.
Ατυχήματα				
Διαρροές πετρελαίου που περιλαμβάνουν • Διαρροή αργού πετρελαίου λόγω έκρηξης • Διαρροή πετρελαίου diesel • Διαρροή πετρελαίου από τα φρεάτια γεωτρήσεων • Διαρροή υγρών από τον εξοπλισμό των καλωδίων (Streamer cable)	Ανάλογα με το μέγεθος και τη φύση των διαρροών, τα αποτελέσματα θα μπορούσαν να περιλάβουν την παραβίαση των προτύπων ποιότητας του νερού, τη μόλυνση των ιζημάτων, το θάνατο ή πρόκληση βλάβης των θαλασσίων θηλαστικών, των χελωνών, και των πουλιών, τη ρύπανση παράκτιων βιότοπων συμπεριλαμβανομένων και των παραλιών και τον περιορισμό δραστηριοτήτων αλιείας, ναυτιλίας, αναψυχής, και τουρισμού κατά τη διάρκεια των διαδικασιών καθαρισμού	• Τοπικές επιπτώσεις στην ατμοσφαιρική ποιότητα λόγω της αεριοποίησης των υδρογονανθράκων • Επιπτώσεις στο μαλακό κατώτατο βένθος γύρω από τις γεωτρήσεις σε περίπτωση υποθαλάσσιας έκρηξης ή διαρροής υγρών των εγκαταστάσεων γεώτρησης.	• Η MARPOL απαιτεί την εφαρμογή Σχεδίου Έκτακτης Ανάγκης αντιμετώπισης της Ρύπανσης από διαρροές υδρογονανθράκων • Οι περί Υδρογονανθράκων Κανονισμοί του 2007 απαιτούν από τους κατόχους άδειας να: (1) έχουν ένα εγκεκριμένο σχέδιο αντιμετώπισης διαρροών υδρογονανθράκων (2) να είναι σε θέση να ανταποκριθούν σε περίπτωση ατυχήματος, χρησιμοποιώντας όλα τα απαραίτητα μέτρα σύμφωνα με τις γενικά αποδεκτές πρακτικές που εφαρμόζονται στη διεθνή βιομηχανία πετρελαίου	Η προσομοίωση της διασποράς της διαρροής (oil spill trajectory modeling) πρέπει να εκπονείται με τρόπο που να βοηθά στην κατανόηση των επιπτώσεων μιας διαρροής υδρογονανθράκων στις διάφορες θέσεις της περιοχής αδειοδότησης, τους περιβαλλοντικούς πόρους που ενδεχομένως επηρεασθούν και τους ελάχιστους χρόνους ανταπόκρισης
Απελευθέρωση Υδρόθειου (H_2S)	Παραβίαση των προτύπων ποιότητας της ατμόσφαιρας Πιθανή πρόκληση θανάτου ή βλάβης σε ανθρώπινες ζωές στις υπεράκτιες εγκαταστάσεις και τα παρακείμενα ύδατα Πιθανή πρόκληση θανάτου ή βλάβης σε είδη της άγριας φύσης συμπεριλαμβανομένων των πτηνών	Καμία	Στο πλαίσιο των περί Υδρογονανθράκων Κανονισμών του 2007, οι κάτοχοι άδειας πρέπει για να υποβάλουν μια έκθεση εγκατάστασης φρεατίων, συμπεριλαμβανομένων των γεωλογικών και γεωφυσικών πληροφοριών και χαρακτηριστικών, όπως επίσης και των μέτρων ασφάλειας που εφαρμόζονται κατά την γεώτρηση.	• Οι κάτοχοι άδειας θα πρέπει να υποβάλουν όλες τις σχετικές πληροφορίες για τα αναμενόμενα επίπεδα H_2S για τα προτεινόμενες γεωτρήσεις (drill sites) ως μέρος της διαδικασίας έγκρισης για τις δραστηριότητες γεώτρησης. • Όπου υφίσταται σημαντικός κίνδυνος εντοπισμού H_2S κατά τη εκτέλεση των διαδικασιών, οι κάτοχοι άδειας θα πρέπει να υποβάλουν ένα σχέδιο δράσης για την αντιμετώπιση των πιθανών προβλημάτων και επιπτώσεων

MARPOL = Διεθνής Συνθήκη για την Πρόληψη της Ρύπανσης από τα Σκάφη

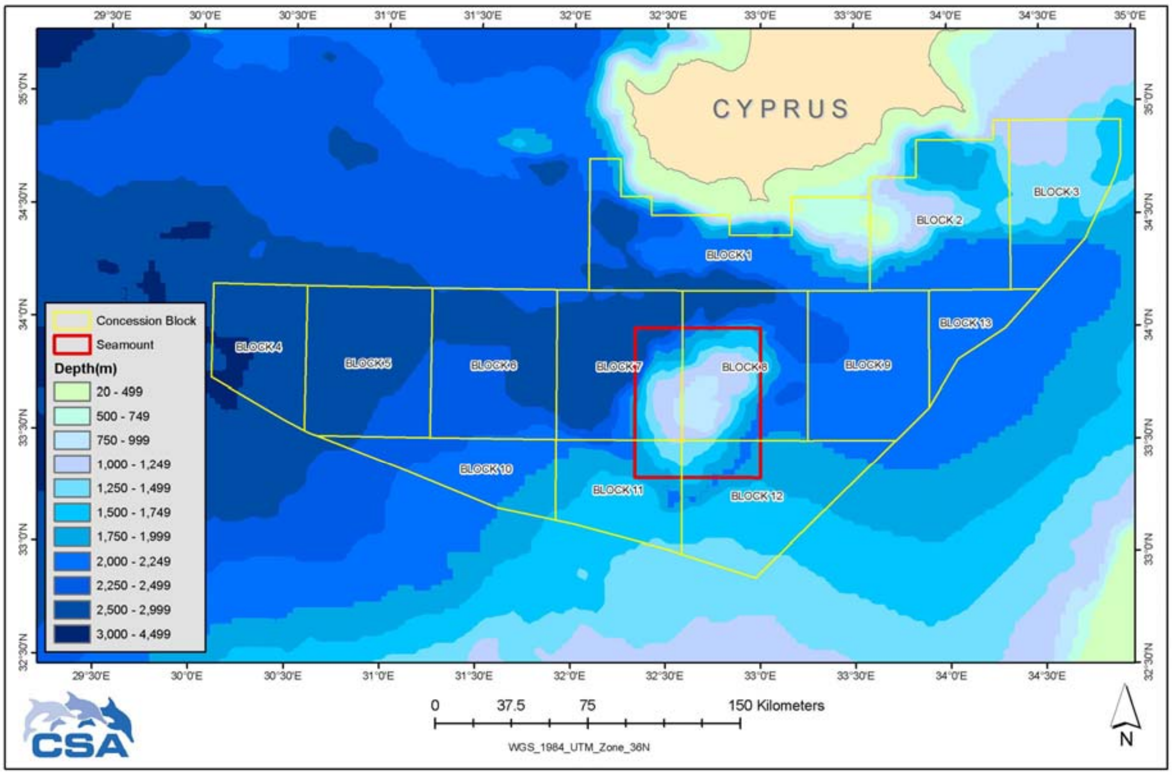
1.5 ΣΥΜΠΕΡΑΣΜΑΤΑ ΚΑΙ ΕΙΣΗΓΗΣΕΙΣ

1.5.1 Κύρια Συμπεράσματα και Εισηγήσεις

Τα ακόλουθα συμπεράσματα και εισηγήσεις είναι βασισμένα στις πιθανά σημαντικές επιπτώσεις όπως αυτές προσδιορίστηκαν κατά την εκπόνηση της ΣΠΜ. Κάθε «επίπτωση» αναφέρεται σε μία πηγή και τους πιθανά επηρεαζόμενους πόρους.

