EP

United Nations
Environment
Programme

UNEP(DEC)/MED/GEF/198/3
7 January 2002

ENGLISH

**MEDITERRANEAN ACTION PLAN**

First Meeting of the ad-hoc Technical Committee to select pollution hot spots for the preparation of pre-investment studies within the GEF Project

Athens, 28-29 January 2002

# REVISION OF POLLUTION HOT SPOTS IN THE MEDITERRANEAN

***COUNTRY REPORTS***

In cooperation with

WHO

UNEP
Athens, 2002

# Introduction

The project on "Formulation of a Strategic Action Programme for the Mediterranean Sea to address pollution from land-based activities" supported by GEF, was implemented within the framework of the MED POL programme during 1997 and 1998. The project aimed specifically to develop a Strategic Action Programme (SAP) for the protection of the Mediterranean sea against degradation, and in particularly pollution from land-based activities. One of the most important components was related to priority pollution hot spots and sensitive areas, in order to have a global situation in the Mediterranean. The final product resulted in lists of pollution hot spots and sensitive areas of national priority, which were compiled according to the country reports prepared by national or international consultants with the assistance and input of the MED POL National Coordinators.

Following the above project, a more detailed one was approved, which is also supported by GEF and related to the "Determination of priority actions for the further elaboration and implementation of the Strategic Action Programme for the Mediterranean Sea".

The innovative component of this project is the preparation of a plan of identification of sources of pollution and their control, which will be included in pre-investment studies. These studies will be prepared in order to assist countries in protecting the environment and coastal zones through prevention of pollution and by reduction and, as far as possible, elimination of pollutant inputs, and to also assist donors in making their financial contribution.

In order to prepare the pre-investment studies, there is a need to prioritize the pollution hot spots in the Mediterranean taking also into consideration the potential risk of a transboundary effect and the financial aspect of the measures required to abate pollution. As in the past, the above task was entrusted to WHO/EURO, within the framework of the MED POL Phase III Programme. For this purpose the GEF-eligible countries were asked to revise the already existing lists as they were included in the MAP Technical Reports Series issue no. 124 and to make eventual changes related to new data and information, based on surveys or new measurements and analyses carried out in the meantime.

In the new lists, changes were made on the pollution hot spots in relation to the following: (a) the reduction of pollution loads; (b) the elimination of pollution sources, (c) the measures taken for progressive or immediate decrease of loads polluting the sea; (d) the existence of another pollution hot spots with greater impact to human health and the environment than the listed ones; and (e) the inappropriate inclusion in the list.

New hot spots are also indicated and supported by relevant data on pollution load, collection, treatment and disposal of municipal and industrial wastewater.

The present report includes the revised country reports on pollution hot spots, which were prepared by national experts taking into consideration the existing ones and were also adopted by the MED POL National Coordinators.

# REVISION OF POLLUTION HOT SPOTS IN THE MEDITERRANEAN

Country report for

***A L B A N I A***

***Acknowledgements***

- *Mr. Emil Gjika, GEF Focal Point, who collected the available data and filled out the questionnaires.*
- *Mr. Gani Deliu of CEP, who provided useful information on the state of the coastal sea.*
- *Mr. Kosta Koci, University of Tirana.*
- *Mr. Veli Puka, Instiute of Hydrometeorology, who provided information on the concentrations of pesticides and chlorinated hydrocarbons, and on river pollution.*
- *Mr. Gazmend Gjtli, Director of The Research Institute of Chemical Technology, who provided information on industrial waste dumping sites.*
- *Mr. Lirim Selfo, Chairman of CEP, for acting as an intermediary with various government offices in order to obtain all the available information.*

**Prepared in 1997 by:** **Mr Ante Bariæ**
**Revised in 2001 by:** **Dr. Tatjana Hema**
**Ms Mirela Kamberi**

## 1. INTRODUCTION

Albania is a small country covering 28,748 $km^2$ and has approximately 3.3 million inhabitants. It is mostly mountainous with hills and mountains accounting for 2/3 of the territory. The coastal area opens to the Adriatic and Ionian Seas. The total length of the coastline is 476 km, of which 200 km in the north are on a coastal plain up to 50 km wide. All Albania's rivers belong to the Mediterranean watershed. The population of the wider coastal area is approximately 1.3 million, and two towns on the coast have more than 100,000 inhabitants: Durres in the northern part, and Vlora in the south, where the Adriatic and Ionian Seas meet. In the north, the town of Lezhe has around 50,000 inhabitants, and in the far south the town of Saranda has some 25,000 inhabitants.

From the end of World War II until 1990, Albania was virtually isolated from the rest of the world, which resulted in severe economic underdevelopment despite considerable natural resources. The social transformation that started in 1990 brought about economic changes. Practically all industries, which had been large-scale polluters, were closed down, but some of the dumping sites created earlier are still active and remain significant sources of pollution. However, the principal source of the coastal sea pollution is the urban wastewater discharged directly into the sea without any treatment, mostly through open canals and numerous outlets, as well as by the rivers.

