

## Special Section “Ocean Pollution”

# Evaluation and control, of marine pollution due to land-based activities — A preview of the Cyprus case

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**Abstract**—Most of marine pollution arises from land-based activities such as urban development and sewage disposal, agriculture, manufacture, transport, energy production and day-to-day domestic activity. Types of pollution include litter and oils, municipal wastewater, nutrients and sediments, radioactive waste, heavy metals and persistent organic pollutants. Once in the marine environment, the pollutants are absorbed by marine life, settle as sediments on sea bed, or follow dispersion. The pollutants pay no attention to national maritime boundaries or the sensitivity of the ecosystems they impact upon. The Mediterranean is a sensitive enclosed area with millions of people living in its coastal cities. This preview focuses on the southern coast of Cyprus, where the city of Limassol is located, in terms of the above mentioned hazards, with suggestions as to measures and practices to be taken in the direction of a model ecological city, based on an integrated coastal zone management practice. Wastewater reuse as a sustainable resource is linked to this study.

**Key words:** coastal policy, nitrates, phosphates, marine pollution

## Introduction

Cyprus, the third largest island in the Mediterranean Sea, has a coastline of 735 km in length: 295 km under the control of the Republic of Cyprus (40%), 370 km under Turkish occupation since 1974 and inaccessible (50, 3%) and 70 km within the Sovereign British Military Bases. This paper refers to the territory under the control of the Republic of Cyprus. There is not a single legal or planning definition of the coastal zone in Cyprus. The most “popular” definition is the one that suggests the width of the coastal strip to be 2 km inland from the coastline. According to this definition, the coastal strip covers 23% of the island’s total area. About 50% of the population lives and works within this strip,

where 95% of the tourist industry is located. Tourism is by far the most important economic activity of the island whose coastal zone is and has always been the primary destination for tourists (1999 figures show Cyprus with 2, 5 million).

With an official target of 3, 5 million tourists by 2010 (Cyprus Tourism Organization) i.e., a planned mean annual growth of 3, 4%, it is obvious that the coastal zone is under extremely high pressure.

## Coastal Marine pollution evaluation

Out of 601 Mediterranean coastal cities with a population of more than 10 000 inhabitants (total resident population of 58.7 million), only 69% operate a wastewater treat-



Fig. 1. Map of Cyprus with areas of major environmental concern and hot spots.

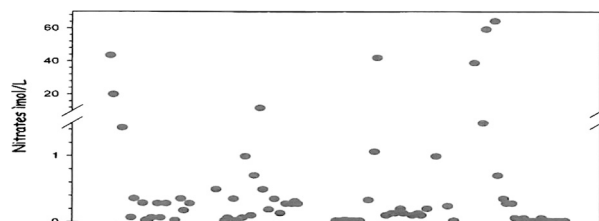
ment plant “EEA (2006)”. Limassol fortunately operates one and this treated effluent is used for agricultural irrigation. The problem is exacerbated by the rapid growth of many coastal cities and towns. Until lately, there were in operation wineries and other beverage industries near the coast of Limassol which since 2004 have been connected to the central sewage system sewers. This has saved the marine ecosystem of the heavy burden of these organic wastes. Their cooling waters however (high in  $BOD_5$ ) are still discharged to the sea. In terms of Industrial effluents the bay of Vassilikos where factories operate with chemical effluents, create hot spots with inert materials from industrial activities possibly blanket the bay’s sediments and have a negative effect on the benthic community of the area.

The thermal effluents from the three power plants of Moni, Vassilikos and Dhekelia, as well as the brine from the two desalination plants in Larnaca and Dhekelia are still reaching the sea.

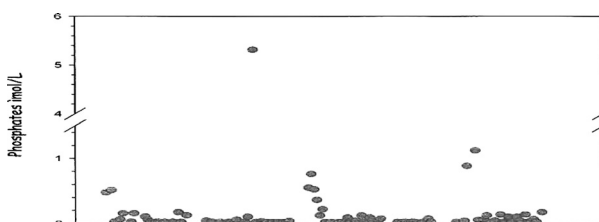
The termination of operations of the Cyprus Petroleum Refinery in Larnaca, (CPRL) in 2004, ceased the discharge of its treated process waters into the sea.