Επίπτωση #1 Επιπτώσεις στα κοράλλια (Eratosthenes Seamount) από τις διαταραχές στον πυθμένα της θάλασσας και τα απόβλητα των διατρήσεων

Το υποθαλάσσιο κοραλλιογενές όρος (Eratosthenes Seamount) βρίσκεται κοντά στο κέντρο της περιοχής αδειοδοτήσεων και καλύπτει μέρος των τμημάτων 7, 8, 11 and 12 (**Εικόνα 1.7**). Το υποθαλάσσιο όρος έχει μήκος 120 km και πλάτος 80 km. Υψώνεται σε ύψος περίπου 2000 m από τον πυθμένα φθάνοντας στα 690 m από τη επιφάνεια της θάλασσας. Παρόλο που η γεωλογική μορφολογία του υποθαλάσσιου όρους έχει μελετηθεί εκτενώς, πολύ λίγες πληροφορίες είναι διαθέσιμες αναφορικά με τα βιολογικά του χαρακτηριστικά.



Σχήμα 1.7. Γεωγραφική τοποθεσία του υποθαλάσσιου όρους Ερατοσθένης. Τα όρια της σημειωμένης με κόκκινο περιμέτρου είναι 33°20’ μέχρι 34°Β γεωγραφικό μήκος και 32°20’ μέχρι 33°Α γεωγραφικό πλάτος.

Η μόνη βιολογική μελέτη του υποθαλάσσιου όρους περιγράφει την παρουσία ποικίλης και πλούσιας πανίδας και την παρουσία σπανίων ειδών κοραλλιών βαθέων νερών καθώς επίσης και την παρουσία είδους γαρίδας μεγάλης εμπορικής σημασίας . Η ποικιλία της πανίδας σημειώνει τα ιδιαίτερα και ξεχωριστά περιβαλλοντικά χαρακτηριστικά του εν λόγω υποθαλάσσιου όρους που πιθανόν να αποτελεί σήμερα καταφύγιο για πολλά είδη τα οποία έχουν αφανιστεί από την ηπειρωτική γραμμή. Γίνεται εισήγηση για επιπρόσθετες περιβαλλοντικές μελέτες με σκοπό την συμπλήρωση και ολοκλήρωση των βιολογικών χαρακτηριστικών του εν λόγω όρους.

Το υποθαλάσσιο όρος Eratosthenes δεν υπάγεται σε οποιαδήποτε επίσημο καθεστώς προστασίας. Εντούτοις το έτος 2006 μέσα στα πλαίσια του Γενικού Συμβουλίου για την Αλιεία της Μεσογείου (General Fisheries Council for the Mediterranean - GFCM) έχει γίνει εισήγηση όπως απαγορευτεί η βενθοπελαγική αλιεία με τράτες βυθού στο εν λόγω όρος. Το Συμβούλιο της Ευρώπης έκανε πρόταση για Κανονισμό που αποσκοπεί στη προστασία των ευπαθών οικοσυστημάτων όπως είναι οι κοραλλιογενείς ύφαλοι, τα υποθαλάσσια όρη, τα κοράλλια βαθιών νερών, τα υποθερμικά ρεύματα (vents) και τα σφουγγάρια στο πυθμένα της θάλασσας. Ο Κανονισμός αυτός υιοθετήθηκε από το Ευρωπαϊκό Κοινοβούλιο το έτος 2008.

Κατά την διάρκεια των δραστηριοτήτων για την έρευνα και εκμετάλλευση υδρογονανθράκων, τα κοράλλια θα υποστούν φυσική φθορά από τις διάφορες αγκυροβολήσεις, την εγκατάσταση του εξοπλισμού παραγωγής στον πυθμένα της θάλασσας και από την εγκατάσταση των σωληνώσεων. Επειδή η ανάπτυξη των εν λόγω κοραλλιών δεν εξαρτάται από το φως του ήλιου, δεν θα υποστούν σοβαρή βλάβη από την απουσία φωτός (light occlusion) λόγω της θολότητας που θα προκαλέσουν τα απόβλητα των γεωτρήσεων. Παρόλα αυτά μπορεί να υποστούν σημαντικές επιπτώσεις ή ακόμα και να καλυφθούν από τα απόβλητα που θα προκύψουν από τις γεωτρήσεις (λάσπη).

Οι πιο σημαντικές επιπτώσεις κατά την έρευνα κα εκμετάλλευση των υδρογονανθράκων στα κοράλλια βαθιών νερών που βρίσκονται στο υποθαλάσσιο όρος Ερατοσθένης (Eratosthenes Seamount) μπορεί να αποφευχθούν υπό την προϋπόθεση ότι θα απαιτηθεί από τους κατόχους αδειών να εκπονήσουν μελέτες μετριασμού των επιπτώσεων σε κάθε σημείο δραστηριότητας. Αυτό αποτελεί και τη βάση της ακόλουθης εισήγησης

<u>Εισήγηση</u> – πριν από τη έναρξη των δραστηριοτήτων που περιλαμβάνουν την διάνοιξη γεωτρήσεων, τις αγκυρώσεις στον πυθμένα του εξοπλισμού, την δημιουργία των φρεατίων εξόρυξης ή/ και των εγκαταστάσεων παραγωγής στον πυθμένα θάλασσας, και την εγκατάσταση των σωληνώσεων, οι κάτοχοι άδειας πρέπει να χρησιμοποιήσουν σεισμικά δεδομένα υψηλής ανάλυσης (δηλ., geohazards), τρισδιάστατα σεισμικά στοιχεία ερευνών, και οποιεσδήποτε άλλες διαθέσιμες πληροφορίες, έτσι ώστε να προσδιορίσουν τις περιοχές του πυθμένα που μπορούν να υποστηρίξουν κοινότητες κοραλλιών. Εάν εντοπιστούν οποιεσδήποτε από τις εν λόγω κοινότητες, οι κάτοχοι άδειας θα πρέπει να διεξαγάγουν προσομοιώσεις διασποράς της λάσπης και των αποβλήτων (muds and cuttings discharge modeling) ούτως ώστε να προσδιοριστεί η απόσταση ασφαλείας που θα προστατεύσει τις εν λόγω κοινότητες κοραλλιών. Σε άλλες περιοχές του κόσμου (π.χ. στον κόλπο του Μεξικού), οι κάτοχοι άδειας είναι υπόχρεοι να τηρούν απόσταση ασφαλείας τουλάχιστο 500m από κάθε προτεινόμενο σημείο γεώτρησης και σημείο απόρριψης αποβλήτων, και 100 m από κάθε άλλη πιθανή θέση διατάραξης του πυθμένα της θάλασσας (όπως είναι αγκυροβολήσεις, αλυσίδες αγκύρων, σχοινιά, σύρματα, σωλήνες κλπ.) (MMS, 2004). Η περιοχή του υποθαλάσσιου όρους Ερατοσθένης (Eratosthenes Seamount) ορίζεται από τις 33° έως 34°Β γεωγραφικό μήκος και 32° έως 33°Α γεωγραφικό πλάτος.