Hot spots were identified on the basis of analyses of available data, completed questionnaires, and direct contacts with the representatives of the Committee for Environmental Protection (CEP) and the SAP Focal Point during the visit to Tirana. Unfortunately, the amount of data available was rather limited. Moreover, those that were available do not usually reflect the actual situation as in the last few years considerable changes have occurred with regard to sources of pollution.

## 2. PROCEDURE FOLLOWED IN IDENTIFYING HOT SPOTS

In order to identify hot spots, the given criteria were used, and the towns of Durres and Vlora, with more than 100,000 inhabitants each, were selected, together with the rivers of Drini, Mati, Semani and Shkumbini, with average flows greater than 30 $m^3/s$. In addition, two locations in the vicinity of Durres and Vlora that had been used in the past for depositing toxic industrial waste were selected, as they represented a constant threat to the coastal sea.

## 3. CONTRIBUTION OF DIFFERENT SOURCES TO DEFINED HOT SPOTS

| Hot spots | Main sources of pollution | Principal supporting data extracted from the questionnaires |
|---|---|---|
| Durres | - Domestic | - BOD 2,864 t/y<br>- $N_{tot}$ 477 t/y<br>- $P_{tot}$ 95.5 t/y<br>- TSS 4,300 t/y<br>- FC $10^9$ col/100 ml |
| ex PVC factory in Vlora | Leakage from chloralkaline plant | Area of approximately 11 ha contaminated by elemental mercury |
| ex chemical factory, Lalzi Bay, Durres | Industrial solid waste | Deposit of approximately 20,000 t of solid waste containing 4-5% of hexavalent chromium |

## 4. PRIORITY HOT SPOTS

The town of Durres is located in the central section of the northern part of the Albanian coast. Owing to its geographical position, it has developed into the most important harbour in Albania. Long sand beaches spread south to the town and along them there are numerous houses, once used as holiday homes by State officials and now permanently populated by immigrants from inland. North of the town there are a number of industrial plants, most of which have ceased production, probably permanently. Most domestic wastewaters are collected by a sewerage system and discharged through an open canal into Lalzi Bay north of the town. The canal is also used to receive untreated industrial wastewaters A small amount of domestic wastewaters from some of the houses located along the beach is discharged without any treatment directly onto the beach through numerous small outlets.

Several kilometres north of the town there was a chemical factory that produced chromium salts and other products. The solid wastes were deposited within the factory premises so today there is a contaminated area of approximately 5 ha covered by some 20,000 t of waste containing 4-5 per cent of hexavalent chromium salts. In places the depth of the layer reaches up to 2 m. Rains wash away the chromium salts and transport them into the nearby sewer, and thus the chrome reaches the sea.

The town of Vlora is situated in the southern part of the country, on the coast of Vlora Bay. North of the town there are many industrial plants, most of which are not operational, while to the south there is a sandy beach. The urban wastewaters are collected by a separate sewerage system, and some 2/3 are discharged into the sea north of the town through an open canal, while 1/3 ends up into the sea south of the town through several outlets at the beach.

Vlora Bay is a semi-enclosed basin framed on the outside by the Karaburmi peninsula, while the opening is further reduced by the small island of Sazan. The bottom of the bay, between the town of Vlora in the east and Cape Galloveci in the west, is covered by Posidonia oceanica seagrass meadows, the most important in the country. Vlora Bay and its Posidonia oceanica seagrass meadows could be classified as a protected seascape, and part of it as a fishery reserve. The bay is threatened by the urban wastewaters of the population of approximately 200,000 living around it, especially since these are discharged into the bay without any treatment. Potentially, the bay could be further threatened by the effluents of industries that might develop in the area of Vlora town.

North of the town of Vlora, some 300 m from the sea, there was a PVC plant utilizing inter alia chloralcaline electrolysis with mercury as the cathode. During the period of operation, approximately 60 t of mercury were lost. Small quantities reached the sea, but most of it ended up in the soil, so that at present, elemental mercury can be found at depths of up to 1.5 m over a contaminated area of some 10 ha. In the immediate vicinity of the coast, the sea often becomes white in colour in patches of approximately 300x50 m, probably as a result of alkali leakage.

All Albanian rivers receive the urban wastewaters of the areas through which they flow without any treatment. Previously, they were also polluted by industrial wastewaters, but industrial pollution has now all but disappeared since industries have largely ceased production and there is little probability that production will be re-launched with the same equipment and technology used up until now. It is very important to point out that Albanian rivers have a significant impact on the ecology of the Southern Adriatic.