Urbanization of the coastline is one of the major problems not only to Cyprus but to the entire Mediterranean region “EEA (1999)”, often leading to loss of biodiversity due to habitat destruction and physical alteration. Problems related to the concretization (increase of artificial surfaces) of the coastline too are encountered throughout the Mediterranean. This is usually due to uncontrolled development, especially tourist infrastructure. Eutrophication is very common in sheltered marine water bodies such as harbors and semi-enclosed bays along the Mediterranean coast, mainly in the vicinity of coastal towns. In the bay of Liopetri and Ayia Napa of Cyprus, nitrogen leaching from the intensely cultivated agricultural areas, because of over-fertilization (150 tons of nitrogen per year) and aquaculture, loading sea waters with nutrients that eventually create ecological problems to the marine environment “EEA (1999)”. Random samples on Nitrate and phosphate concentrations are shown in figures 2 and 3.

Sand erosion is a common problem in many Mediterranean countries “EEA (2006)”, “Loizidou, X, Iacovou N, G (1995)”. Although it is rooted in natural causes, such as marine sediment transport, it can be amplified by human activities (e.g. sand quarrying, water impounding works and tourist development). The construction of the Limassol harbor resulted in beach erosion and the rectification measures, (breakwaters perpendicular to the coastline) resulted in serious degradation of water quality “Loizidou, X, Iacovou N, G (1995)”. Marine transport is one of the main sources of petroleum hydrocarbon (crude oil) and PAH pollution in the Mediterranean Sea. Climatic changes in conjunction with deteriorated ecosystems near ports and lagoons have resulted in significant changes of biodiversity due to the introduction



**Fig. 2.** Nitrate concentrations ( $\mu\text{mol/L}$ ) in the coastal waters of Cyprus sampled during fall and winter of 2005, “State of the environment report (2005)”.



**Fig. 3.** Phosphate concentrations ( $\mu\text{mol/L}$ ) in the coastal waters of Cyprus sampled during fall and winter of 2005, “State of the environment report (2005)”.

and establishment of exotic species. The majority of exotics are found in the eastern basin (Levantine) “Stergiou, K.I. and Koulouris, M., (2000)”.

Exploitation of marine resources due to fishing let down the marine food web and has a negative impact on whole ecosystems.

## Coastal Policy framework in Cyprus

Cyprus has not yet adapted Coastal Zone Management Policy as a separate and self contained document. These Policies however are included in various sectoral policies which apply to different administration areas. The main policies are:

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

**Tourism Policy:** The Cyprus Tourism Organization (CTO), a semi- Governmental Organization under the Ministry of Commerce Industry and Tourism is the authority responsible for the Tourism Policy. Several policies and measures for the regulation of tourism development and tourism establishments are in force on the basis of the CTO legislation. As mentioned in the introduction, 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 in a 40% increase of the number of

tourists “Cyprus Tourism Organization, (2000)”.

Environmental Policy: The responsibility for the Environmental Policy lies mainly at the Environment Service of the Ministry of Agriculture, Natural Resources and Environment. At this moment, environmental policy in Cyprus is focused on the 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 involved in Environment Policies are rather creating a complex system.

## Coastal Development in Cyprus — Land uses

Cyprus shows the following development tendencies:

- Sub-urbanization, i.e., rapid population growth and urban development in suburbs located at the edges of the main urban areas.
- Coastal development, i.e., rapid coastal tourism development, driving property prices to very high levels.