Επίπτωση #2 Επιπτώσεις στις Χημοσυνθετικές Κοινότητες (Chemosynthetic Communities) λόγω διαταράξεων του Θαλάσσιου Πυθμένα και απόρριψης αποβλήτων των Γεωτρήσεων

Οι χημοσυνθετικές κοινότητες (Chemosynthetic) είναι σπάνιες και βρίσκονται συχνά σε βαθιά νερά υψηλής πυκνότητας με μειωμένη δραστηριότητα φωτοσύνθεσης. Οι εν λόγω κοινότητες βασίζονται στα συμβιωτικά βακτηρίδια που οξειδώνουν ενώσεις όπως το H_2S και το μεθάνιο. Στα βάθη όπου δεν υπάρχει φωτοσύνθεση και όπου εμφανίζονται εκλύσεις υδρογονανθράκων, υδροθερμικά ρεύματα και άλλες γεωλογικές διαδικασίες, οι εν λόγω κοινότητες (chemosynthesis) μπορούν να αποτελέσουν το κυρίαρχο στοιχείο του οικοσυστήματος.

Η ύπαρξη των χημοσυνθετικών κοινοτήτων (chemosynthetic) στην περιοχή αδειοδότησης δεν έχει τεκμηριωθεί, αλλά υπάρχει η πιθανότητα ύπαρξής τους στην εν λόγω περιοχή. Οι χάρτες από το πρόγραμμα HERMES (**H**otspot **E**cosystems **R**esearch on the **M**argins of **E**uropean **S**eas) παρουσιάζουν διάφορους τέτοιους βιότοπους στην ανατολική Μεσόγειο. Επιπλέον, πρόσφατες ακουστικές έρευνες έχουν τεκμηριώσει τη παρουσία ηφαιστειογενούς λάσπης και ροής λάσπης κατά μήκος του «τόξου» της Κύπρου, το οποίο βρίσκεται ανάμεσα στο υποθαλάσσιο όρος Ερατοσθένης (Eratosthenes) και των ακτών της Κύπρου. Αυτά τα χαρακτηριστικά του θαλάσσιου πυθμένα είναι ενδεικτικά των συνθηκών που μπορούν να υποστηρίξουν την παρουσία χημοσυνθετικών κοινοτήτων (chemosynthetic communities).

Κατά τη διεξαγωγή των δραστηριοτήτων έρευνας και εκμετάλλευσης υδρογονανθράκων οι χημοσυνθετικές κοινότητες είναι ευπαθείς σε φυσικές καταστροφές από τις αγκυροβολήσεις, την εγκατάσταση του εξοπλισμού παραγωγής στον πυθμένα της θάλασσας και την εγκατάσταση του δικτύου των σωληνώσεων. Επειδή οι εν λόγω κοινότητες δεν εξαρτώνται από το φως του ήλιου, δεν θα υποστούν σοβαρή ζημιά εξαιτίας της θολότητας που θα προκαλέσουν τα απόβλητα των γεωτρήσεων. Όμως οι κοινότητες αυτές μπορούν να επηρεαστούν ή και να θαφτούν από τα απόβλητα που θα προκύψουν από τις γεωτρήσεις (π.χ. λάσπη).

Οι εν λόγω κοινότητες θεωρούνται ως περιβαλλοντικά ευαίσθητες και αναγνωρίζονται από την Ευρωπαϊκή Κοινότητα ως βιότοποι που χρήζουν προστασίας. Η ΣΠΜ δεν προσδιόρισε οποιοδήποτε νομοθετικό πλαίσιο σε κοινοτικό ή εθνικό επίπεδο που να προστατεύει συγκεκριμένα τις χημοσυνθετικές κοινότητες (chemosynthetic) από πιθανές επιπτώσεις από την έρευνα και εκμετάλλευση υδρογονανθράκων. Παρόλη την έλλειψη νομοθετικού πλαισίου, μπορεί να καθοριστεί ένα πλαίσιο δράσης με βάση την εμπειρία που απορρέει από συναφείς δραστηριότητες σε άλλες περιοχές όπως είναι ο κόλπος του Μεξικού όπου χημοσυνθετικές κοινότητες έχουν ανακαλυφθεί κοντά σε περιοχές έρευνας και εκμετάλλευσης υδρογονανθράκων. Μελέτες στον κόλπο του Μεξικού έχουν δείξει ότι η παρουσία των χημοσυνθετικών κοινοτήτων συνδέεται άμεσα με συγκεκριμένα και αναγνωρίσιμα γεωφυσικά χαρακτηριστικά έτσι ώστε να είναι σχετικά εύκολη αποτελεσματική προστασία τους.

Εισήγηση – Οι κάτοχοι άδειας που προτίθενται να εμπλακούν σε δραστηριότητες έρευνας και εκμετάλλευσης στη περιοχή αδειοδότησης, οι οποίες περιλαμβάνουν την διάνοιξη γεωτρήσεων, τις αγκυρώσεις του εξοπλισμού στον πυθμένα της θάλασσας, την δημιουργία των φρεατίων εξόρυξης ή/ και των εγκαταστάσεων παραγωγής στον πυθμένα θάλασσας, και την εγκατάσταση των σωληνώσεων, πρέπει να χρησιμοποιήσουν σεισμικά δεδομένα υψηλής ανάλυσης (δηλ., geohazards), τρισδιάστατα σεισμικά στοιχεία ερευνών, και οποιεσδήποτε άλλες διαθέσιμες πληροφορίες, έτσι ώστε να προσδιορίσουν τα γεωλογικά χαρακτηριστικά τα οποία μπορούν να υποστηρίξουν μεγάλη ποικιλία χημοσυνθετικών κοινοτήτων. Στην περίπτωση εντοπισμού τέτοιων γεωλογικών χαρακτηριστικών, οι κάτοχοι άδειας πρέπει να εφαρμόσουν αποστάσεις ασφαλείας τουλάχιστον 500m από κάθε προτεινόμενο σημείο γεώτρησης και σημείο απόρριψης αποβλήτων, και 100 m από κάθε άλλη πιθανή θέση διατάραξης του πυθμένα της θάλασσας (όπως είναι αγκυροβολήσεις, αλυσίδες αγκύρων, σχοινιά, σύρματα, σωλήνες κλπ.)