In the area between the mouths of the rivers Drini and Mati there are numerous lagoons. The best known are the Kuna and Vaini lagoons, with a surface area of

approximately 15 $km^2$ and depth of up to 0.9 m. Both lagoons are protected as nature or hunting reserves, and represent the most important nesting grounds for birds in Albania.

They are also of great importance for fishing. The lagoons are threatened by the urban wastewaters of the town of Lezha (some 50,000 inhabitants) and the surrounding rural settlements, as well as by industrial wastewaters, especially from the paper factory and copper smelter situated upstream, along the Drini river.

The Karavasta lagoon is situated between the rivers Shkumbini and Mbledhesi. It covers a surface of 43.3 $km^2$ and has a maximum depth of 1.5 m. It is considered the most important coastal wetland of Albania, and is one of the biologically richest lagoons of the Mediterranean area. It is also important for fishing. There is a proposal that the whole lagoon be given the status of a national park and included in the Ramsar Convention List. The lagoon is threatened by the urban wastewaters of the neighbouring settlements.

The Narta lagoon is situated between the mouth of the Vjosa river and the town of Vlora, covering a surface of 41.8 $km^2$, with an average depth of 0.8 m. Approximately 1/3 of the total surface is taken up by the Skrofotina salt pans, with an annual production of 120,000 t. In the north-eastern part, a fish farm has recently been established. The primary importance of the lagoon is for fishing, but also, potentially, for eco-tourism. Vine growing is well developed in the surrounding areas and this might result in agricultural runoff. In the southern corner of the lagoon there is a basin that used to receive effluents from a PVC factory. The factory is out of operation and it is highly improbable that it would be reactivated, but the sediment of the retention basin is heavily polluted by mercury. Narta lagoon is undergoing very rapid degradation due to extremely limited marine and fresh water input. This phenomenon first occurred some five years ago. During summer and early autumn almost half the lagoon is completely dry and the rest has a depth of only 10-20 cm.

## 5. IDENTIFICATION OF MAIN GAPS AND CONSTRAINTS

The basic problem in the identification of hot spots is the lack of relevant information necessary to show precisely the pollution load and environmental state. This primarily means data on the water quality of the rivers that receive the untreated urban wastewaters of the areas through which they flow, as well as industrial wastewaters and runoff waters that flow over various waste disposal grounds. There are no data whatsoever on the water quality of the Viosa river, which is comparatively large (average annual flow amounting to 171 $m^3/s$). Similarly, there are very few data on seawater quality and the state of marine ecosystems.

## 6. PROPOSED OPTIONS FOR REMEDIAL ACTION

The pollution problems caused by the urban wastewaters of Durres and Vlora will be resolved by the construction of separate sewerage systems complete with adequate wastewater treatment plants and submarine outfalls. During the revision of the hot spots, Vlora's municipal wastewater treatment plant (a previously domestic hot spot), is very soon expected to be constructed with the assistance of the EU. All future industrial plants, or the present ones if reactivated - which is highly improbable - will have to treat their wastewaters, at least to the level of urban wastewaters, before they can be allowed to discharge into the urban sewerage systems. Particular attention will have to be paid to the elimination of toxic matter that could disturb the functioning of the treatment plants.

The most appropriate solution to resolve the problem of solid waste containing chromium deposited in the Durres region has to be found as soon as possible. One option

would be to find an appropriate place to dump the entire quantity, taking the necessary measures to protect it against action of runoff, surface and ground waters. Another alternative could be chemical treatment of the entire waste material) in order to remove the chromium or transform it into an insoluble or less toxic chromium (iii) salt.

An appropriate sanitation method has to be found for the area contaminated by mercury in the Vlora region. Probably the most suitable solution would be to remove the elemental mercury from the contaminated soil by a thermal method.

Support for capacity-building (including experts and institutions) will be necessary in order to improve the amount and quality of environmental data, as well as management of coastal zones. The amount is estimated at around US$155 million (also considering the construction of the municipal wastewater treatment plant of Vlora).

***Pollution Hot Spots in ALBANIA***

| Name | Type | Public Health | Drinking Water Quality | Aquatic Life | Recreation | Other beneficial us | Welfare and economy | Category | Nature of investment | Preliminary estimated financial requirement (in US$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | (1) | (0.9) | (0.7) | (0.8) | (0.8) | (0.7) | | | |
| Durres | Domestic | 6 | 4,5 | 2,1 | 4 | 1,6 | 1,4 | C | WWTP | 20 millions |
| Durres | Industrial | 6 | 5,4 | 3,5 | 4,8 | 1,6 | 1,4 | B | Area rehabilitation | 12 millions |
| Vlora | Industrial | 6 | 5,4 | 3,5 | 4,8 | 1,6 | 1,4 | B | Area rehabilitation | 12 millions |

# REVISION OF POLLUTION HOT SPOTS IN THE MEDITERRANEAN

Country report for

***A L G E R I A***

**Prepared in 1997 by:** **Mr Youssef Zenir**
**Revised in 2001 by:** **Ms Samira Nateche**

# 1. INTRODUCTION

## 1.1 Present situation

Extending for almost 1,200 km., the Algerian coastline offers an exceptional maritime frontage punctuated by beaches and broken up by deep estuaries.