During the last two decades coastal development was characterized by the conversion of formerly agricultural and natural zones to tourist development zones after each revision of the land use planning zones every four years. The situation along the coastline after the revision of the land use planning zones in 1997–1998 was as follows:

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

As a result of the policies and the targets of the Cyprus Tourism Organization, the number of beds in the coastal areas of Cyprus has increased seven fold over the last twenty years, i.e. from 12524 beds in 1980 it became 88302 in 2001. At the same time the numbers in inland areas have increased only by 11%, i.e. from 3902 in 1980 to 4358 in 2001 “Cyprus Tourism Organization, (2000)”.

## Conclusions

Mediterranean region, which is the most industrialized, there are *a priori* necessary prevention mechanisms, correction technologies and the appropriate legal framework. However, there is a lack of political willingness from the countries to enforce environmental regulation. The southern Mediterranean region is growing at the expense of the envi-

ronment since neither the economic conditions nor the required technologies are available. The problem of erratic and fragmented approach of coastal development still exists. The complexity in the decision-making process, the large number of involved authorities, the lack of effective coordination and the huge financial interests involved in the coastal area can be addressed as the main reasons for this situation.

As an island, the vulnerability of the coastal strip is extremely high in Cyprus, since all land-based activities have a direct impact on this narrow strip. A well balanced coastal policy, based on an integrated approach and involving all the stakeholders is a demand of high priority for Cyprus, at least if the target is sustainable development.

## References

- Cyprus Tourism Organization, 2000, Strategic Plan for Tourism 2000–2010, Nicosia.
- De Leiva Moreno, J. I., Agostini, V. N., et al, 2000. Is the pelagic-demersal ratio from fishery landings a useful proxy for nutrient availability? A preliminary data exploration for the semi-enclosed seas around Europe. *ICES J. Mar. Sci.* 57: 1090–1102.
- Delft Hydraulics, Coastal Zone Management for Cyprus, Phase III Report, 1995 X.I. Loizidou et al, Coastal Zone Management for Cyprus, Proceedings of MEDCOAST 95.
- Demetropoulos A., SAP- Bio Cyprus Draft report, Nicosia February 2003.
- EEA, 1999. State and pressures of the marine and coastal Mediterranean environment. E. Papatthanassiou and G. P. Gabrielidis (Eds.).
- EEA 2006, Priority issues in the Mediterranean environment 2006 88 pp. Office for official publication of the European communities, Luxembourg.
- Karakassis, I., Tsapakis, M., Hatziyanni, E., et al. 2000. Impact of cage farming of fish on the sea bed in three Mediterranean coastal areas. *ICES J. Mar. Sci.* 57: 1462–1471.
- Loizidou, X, I Iacovou N, G 1995 The Cyprus Experience in coastal zone monitoring as a basis for shoreline management and erosion control, Proceedings of MEDCOAST 95.
- Pavlakis P, Tarchi D. and Sieber A. J., 2001. On the monitoring of illicit vessel discharges usingspaceborne SAR remote sensing— A reconnaissance study in the Mediterranean Sea. *Ann. Telecommu.* 56: 700–718.
- Stephanou, D., 1997. Experience of offshore fish farming in Cyprus. In: Muir J. (ed.), Basurco B. (ed.). Mediterranean offshore mariculture. Zaragoza: CIHEAM-IAMZ, 2000. pp. 57–64: 2 graphs. 3 tables. 6 ref. Summaries (En, Fr). (OptionsMéditerranéennes: Série B. Etudes et Recherches; n. 30). Advanced Course of the CIHEAM Network onTechnology of Aquaculture in the Mediterranean on ‘Mediterranean Offshore Mariculture’, 1997/10/20–24, Zaragoza (Spain).
- Stergiou, K. I. and Koulouris, M., 2000. Fishing down the marine food webs in the Hellenic seas, pp. 73–78. In: Fishing down the Mediterranean food webs CIESM Workshop Series 12, p. 99.
- State of the Environment Report, Integrated Assessment, and Aquatic Environment, marine and coastal, Department of Fisheries-Cyprus 2005
- World Bank, 1993, Republic of Cyprus—Environmental Review and Action Plan, Nicosia.