Επίπτωση #3 Επιπτώσεις στα Ναυάγια και στους Υποβρυχίους Αρχαιολογικούς Χώρους λόγω Διαταράξεων του Πυθμένα

Η περιοχή αδειοδότησης βρίσκεται σε περιοχή όπου είναι πιθανή η ύπαρξη ιστορικών ναυαγίων και υποβρύχιου αρχαιολογικού πλούτου. Τα παραπάνω είναι ευπαθή σε φυσικές καταστροφές λόγω διατάραξης του πυθμένα από δραστηριότητες όπως αγκυροβόληση, εγκατάσταση του εξοπλισμού παραγωγής και εγκαταστάσεων σωλήνων.

Η ΣΠΜ δεν εντόπισε οποιοσδήποτε εθνικό νομοθετικό πλαίσιο ή κατευθυντήριες γραμμές ειδικά σχεδιασμένες για την προστασία ναυαγίων και υποβρύχιου αρχαιολογικού πλούτου. Με βάση την εμπειρία από σχετικές δραστηριότητες στον Κόλπο του Μεξικού, (μια περιοχή όπου έχουν ανακαλυφθεί πολλά ναυάγια κοντά σε περιοχές όπου διεξάγεται εκμετάλλευση υδρογονανθράκων) αυτοί οι πόροι μπορούν να προστατευτούν με την διεξαγωγή ερευνών τηλεπισκόπησης (remote sensing surveys) και την εκπόνηση αρχαιολογικών μελετών του πυθμένα. Οι εν λόγω αρχαιολογικές έρευνες και αξιολογήσεις εκπονούνται παράλληλα με άλλες μελέτες πριν τη έναρξη των δραστηριοτήτων της εκμετάλλευσης των υδρογονανθράκων.

Εισήγηση – πριν από τη έναρξη των δραστηριοτήτων που περιλαμβάνουν την διάνοιξη γεωτρήσεων, τις αγκυρώσεις του εξοπλισμού στον πυθμένα της θάλασσας, την δημιουργία των φρεατίων εξόρυξης ή/ και των εγκαταστάσεων παραγωγής στον πυθμένα θάλασσας, και την εγκατάσταση των σωληνώσεων, οι κάτοχοι άδειας θα πρέπει να εκπονήσουν έρευνες τηλεπισκόπησης (remote sensing survey) του πυθμένα για να αξιολογηθούν έτσι οι πιθανότητες να υπάρχουν σε αυτόν ναυάγια και αρχαιολογικοί χώροι. Οι κάτοχοι άδειας πρέπει να υποβάλουν αρχαιολογικές μελέτες (που εκπονούνται από ειδικούς αρχαιολόγους) οι οποίες να καταδεικνύουν την ύπαρξη ή μη αρχαιολογικών περιοχών, και να εισηγούνται μέτρα προστασίας αυτών. Με βάση αυτή την έκθεση το Υπουργείο μπορεί να απαιτήσει αποφυγή οποιασδήποτε επέμβασης ή άλλα μέτρα προστασίας των εν λόγω χώρων

Επίπτωση # 4 Επιπτώσεις στα Θαλάσσια Θηλαστικά και Χελώνες από τον Θορύβου (Airgun)

Η Μεσόγειος υποστηρίζει ποικιλία από θαλάσσια θηλαστικά πανίδας συμπεριλαμβανομένων και ειδών τα οποία βρίσκονται στη λίστα του IUCN και χαρακτηρίζονται ως απειλούμενα (π.χ. φάλαινες). Κοινά είδη είναι τα δελφίνια (*bottlenose dolphin, Risso's dolphin και striped dolphin*). Το σπάνιο απειλούμενο είδος της Μεσογειακής φώκιας μπορεί να βρίσκεται στα ύδατα των παράκτιων περιοχών της Κύπρου αλλά είναι απίθανο να εντοπιστεί στα νερά της περιοχής αδειοδότησης λόγω του βάθους και της απόστασης από τις ακτές που την χαρακτηρίζουν. Τρία απειλούμενα είδη θαλάσσιας χελώνας εντοπίζονται στην περιοχή όπως είναι η πράσινη και η χελώνα loggerhead καθώς επίσης και η χελώνα leatherback.

Ένα κοινό χαρακτηριστικό γνώρισμα των περισσότερων θαλασσίων σεισμικών ερευνών είναι η χρήση «των airguns» (μια πηγή ήχου που λειτουργεί με συμπιεσμένο αέρα, και ρυμουλκείται συνήθως από ένα σκάφος) για να παράγει ακουστικά κύματα που διαπερνούν τον γήινο φλοιό. Κατά τη διάρκεια αυτών των ερευνών, υπάρχει κίνδυνος προσωρινού ή μόνιμου ακουστικού τραύματος για τα θαλάσσια θηλαστικά και τις χελώνες σε ακτίνα μερικών εκατοντάδων μέτρων από μια σειρά airguns, ιδιαίτερα αν αυτά βρίσκονται κάτω από την ηχητική πηγή. Οι φάλαινες Baleen και μερικά είδη βαθιάς κατάδυσης (π.χ. ραμφοειδείς φάλαινες) μπορούν να διατρέξουν ακόμα μεγαλύτερο κίνδυνο από αυτό που διατρέχουν τα μικρά δελφίνια. Σχετικά περιορισμένα στοιχεία είναι γνωστά αναφορικά με την λειτουργία της ακοής των θαλάσσιων χελωνών αλλά οι ήχοι που παράγονται από τα airguns περιλαμβάνουν το εύρος των συχνοτήτων στις οποίες οι θαλάσσιες χελώνες είναι περισσότερο ευαίσθητες. Τα θαλάσσια θηλαστικά και οι χελώνες μπορούν να αποφύγουν την περιοχή σεισμικών ερευνών, σε αποστάσεις μέχρι και μερικά χιλιόμετρα. Η ΣΠΜ δεν εντόπισε οποιοδήποτε νομοθετικό πλαίσιο που να προστατεύει από ακουστικά τραύματα τα θαλάσσια θηλαστικά και τις χελώνες κατά τη διάρκεια των σεισμικών ερευνών. Οι συστάσεις μετριασμού των επιπτώσεων που προτείνονται βασίζονται στα ευρέως χρησιμοποιημένα προστατευτικά μέτρα που έχουν αναπτυχθεί στις ΗΠΑ.