It is delimited by a narrow continental shelf that is irregular and uneven. This shelf is characterized by steep rocky slopes on the sea bed that are difficult to trawl and it covers almost two thirds of Algeria's sea area.

Between these rocky sections, there are areas where the continental shelf is slightly wider and more favourable for trawling. These account for the remaining one third of the maritime area and are mainly situated in western Algeria (the Gulfs of Ghazaouet and Arzew-Mostaganem), which contain over 60 per cent of Algeria's fishery resources, but they are also found to a lesser extent in eastern Algeria (Skikda and Annaba Bays), as well as in the Bays of Bousmail and Béjaia in central Algeria, which contain sizeable resources of deep sea fish (bluefish) and coral reefs, notably in the furthermost eastern part of the coast (El Kala region), where the largest quantities of red and pink coral are to be found.

These are also extremely important spawning grounds; for example, the western part of the coast between the Moroccan border and Mostaganem is the country's most important breeding area, while there are less important spawning grounds in the central and eastern parts.

The Algerian coast also has exceptional natural and cultural assets that bear witness to the passage of several ancient civilizations.

Some coastal cities not only possess historical remains, but are themselves listed as part of the national cultural heritage; this is the case for the ancient site of Annaba and others which are classified as part of the world heritage such as Tipaza.

The Algerian coast is one of the most densely populated in the Mediterranean. It contains over 20 per cent of Algeria's population in an area that represents less than 0.4 per cent of

Cities of national importance such as Algiers, Oran, Annaba, Skikda, Béjaia and Mostaganem, whose populations exceed 100,000, account for 12 per cent of Algeria's total population and 62 per cent of the coastal population.

An analysis by commune shows, however, that population density varies greatly from a maximum of 10,170 inh/km$^2$ in the city of Oran to a minimum of 20 inh/km$^2$ in the commune of Ain Zouiet in the Province of Skikda.

This clearly underlines the marked imbalance between the high-density urban areas, at the level of communes' administrative centres, and the scattered zones in rural areas whose population density is insignificant in comparison with the total population.

The ongoing decline in these scattered zones is mainly due to the rural exodus, which drains rural communes and increases the population to an excessive extent in urban centres, resulting in problems such as urban pollution, which significantly degrades the environment in the coastal strip and consequently also natural resources.

Although fisheries, tourism, agriculture and industry are the major activities in the coastal strip, industry in particular occupies an important place.

Fishing is mainly concentrated in the eight ports and 10 fishing refuges already existing. It has to be recognized that, even though this sector has been given an additional infrastructure

under the plans to build and reorganize ports and fishing refuges, notably certain mixed (trade/fishing) ports, its development is not sufficient because the policy on which it is based essentially focuses on traditional small-scale fishing, which has its limits.

In the area of tourism, the various types of activity carried out along the coast are mainly in seaside resorts, where large luxury complexes have been built near big cities, or in spas. The thermal potential of the Algerian coast is fairly important and it has a role to play at the national level as well as being of top-quality therapeutic value, especially in certain coastal cities of high cultural renown that contain historical sites, for example, Tipaza, which is part of the world heritage.

In addition to its sites, its archaeological remains and its proximity to the capital, Tipaza has almost one half (42 per cent) of total tourist capacity, followed by the two Provinces of Algiers and Oran, which between them have 31 per cent of total capacity.

At the environmental level, it must be stressed that this sector causes problems of domestic origin (liquid and solid wastes), mostly during the summer season when the population may double or even triple. In the majority of cases, the tourism sector is itself the victim of pollution caused by other sectors, in particular industry.

Concerning agriculture, various studies along the coastal strip have shown that its potential as agricultural land corresponds to around 2 per cent of the total area usable for agriculture in the coastal communes.

Provinces in the east, which have the highest forestry potential in the coastal strip, combine agriculture, grazing and forestry. In these regions, there is extensive farming, with the establishment of support structures aimed at the agri-food industry.

In Provinces in the centre, on the other hand, intensive farming is virtually ubiquitous, with the development of cultivation in greenhouses. Intensive farming practices have led to chemical pollution of agricultural origin due to the excessive and irrational use of phytosanitary products.

The majority of industrial activity is also situated on the coast. The four largest port and industrial zones, where there is practically no treatment of industrial waste, are all on the coast. These are, on the one hand, the industrial zones of Skikda and Annaba in the east, Algiers-Oued Smar and Rouiba-Reghaia in the centre, Oran-Arzew in the west, and on the other the industrial complexes of Ghazaouet, Mostaganem, Béjaia and Jijel.

In most instances, these large coastal complexes are sited on land with considerable agricultural potential and close to marine zones that contain the majority of the national fisheries resources.

The vast industrial zones of Arzew (3,500 hectares), Skikda (200 hectares), Annaba (2,000 hectares), Rouiba-Reghaia (1,000 hectares), and the industrial complexes of Ghazaouet and Mostaganem are the most striking examples.

Most of these zones discharge their principal wastes, full of toxic substances, into the sea or nearby wadis, causing heavy pollution along the Algerian coast.

As already emphasized, because of its geographical position, the coastal area is subject to much greater pressure than other areas. This pressure is strongly exacerbated by the phenomena of urbanization and industrialization experienced in the major cities that are a focus of attraction, for example, Algiers, Oran, Annaba, Skikda, Béjaia and Mostaganem.

The urbanization and industrialization of the principal urban centres means that these cities, which also have a port infrastructure, suffer urban and industrial pollution.

As an example, analyses of samples of seawater and sediment, taken inside and outside the main ports in these cities, show high concentrations of pollutants that in some instances exceed several times the permitted levels in Algeria. This underlines the impact that activities such as maritime transport and industry, and urban waste, have on marine pollution.

These urban and industrial activities generate large amounts of chemical and organic pollutants, which are discharged directly into the marine environment, usually without any treatment.

Like urban and industrial wastewater, solid wastes receive practically no prior treatment and no precautions are taken before they are discharged, as can be seen from the proliferation of illegal dumps that are only too often to be found in or beside wadis, cliffs or other natural depressions. This means twofold pollution of the marine environment by solid wastes: directly, through illegal dumping on cliffs and beaches, and indirectly, through dumping in wadis, where the waste is subsequently carried down to the sea whenever the water level rises.

These major sources of pollution, together with many others, cause extensive damage to marine biological resources and all forms of marine activity. They lead to substantial damage to the marine flora and fauna, thereby destroying many natural breeding areas (spawning grounds of Mostaganem) and natural habitats (zones of Annaba and Ghazaouet), so constituting a major handicap for the fisheries sector.

Other uses of the sea are increasingly being jeopardized by pollution; Algeria's beaches are ceasing to be clean as can be seen from the number where bathing is now prohibited.

Bathing is prohibited at almost one third of the 360 beaches in Algeria because of the danger to bathers' health. The prohibition most affects beaches near large urban, tourist and industrial centres along the coast.

### 1.2 Conduct of the study

This survey has been carried out by the directorate for the prevention of pollution in the Ministry of State for the Environment, in collaboration with the relevant services of the Ministry of Public Works responsible for water resources (sub-directorate of sanitation), services of the Ministry of Industry, the National Agency for Water Resources (ANRH), the National Land Planning Agency (ANAT), the National Statistical Office (ONS), experts from the National Marine Sciences Institute (ISMAL), and the Maritime Studies Laboratory (LEM).

All the information contained in this report is derived from reports and studies undertaken by the aforementioned services of the various ministerial departments, national agencies and laboratories, as well as from the report containing a METAP study on protecting Algerian ports and coastal areas against pollution, carried out in 1994 by the Danish Water Quality Institute (VKI).

These data reflect the current situation and can be summarized in the following information:

- population and the discharge of wastewaters;

- assessment of industrial pollution based on data from the Ministry of Public Works and some basic theoretical assumptions.

The cost of installing treatment plants for polluting industries cannot be estimated because it would require an in-depth study for each type of industry and a minimum amount of time.

The data on the cost of reorganizing, expanding or installing new treatment plants for the coastal cities are based on the drafts prepared for operations planned by the water resources services of the Ministry of Public Works. Consequently, the estimate of the cost of the investment recommended is only a rough guide and will have to be updated.

## 2. IDENTIFICATION OF HOT SPOTS

### 2.1 Methodology

As already mentioned, almost all socio-economic activity is concentrated in the coastal strip where the large urban centres and major industrial hubs are concentrated.

The following were identified as hot spots with a population of 100,000 or over or as major industrial hubs: Algiers, Oran, Annaba, Skikda, Béjaia, Mostaganem, and Ghazaouet (see Table 1).

Table 1

Potential hot spots

| Location/city | Population Source: ONS | Main activities |
|---|---|---|
| Algiers | 2,460,069 | Urban, industrial |
| Annaba | 555,485 | Urban, industrial |
| Oran | 1,281,378 | Urban, industrial |
| Skikda | 910,680 | Urban, industrial |
| Béjaia | 901,263 | Urban, industrial |
| Mostaganem | 629,445 | Urban, industrial |
| Ghazaouet | 108,692 | Urban, industrial |

The major risk for the environment along the Algerian coastline is the discharge of domestic and industrial effluents and the quarrying of sand for building.