Εισήγηση – κατά τη διάρκεια των σεισμικών ερευνών, οι κάτοχοι άδειας πρέπει να εφαρμόσουν ένα πρωτόκολλο για να μειώσουν τον κίνδυνο ακουστικού τραύματος στα θαλάσσια θηλαστικά και τις χελώνες. Το πρωτόκολλο πρέπει να περιλαμβάνει τουλάχιστον τα ακόλουθα:

- **Ελεγχόμενη έναρξη -** κάθε φορά που ενεργοποιείται η χρήση της σεισμικής σειράς, οι διαδικασίες «ελεγχόμενης έναρξης» πρέπει να εφαρμόζονται για να δώσουν χρόνο στα θαλάσσια θηλαστικά και στις χελώνες να απομακρυνθούν προτού να φθάσει η σειρά στην πλήρη ισχύ. Η διαδικασία πρέπει να αρχίσει με τη μικρότερη πηγή ήχου στη σειρά, και να φτάσει στη μέγιστη ισχύ σε χρονικό διάστημα από 20 έως 40 λεπτά.
- **Οπτικός έλεγχος -** Πρέπει να ξεκινά τουλάχιστον 30 λεπτά πριν από την έναρξη της διαδικασίας σεισμικής έρευνας κατά τη διάρκεια της ημέρας. Οι οπτικοί παρατηρητές πρέπει να ελέγχουν μια ζώνη ασφάλειας (αποκλεισμός) ακτίνας 500 m γύρω από το σκάφος της ηχητικής πηγής. Η διαδικασία σεισμικής έρευνας ενεργοποιείται μόνο εφόσον δεν υπάρχει παρουσία για τουλάχιστον 20 λεπτά θαλασσίων θηλαστικών και χελωνών εντός της ζώνης ασφάλειας.
- **Απενεργοποίηση της ηχητικής πηγής (array) -** ο οπτικός έλεγχος της θαλάσσιας επιφάνειας πρέπει να συνεχίζεται καθ' όλη τη διάρκεια λειτουργίας της ηχητικής πηγής κατά τη διάρκεια της ημέρας. Η λειτουργία της ηχητικής πηγής πρέπει να διακοπεί εάν μια φάλαινα ή μια χελώνα εισέλθουν στη ζώνη ασφάλειας κατά τη διάρκεια του οπτικού ελέγχου.

Επίπτωση #5 Επιπτώσεις στην αλιεία και τη ναυτιλία από την παρουσία των Σεισμικών Ερευνητικών Σκαφών και του ρυμουλκούμενου εξοπλισμού (streamers)

Κατά τη διάρκεια των σεισμικών ερευνών, μια ζώνη ασφάλειας πρέπει να διατηρείται γύρω από το σκάφος και το ρυμουλκούμενο εξοπλισμό (streamers). Η ζώνη ασφάλειας είναι απαραίτητη για να αποτρέψει την καταστροφή του εξοπλισμού ερευνών από τα αλιευτικά σκάφη ή άλλα σκάφη. Ένα χαρακτηριστικό παράδειγμα θα μπορούσε να είναι 20 km μήκος με 12 km πλάτος και, εάν το ερευνητικό σκάφος κινείται σε 4.5 κόμβους (8.3 χλμ ανά ώρα), θα χρειαστεί χρονικό διάστημα 2 έως 3 ωρών για να περάσει από ένα σημείο. Οι αλιευτικές δραστηριότητες στην περιοχή αδειοδότησης μπορούν να διακοπούν προσωρινά λόγω της έκτασης της κινούμενης ζώνης ασφάλειας γύρω από το σκάφος ερευνών. Οι ζώνες ασφάλειας θα μπορούσαν να οδηγήσουν στον προσωρινό αποκλεισμό των αλιευτικών σκαφών και άλλων σκαφών από ορισμένες περιοχές. Μερικά σκάφη πιθανόν να απαιτηθεί να παρακάμψουν την περιοχή ερευνών.

Δεν έχουν εντοπιστεί μέτρα ελέγχου της εν λόγω δραστηριότητας. Εντούτοις, οι περί Υδρογονανθράκων Κανονισμοί του 2007 απαιτούν από τους κατόχους άδειας όπως εξασφαλίσουν ότι οι εφαρμοζόμενες από αυτούς διαδικασίες είναι περιβαλλοντικά αποδεκτές και ασφαλείς, και σύμφωνες με την εφαρμόσιμη περιβαλλοντική νομοθεσία και την ορθή διεθνή πρακτική της βιομηχανίας. Επίσης, θεωρείται ότι τα ερευνητικά σκάφη θα χρησιμοποιούν τα κατάλληλα μέσα σήμανσης σύμφωνα με το διεθνές θαλάσσιο δίκαιο (συμπεριλαμβανομένων των επικοινωνιών μέσω ασυρμάτου, φώτων, και των σημαιών) για να προειδοποιήσουν άλλα σκάφη για την ύπαρξη ζώνης αποκλεισμού.

Εισήγηση – Οι κάτοχοι άδειας πρέπει να συνεργαστούν με τους ενδιαφερόμενους φορείς πριν την έναρξη των ερευνών, για να εξασφαλίσουν την ελαχιστοποίηση των επιπτώσεων στις αλιευτικές και ναυτιλιακές δραστηριότητες.

Επίπτωση #6 Επιπτώσεις στην Ποιότητα του Αέρα και των Υδάτων από τις διαδικασίες δοκιμής των γεωτρήσεων

Σε περίπτωση ανακαλύψεως αποθεμάτων υδρογονανθράκων κατά τη διάρκεια της διερευνητικής γεώτρησης, μπορεί να απαιτηθεί η διενέργεια δοκιμών των γεωτρήσεων. Ένας τέτοιος έλεγχος γίνεται για να καθοριστεί η παραγωγική δυνατότητα, η πίεση, η διαπερατότητα, ή/και η έκταση των αποθεμάτων υδρογονανθράκων. Εάν κατά τη διάρκεια της δοκιμής απελευθερωθούν από το φρεάτιο υδρογονάνθρακες τότε αυτοί καίγονται. Μια τέτοια καύση προκαλεί ατμοσφαιρικές εκπομπές. Οι εκπομπές ατμοσφαιρικών ρύπων κατά την δοκιμή της γεώτρησης έχουν τοπικές μεμονωμένες επιπτώσεις στην ποιότητα του αέρα που περιορίζονται κοντά στη γεώτρηση κατά τη διάρκεια της δοκιμής Λόγω της απόστασης από τις ακτές δεν αναμένονται αρνητικές επιπτώσεις στην ποιότητα της ατμόσφαιρας των παράκτιων περιοχών. Παρόλα αυτά, η παρουσία σταγονιδίων πετρελαίου μπορεί να δημιουργήσει ένα φιλμ υδρογονανθράκων στην επιφάνεια της θάλασσας, το οποία μπορεί να θεωρηθεί ότι αποτελεί σημαντική επίδραση.