## 3. SOURCES OF POLLUTION

| Location | Major sources of pollution | Rate $m^3/j$ (*) | Parameter Tonnes/year (**) | |
|---|---|---|---|---|
| Algiers | Urban Industrial | 295,208 | DBO5 : 53,875<br>DCO :89,792<br>Ntotal : 13,468<br>Ptotal : 5,387 | TSS : 80,812 |
| Annaba | Urban Industrial | 66,658 | DBO5 : 12,165<br>DCO : 20,275<br>Ntotal : 3,041<br>Ptotal : 1,216 | TSS : 18,247 |
| Oran | Urban Industrial | 153,765 | DBO5 : 28,062<br>DCO : 46,770<br>Ntotal : 7,015<br>Ptotal : 2,806 | TSS : 42,213 |

| | | | | |
|---|---|---|---|---|
| Skikda | Urban Industrial | 109,281 | DBO5 : 19,943<br>DCO : 33,239<br>Ntotal : 4,985<br>Ptotal : 1,994 | TSS : 30,034 |
| Béjaia | Urban Industrial-port | 108,151 | DBO5 : 19,737<br>DCO : 32,896<br>Ntotal : 4,934<br>Ptotal : 1,973 | TSS : 29,606 |
| Mostaganem | Urban Industrial | 75,533 | DBO5 : 13,784<br>DCO :22,974<br>Ntotal : 3,446<br>Ptotal : 1,378 | TSS : 20,752 |
| Ghazaouet | Urban Industrial | | DBO5 : 2,380<br>DCO : 4,760<br>Ntotal : 39<br>Ptotal : 99 | TSS : 2777 |

(*) The estimate of the rate of flow of wastewater discharged has been calculated on the basis of 80 per cent of the quantity used daily i.e. 150 l/inh x 80%

(**) The parameters used to quantify pollution have been calculated according to the following formula:
$BOD_5$ : 60g/inh/day, COD: 100 g/inh/day
Total N: 15 g/inh/day, Total P: 6 g/inh/day.

## 4. INDICATORS OF HOT SPOTS

The estimate of the eight hot spots has been determined according to criteria based on the evaluation of potential risks caused by sources of pollution to the quality of drinking water, the effects on public health, aquatic life and the socio-economic conditions, as shown in Table 4.

## 5. IDENTIFICATION OF PRINCIPAL GAPS AND CONSTRAINTS

The principal gaps are related to:

- the lack of information on the concentration of hydrocarbons, heavy metals and organochlorides in domestic sewage;

- the lack of information on particular industries.

Attention should also be drawn to the major constraint posed by the completion of the questionnaires.

## 6. PROPOSALS AND RECOMMENDATIONS

The marine environment of Algeria's coastal strip is greatly harmed by the waste from urban and industrial activities, especially along the coast between Oran and Ghazaouet; action should be taken immediately therefore to treat the urban wastewater coming from the major coastal cities by building plants or expanding or reorganizing those already existing.

In addition, the treatment of industrial effluents at sources should be improved before they are discharged into the sanitation network and the municipal treatment plant.

Table 4

Hot spots - Algeria

| Name | Type | Public heatlh | Drinking water quality | Aquatic life | Recreation | Other beneficial uses | Welfare and economy | Category | Nature of investment | Preliminary estimated financial requirement (in US$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | (1) | (0.9) | (0.7) | (0.8) | (0.8) | (0.7) | | | |
| Oran | Urban and industrial | 5 | 1 | 4 | 6 | 5 | 5 | B | WWTP : Rehabilitation<br>Expansion<br>PTIW : Implementation | 90 millions of dollars<br>ND |
| Rouiba - Réghaia | Urban and industrial | 5 | 2 | 5 | 5 | 4 | 5 | B | PTIW : Implementation | ? |
| Ghazaouet | Urban and industrial | 5 | 1 | 6 | 5 | 4 | 5 | B | WWTP : Implementation<br>PTIW : Implementation | 19 millions of dollars<br>ND |
| Alger | Urban and industrial | 5 | 1 | 4 | 6 | 4 | 5 | B | WWTP : Rehabilitation<br>PTIW : Implementation | 30.000 dollars<br>ND |
| Mostaganem | Urban and industrial | 4 | 1 | 6 | 4 | 4 | 5 | B | WWTP : Implementation<br>PTIW : Implementation | 50 millions of dollars<br>ND |
| Béjaia | Urban and industrial | 5 | 1 | 5 | 5 | 4 | 4 | C | WWTP : Implementation<br>Expansion<br>PTIW : Implementation | 700.000 dollars<br>ND |
| Annaba | Urban and industrial | 5 | 1 | 4 | 5 | 4 | 4 | C | WWTP : Rehabilitation<br>Expansion<br>PTIW : Implementation | 408.000 dollars<br>ND |
| Skikda | Urban and industrial | 5 | 1 | 5 | 4 | 3 | 4 | C | WWTP : Implementation<br>PTIW : Implementation | 20 millions of dollars<br>ND |