Εισήγηση - Κατά τη διάρκεια της δοκιμής της γεώτρησης, οι κάτοχοι άδειας θα πρέπει να (1) χρησιμοποιούν καυστήρες υψηλής απόδοσης για να ελαχιστοποιήσουν τις εκπομπές αέριων ρύπων καύσης, και (2) να παρακολουθούν την επιφάνεια της θάλασσας για να διασφαλίσουν ότι δεν θα δημιουργεί φιλμ υδρογονανθράκων

Επίπτωση #7 Επιπτώσεις από την Κίνηση Ελικοπτέρων εντός Σημαντικών Περιοχών Πτηνών

Η κυκλοφορία σκαφών και ελικοπτέρων θα μπορούσε περιοδικά να ενοχλήσει τις ομάδες παράκτιων πτηνών. Τα αποτελέσματα είναι παρόμοια με εκείνα που προκαλούνται από την υφιστάμενη κυκλοφορία σκαφών και αεροσκαφών. Είναι πιθανό να προκληθεί αλλαγή συμπεριφοράς των πτηνών, στη χειρότερη περίπτωση για μικρό χρονικό διάστημα, και η επίδραση αυτή δεν θεωρείται σημαντική. Εντούτοις, σημαντικές επιπτώσεις μπορεί να προκληθούν εάν τα ελικόπτερα κινούνται πάνω από Ειδικές Περιοχές Προστασίας (Special Protection Areas – SPAs)), ή άλλες Σημαντικές Περιοχές Πτηνών (Important Bird Areas - IBAs). Αυτή τη στιγμή υπάρχουν 7 περιοχές SPA και 25 περιοχές IBA στην Κύπρο.

> **Εισήγηση** – Οι κάτοχοι άδειας πρέπει να αποφεύγουν τη πτήση ελικοπτέρων πάνω από περιοχές SPAs και IBAs όταν ταξιδεύουν προς και από τα σημεία των γεωτρήσεων. Χάρτες των περιοχών SPAs και IBAs πρέπει να κοινοποιούνται γι' αυτό τον σκοπό.

Επίπτωση #8 Επιπτώσεις στα Θαλάσσια Θηλαστικά και στις Χελώνες από τις εργασίες αποξήλωσης και απομάκρυνσης των εγκαταστάσεων

Εάν δημιουργηθούν εγκαταστάσεις παραγωγής στην περιοχή αδειοδότησης, αυτές με το τέλος της ωφέλιμης ζωής τους θα πρέπει να αποσυναρμολογηθούν και απομακρυνθούν από την περιοχή. Κατά τη διάρκεια της αποσυναρμολόγησης, οι εγκαταστάσεις παραγωγής όπως οι υπεράκτιες πλατφόρμες θα πρέπει να απομακρυνθούν. Συνήθως οι βάσεις τους κόβονται κοντά στον πυθμένα της θάλασσας, χρησιμοποιώντας μερικές φορές εκρηκτικές ύλες. Για τις σωληνώσεις, η συνήθης διεθνής πρακτική περιλαμβάνει τον καθαρισμό τους και την εγκατάλειψή τους.

Εάν χρησιμοποιηθούν εκρηκτικές ύλες για την αποσυναρμολόγηση των πλατφορμών, υπάρχει ο κίνδυνος αρνητικών επιπτώσεων στα θαλάσσια θηλαστικά και τις θαλάσσιες χελώνες, συμπεριλαμβανομένων των απειλούμενων, κρίσιμα απειλούμενων, και υπό εξαφάνιση ειδών. Ο κίνδυνος πρόκλησης θανάτων και τραυματισμών των θαλασσίων θηλαστικών και των χελωνών μπορεί να αποφευχθεί αποτελεσματικά μέσω του ελέγχου κατά τη διάρκεια των διαδικασιών απομάκρυνσης των εγκαταστάσεων.

> **Εισήγηση** – Οι κάτοχοι άδειας πρέπει να ακολουθούν τη διεθνή καλή πρακτική για την ασφαλή απομάκρυνση του εξοπλισμού κατά τη διάρκεια της αποσυναρμολόγησης των εγκαταστάσεων Πριν τη αποσυναρμολόγηση των κατασκευών απαιτείται η εκπόνηση πλάνου αποσυναρμολόγησης, το οποίο θα συμπεριλαμβάνει την παρακολούθηση και έλεγχο της παρουσίας των θαλάσσιων θηλαστικών και χελωνών με σκοπό την αποφυγή πιθανών επιπτώσεων που θα προκύψουνε από τις υποβρύχιες εκρήξεις.

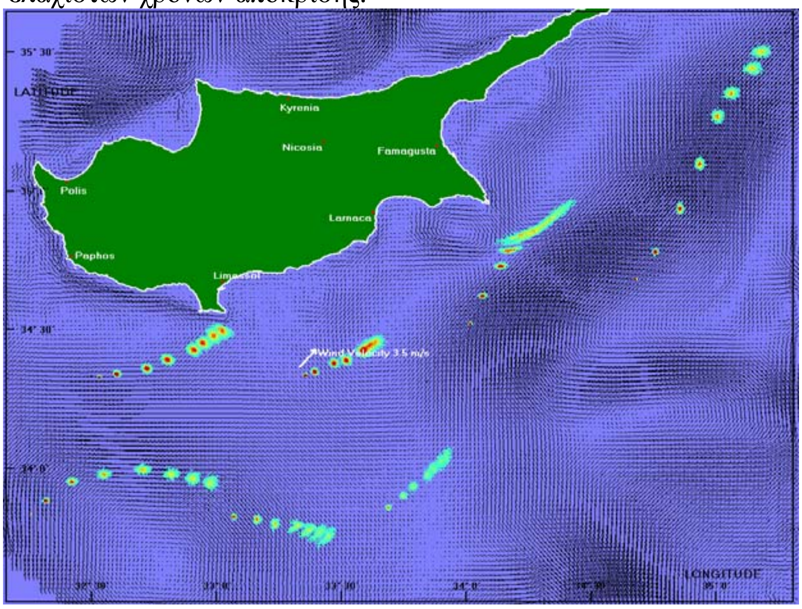
Επίπτωση #9 Επιπτώσεις στο Θαλάσσιο Περιβάλλον από τις διαρροές υδρογονανθράκων

Οι διαρροές υδρογονανθράκων χαρακτηρίζονται ως σπάνια γεγονότα, αλλά οι περιβαλλοντικές και κοινωνικοοικονομικές επιπτώσεις τους μπορεί να είναι σημαντικές. Οι επιπτώσεις ποικίλουν ανάλογα με το μέγεθος της διαρροής, τα χημικά χαρακτηριστικά της, τις ωκεανογραφικές και μετεωρολογικές συνθήκες που επικρατούν την στιγμή της διαρροής και την αποτελεσματικότητα των μέτρων αντιμετώπισης της διαρροής.