WWTP : Urban wastewater treatment plant
PTIW : Pretreatment of industrial effluents
ND : Not determined (requires a specific study for each industry)

***Teneurs en métaux lourds et en hydrocarbures polyaromatiques du sédiment marin le long de la cote algérienne (µg/g) au niveau des zones points chauds***

| Radiale | As | Cd | Cr | Cu | Mn | Pb | Zn | Hg | Fe | HPA |
|---|---|---|---|---|---|---|---|---|---|---|
| Ghazaouet | 33.53 | 0.18 | 14.77 | 12.33 | 344.63 | 36.71 | 109.03 | | | 0.76 |
| Oran | 21.62 | 0.49 | 10.47 | 8.50 | 79.50 | 51.04 | 46.73 | | | 2.37 |
| Arzew | 21.10 | 1.23 | 18.54 | 10.87 | 187.70 | 45.39 | 102.80 | | | 12.18 |
| Mostaganem | 18.02 | 0.10 | 21.75 | 10.17 | 147.10 | 27.23 | 89.97 | | | 2.12 |
| Niv 1 baie Alger | | 0.44 | 31.76 | 36.58 | 230.14 | 38.51 | 122.52 | 0.56 | | |
| Niv 2 baie Alger | | 9.88 | 51.53 | 39.77 | 212.66 | 31.93 | 85.58 | 0.57 | | |
| Niv 3 baie Alger | | 8.86 | 49.02 | 36.44 | 274.96 | 36.19 | 100.03 | 1.63 | | |
| Niv4 baie Alger | | 3.83 | 32.87 | 36.60 | 281.47 | 33.08 | 107.16 | 1.23 | | |
| Niv 5 baie Alger | | 0.34 | 30.51 | 37.02 | 323.71 | 26.54 | 154.40 | 2.18 | | |
| Centre baie Bejaia | | | 26.63 | 18.53 | 306.70 | | 100.85 | 0.64 | 18.30 | 4.76 |
| Z.I. Bougie | | | 27.67 | 21.93 | 371.30 | | 114.90 | 1.53 | 6.60 | 1.14 |
| Skikda | | | 13.14 | 9.22 | 265.20 | | 66.40 | 0.23 | 25.50 | 4.43 |
| Z.I. de Skikda | | | 9.09 | 6.48 | 332.20 | | 55.85 | 0.32 | 23.90 | 12.88 |
| Est Z.I. de Skikda | | | 16.36 | 12.72 | 213.60 | | 89.80 | 1.20 | 27.40 | 14.41 |
| Centre golfe Skikda | | | 19.98 | 13.91 | 224.34 | | 98.32 | 0.49 | 30.26 | 9.23 |

Le tableau ci-dessous indique la plus haute teneur par métal pour chaque site. L'unité est don en mg/kg/ms.

***Teneur en métaux lourds des sédiments portuaires***

| PORTS | Mercure | Cadmium | Plomb | Cuivre | Zinc | Chrome |
|---|---|---|---|---|---|---|
| Oran | 2,6 | 2 | 480 | 200 | 800 | 380 |
| Arzew | 0,5 | 0,2 | 100 | 50 | 230 | 60 |
| Mostaganem | 3,2 | 0,4 | 50 | 65 | 200 | 60 |
| Alger | 5,8 | 2,9 | 870 | 325 | 1100 | 100 |
| Béjaia | 0,3 | 2,8 | 100 | 65 | 440 | 100 |
| Jijel | 5,9 | 2,35 | 510 | 190 | 700 | 110 |
| Skikda (AP) | 3,3 | 1,58 | 120 | 200 | 770 | 70 |
| Skikda (NP) | 18 | 0,12 | 30 | 65 | 170 | 40 |
| Annaba | 1,1 | 2,5 | 220 | 115 | 400 | 85 |

# REVISION OF POLLUTION HOT SPOTS IN THE MEDITERRANEAN

Country report for

***BOSNIA AND HERZEGOVINA***

***Acknowledgements***

- *Mr. Tarik Kupusovic, Special Adviser to the Minister of Physical Planning and Environment, Faculty of Civil Engineering, Hydro-Engineering Institute.*

**Prepared in 2001 by: Ms Gorjana Radulovic**

***General***

B&H, as a successor country of former Yugoslavia, is a signatory of Barcelona Convention. However, due to the war activities, B&H has not participated in the activities concerning environmental protection related to the Mediterranean for almost six years. After the war, the most of industrial units was out of operation, and migration of people changed the number of inhabitants recorded by listing in 1991. Situation is almost the same now. Industrial plants have been waiting for privatization, and the most of them still are not in operation, and population has settled within bigger cities. Listing of inhabitants has not yet occurred so the current number is not available.

Due to very short coastal strip (approx. 25 km) which belongs to B&H territory, there is only one real coastal Hot Spots in B&H territory - (Neum City) and the other Hot Spots are land – based.