Τα μέτρα πρόληψης των διαρροών και το σχέδιο αντιμετώπισης είναι βασικά στοιχεία για τη μείωση του κινδύνου πρόκλησης σημαντικών περιβαλλοντικών επιπτώσεων. Οι περί Υδρογονανθράκων Κανονισμοί του 2007 απαιτούν όπως οι κάτοχοι άδειας προετοιμάσουν και υποβάλουν στον αρμόδιο Υπουργό σχέδιο για την εκτίμηση της πιθανότητας διαρροής υδρογονανθράκων και πρόκλησης πυρκαγιάς . Σε περίπτωση διαρροής ή πυρκαγιάς, ο κάτοχος της άδειας πρέπει να εφαρμόσει αμέσως το εν λόγω σχέδιο. Ο κάτοχος άδειας πρέπει να λαμβάνει τα απαραίτητα μέτρα σύμφωνα με τις γενικά αποδεκτές εφαρμοζόμενες πρακτικές.

Η προσομοίωση της διασποράς της διαρροής αποτελεί πολύτιμο εργαλείο στην διαμόρφωση των σχετικών σχεδίων αντιμετώπισης. Το μεσογειακό μοντέλο προσομοίωσης της διασποράς διαρροής υδρογονανθράκων γνωστό ως MEDSLIK έχει χρησιμοποιηθεί εκτενώς στην περιοχή από διάφορούς φορείς χωρών της περιοχής, όπως επίσης και από το Περιφερειακό Κέντρο Έκτακτης Ανάγκης για την Θαλάσσια Ρύπανση (Regional Marine Pollution Emergency Response Centre (REMPEC).

Μια πιλοτική εφαρμογή του μοντέλου MEDSLIK στην ΑΟΖ της Κυπριακής Δημοκρατίας έχει γίνει από το Κέντρο Ωκεανογραφίας του Πανεπιστημίου Κύπρου χρησιμοποιώντας θερινά μετεωρολογικά και ωκεανογραφικά δεδομένα. Τα αποτελέσματα έδειξαν ότι για αυτήν την χρονική περίοδο, η ακτή της Κύπρου δεν βρίσκεται σε κίνδυνο (**Σχήμα 1.8**). Η περαιτέρω εφαρμογή του μοντέλου, για διαφορετικές μετεωρολογικές και ωκεανογραφικές συνθήκες και εποχές, όπως επίσης και διαφορετικά θέσεις διαρροών (πχ ερευνητικά τεμάχια της περιοχής αδειοδότησης) θα παράσχουν σημαντική βοήθεια στην πληρέστερη κατανόηση της χωρικής συμπεριφοράς των πιθανών διαρροών στην περιοχή αδειοδότησης καθώς επίσης και στον καθορισμό των ελάχιστων χρόνων απόκρισης.



Σχήμα 1.8. Ένα παράδειγμα των προβλέψεων του MEDSLIK κατά τη διάρκεια μελέτης που πραγματοποιήθηκε από το Κυπριακό Ωκεανογραφικό Κέντρο χρησιμοποιώντας θερινά μετεωρολογικά και ωκεανογραφικά δεδομένα.

Εισήγηση – Να χρησιμοποιηθεί το μοντέλο MEDSLIK για να προσδιοριστούν οι πιθανές κατευθύνσεις των διαρροών στην περιοχή αδειοδότησης, χρησιμοποιώντας εποχιακά μετεωρολογικά και ωκεανογραφικά στοιχεία. Τα αποτελέσματα να χρησιμοποιηθούν για να καθοριστεί η πιθανή επίπτωση των διαρροών στην περιοχή, ενδεχομένως και των επηρεαζόμενων περιβαλλοντικών πόρων, και η εκτίμηση του χρόνου που χρειάζεται να φθάσουν οι εν λόγω διαρροές στις ακτές της Κύπρου και άλλων χωρών της ευρύτερης περιοχής.

1.5.2 Εισηγήσεις για Επιπρόσθετο Έλεγχο, Διαχείριση και Παρακολούθηση

Η Κυπριακή Δημοκρατία αναθεώρησε πρόσφατα το νομικό της πλαίσιο για να το εναρμονίσει πλήρως με την οδηγία 94/22/EC του Ευρωπαϊκού Κοινοβουλίου για τους όρους και τις εγκρίσεις για την πρόβλεψη, την έρευνα και την παραγωγή των υδρογονανθράκων. Ο νόμος περί Υδρογονανθράκων του 2007 και οι περί Υδρογονανθράκων Κανονισμοί του 2007 αποτελούν το βασικό νομικό πλαίσιο για τις δραστηριότητες πετρελαίου και αερίου στην περιοχή αδειοδότησης. Εντούτοις, η Κύπρος δεν έχει στο παρόν στάδιο κανονισμούς που να διέπουν τα υγρά απόβλητα γεωτρήσεων ή τα απόβλητα από υπεράκτιες εγκαταστάσεις.

Δεν εντοπίστηκαν Ευρωπαϊκές οδηγίες ή κατευθυντήριες οδηγίες που να αφορούν στον έλεγχο των διαρροών από υπεράκτιες δραστηριότητες για την έρευνα και εκμετάλλευση των υδρογονανθράκων. Εντούτοις δύο παράλληλα σύνολα κατευθυντήριων οδηγιών έχουν χρησιμοποιηθεί από άλλες χώρες μέλη της Ευρωπαϊκής Ένωσης. Αυτές είναι η Σύμβαση OSPAR και η Σύμβαση της Βαρκελώνης.

Σύμβαση OSPAR . Για τις περισσότερες χώρες-παραγωγούς υδρογονανθράκων της Δυτικής Ευρώπης (τα συμβαλλόμενα μέλη είναι το Βέλγιο, η Δανία, η Φινλανδία, η Γαλλία, η Γερμανία, η Ισλανδία, η Ιρλανδία, το Λουξεμβούργο, οι Κάτω Χώρες, η Νορβηγία, η Πορτογαλία, η Ισπανία, η Σουηδία, η Ελβετία, και το Ηνωμένο Βασίλειο), η «Συνθήκη για την προστασία του θαλάσσιου περιβάλλοντος του Βορειοανατολικού Ατλαντικού» (Συνθήκη OSPAR) είναι η βάση για τις εθνικές νομοθεσίες που διέπουν την απόρριψη των υπεράκτιων.

Οι δραστηριότητες στο πλαίσιο της Συνθήκης OSPAR οργανώνονται σε έξι στρατηγικές: (1) προστασία και συντήρηση της θαλάσσιας βιοποικιλότητας και των οικοσυστημάτων (2) ευτροφισμός (3) επικίνδυνες ουσίες (4) βιομηχανία πετρελαίου και φυσικού αερίου ανοικτής θαλάσσης (5) ραδιενεργές ουσίες και (6) έλεγχος και αξιολόγηση. Η τέταρτη στρατηγική περιλαμβάνει τις αποφάσεις και τις συστάσεις σχετικά με τις χημικές ουσίες, τα οργανικής φύσης ρευστά γεωτρήσεων, τη διαχείριση των υπεράκτιων απορριμμάτων, τη διάθεση των μη χρησιμοποιούμενων υπεράκτιων εγκαταστάσεων, τα περιβαλλοντικά συστήματα διαχείρισης, τις δοκιμές τοξικότητας, την παρακολούθηση και υποβολή εκθέσεων. Τα κράτη μέλη δεσμεύονται να εφαρμόσουν της αποφάσεις και συστάσεις της OSPAR στο πλαίσιο του εθνικού ρυθμιστικού συστήματός τους.

Σύμβαση της Βαρκελώνης. Το 1976, 16 μεσογειακές χώρες υιοθέτησαν τη «Συνθήκη για την προστασία της Μεσογείου ενάντια στη ρύπανση» (Συνθήκη της Βαρκελώνης). Η Συνθήκη της Βαρκελώνης περιλαμβάνει ένα πρωτόκολλο που αναπτύχθηκε για να ελέγξει τη ρύπανση κατά τη διάρκεια των υπεράκτιων δραστηριοτήτων για την έρευνα και εκμετάλλευση των υδρογονανθράκων. Το εν λόγω πρωτόκολλο υιοθετήθηκε το 1994 και έχει υπογραφθεί και επικυρωθεί από την Κύπρο. Εντούτοις, δεν έχει τεθεί ακόμα σε ισχύ επειδή δεν έχει επικυρωθεί από τον απαραίτητο αριθμό χωρών. Το πρωτόκολλο διέπει τον έλεγχο των επιβλαβών ή noxious ουσιών και υλικών, του πετρελαίου και των ελαιούχων μιγμάτων, των αποβλήτων γεωτρήσεων, των αστικών υγρών αποβλήτων, των στερεών αποβλήτων, των εγκαταστάσεων υποδοχής, της διασυνοριακής ρύπανσης κλπ.

Το πρωτόκολλο υπεράκτιων δραστηριοτήτων της Συνθήκης της Βαρκελώνης είναι η βάση για την δημιουργία προτύπων για την απόρριψη αποβλήτων σε θαλάσσια οικοσυστήματα σε

Μεσογειακές χώρες της Ευρωπαϊκής Ένωσης και μπορεί να αποτελέσει το σημείο αναφοράς για την ανάπτυξη των Κυπριακών απαιτήσεων αναφορικά με την απόρριψη αποβλήτων υπεράκτιων δραστηριοτήτων για την έρευνα και την εκμετάλλευση των υδρογονανθράκων. Επιπλέον η Σύμβαση της Βαρκελώνης περιέχει συγκεντρωμένες σε ένα έγγραφο τις κατευθυντήριες οδηγίες για διάφορες υπεράκτιες δραστηριότητες σε αντίθεση με τη Σύμβαση OSPAR..

Δύο μειονεκτήματα της Σύμβασης της Βαρκελώνης που πρέπει να αναφερθούν αφορούν αφ' ενός στο γεγονός ότι δεν έχει νομικά υιοθετηθεί μέχρι σήμερα, και αφετέρου ότι οι πρόνοιές της δεν είναι επικαιροποιημένες.

Εισήγηση – Θα πρέπει να καθοριστούν οι απαιτήσεις για τη διαχείριση των αποβλήτων των γεωτρήσεων, και των άλλων αποβλήτων που σχετίζονται με τις δραστηριότητες εκμετάλλευσης των υδρογονανθράκων στη περιοχή αδειοδότησης. Κατά τη ανάπτυξη των εν λόγω απαιτήσεων θα πρέπει να ληφθούν υπόψη οι σχετικές πρόνοιες της Σύμβασης της Βαρκελώνης και της Σύμβασης OSPAR. Επιπλέον γίνεται εισήγηση όπως γίνει λεπτομερής ανάλυση των προνοιών του πρωτοκόλλου υπεράκτιων δραστηριοτήτων της Σύμβασης της Βαρκελώνης και των Παραρτημάτων του έτσι ώστε να επιβεβαιωθεί ότι όλες οι δραστηριότητες έρευνας και εκμετάλλευσης υδρογονανθράκων στη περιοχή αδειοδότησης είναι σύμφωνες με τις απαιτήσεις του.

1.5.3 Ελλείψεις Στοιχείων

Η Περιβαλλοντική Μελέτη συμπεριλαμβάνει ανασκόπηση των υφισταμένων περιβαλλοντικών και κοινωνικό-οικονομικών στοιχείων της περιοχής.

Αν και κατά τη διάρκεια εκπόνησής της διαπιστώθηκε η έλλειψη στοιχείων που αφορούν σε μια σειρά από θέματα, μόνο όσα είναι σχετικά με το πρόγραμμα αδειοδότησης παρατίθενται εδώ. Πρώτιστη είναι η έλλειψη γνώσης σχετικά με την οικολογία του υποθαλάσσιου όρους Ερατοσθένης (Seamount Eratosthenes), συμπεριλαμβανομένης της έκτασης και των βιολογικών χαρακτηριστικών των κοραλλιών. Προκειμένου να καλυφθεί αυτό το κενό, θα πρέπει να διεξαχθεί μια μελέτη αναγνώρισης του όρους, για να χαρτογραφηθεί η έκταση του βυθού, για να τεκμηριωθεί η παρουσία των κοραλλιών και άλλων χαρακτηριστικών του πυθμένα της θάλασσας (epifauna) σε σχέση με τα χαρακτηριστικά του, και για να προσδιοριστεί η πανίδα της περιοχής.

Η κάλυψη των ελλείψεων αυτών θα επιτρέψει την καλύτερη κατανόηση της υπάρχουσας περιβαλλοντικής κατάστασης στην περιοχή αδειοδότησης, αλλά δεν θεωρείται ως απαραίτητη και ικανή συνθήκη για την συνέχιση της διαδικασίας αδειοδότησης.

Συνοπτικά τα σχετικά ελλείμματα στοιχείων που προσδιορίζονται στην περιβαλλοντική μελέτη, με τις σχετικές συστάσεις για περαιτέρω μελέτη, είναι τα ακόλουθα:

- Αξιολόγηση της οικολογίας του υποθαλάσσιου όρους Ερατοσθένης (Eratosthenes) συμπεριλαμβανομένων των κοραλλιών.

- Μετρήσεις των συγκεντρώσεων των υδρογονανθράκων και βαρέων μετάλλων στα ιζήματα του πυθμένα της θάλασσας στην περιοχή αδειοδότησης, ούτως ώστε να είναι δυνατή η εκτίμηση των επιπτώσεων και αλλαγών λόγω των δραστηριοτήτων έρευνας και εκμετάλλευσης των υδρογονανθράκων στην περιοχή.

- Επέκταση ή αύξηση της ανάλυσης των υφιστάμενων ωκεάνιων προγνωστικών μοντέλων ροής προκειμένου να βελτιωθεί η ακρίβεια και η αξιοπιστία των προσομοιώσεων της διασποράς των διαρροών πετρελαίου.

- Συλλογή επιπρόσθετων στοιχείων και δεδομένων σε σχέση με τα υποεπιφανειακά ρεύματα, τη θερμοκρασία και την αλατότητα στην περιοχή αδειοδότησης.