Regarding to land – based Hot sports, it should be emphasized that, due to the karstic geological characteristics, rapid flow of surface and underground water, polluted water transfer towards the Adriatic sea occurs in a very short period of time. Thus, there is a need for serious consideration of land –based potential sources of pollution, whether it originates from settlements or industry. Further on, rapid transfer of pollution load threatens very sensitive areas (welfare wetland and hunting area Hutovo Blato and Neretva river Delta), which are shared with neighboring Republic of Croatia, and thus present potential transboundary pollution.

***Population***

*Population* within Adriatic Sea watershed river basin amounts as follows:

- Neretva river basin 380,000 inhabitants
- Trebi{njica river basin 55,000 inhabitants
- Cetina river basin 90,000 inhabitants

These data were recorded before the war. Current population number is not available. The largest city is Mostar (130,000 inh.), then [iroki brijeg, ^apljina, Trebinje and Tomislav grad (about 30,000 inh.), Konjic and Livno (about 20,000 inh.), Neum (4 300) and over 1,200 smaller settlements, the most of which (1,170) amounts about 2,000 inhabitants.

According to MAP recommendations concerning the nature of the hot spots which may be included in the national inventories - *"coastal cities and urban coastal agglomerates with considerable population (e.g.more than 100,000 )",* if applied to B&H which is small-sized country comparing to the most other Mediterranean countries, only city of Mostar should be listed in the hot spots inventory. But, existing pollution sources situated in smaller urban agglomerates in B&H (less than100.000 inhabitants), presents also very significant pollution source.

The only town that exists in the coastal area within B&H boundary is small tourist town Neum. It is situated at the Adriatic coast forming two bays: Neum-Klek Bay and Mali Ston Bay. Neum has inadequate waste water treatment. Although the number of inhabitants is low (4. 300 inh.), it increases in the summer two to three times and thus, causes significant pollution impact, specially during three to four season's months, every year.

***Industry***

Industrial plants are mostly situated inside or nearby the cities. Recorded industrial plants belong to the following sector groups:

- Food industry,
- Metal finishing and plating industry,
- Alumina and electrolysis industry and
- Textile industry.

*Food processing industry* is concentrated to greater extent in Mostar, while some other single units are located within smaller settlements. Production units of meat, milk, vines and juice and distillery unit, as well were identified. All wastewater generating in food processing units are/will be connected to municipal sewerage systems with/without pretreatment facilities (if needed), and are to be treated at foreseen sewage treatment plants. In Mostar, vine production factory generates wastewater with pollution over 30,000 population equivalent, that contributes to the total pollution load of the city. Total pollution loading from food industry within Neretva river basin amounts up to 50 000 PE. Food processing industry in Trebisnjica river basin is negligible, and in Cetina river basin amounts up to 15 000 PE.

Within the Neretva river basin *metal finishing and plating industry* is far above the others according to the number, capacity and variety. At the larger cities there are in operation: at Konjic seven metal finishing units (up to 25 000 PE), and in Mostar three units (up to 8 000 PE). At smaller settlements another nine metal finishing units are constructed. Some of them have been put in operation after post-war reconstruction, but some has not yet. Only three of the nineteen units in total do not treat their wastewater at all. In the rest of industrial units treatment plants exist, but the efficiency is not always satisfactory. At the town of Trebinje (Trebisnjica river basin) the large tools production unit is sited as well. All wastewater produced in this type of industry is very toxic and absolutely need to be treated.

*Alumina and Electrolysis Industry* producing alumina from bauxite and aluminum in electrolytic process is sited in the vicinity of the city of Mostar. By-product generating in alumina production – so called “red sludge”, highly toxic and alkaline in character is disposed into the controlled landfill, not having any impact to the environment. It has not been normally recognized as current but potential hot spot, since a kind of unforeseen accidents is always possible. The rest of wastewater means cooling water that is cooled artificially. Pollution loading of alumina factory and aluminum electrolysis factory amounts about 2,000 and 6,000 PE, respectively.

*Textile Industry* exists in two river basins: Neretva river at the city of Mostar, and Trebisnjica river at the town of Bileca. At Mostar the intention is to start the operation of the plant in near future. Not in full extent, but introducing new process in dying unit, related to changes in type and quantity of colors, what results in pollution reduction. Before the war, wastewater was chemically treated and discharged directly into Neretva river. By construction of the north sewerage system line for the city of Mostar, wastewater sewer is going to be connected to the city sewerage system and treated at the future central sewage treatment plant. With regard to pre-war examinations recorded population equivalent was almost 100,000 PE. At Bileca Textile Factory (carpet production), there is wastewater pre-treatment plant, constructed some time before the war, successfully operated, but today out of operation. However, there is a need to point out that pre-treated wastewater from the factory was discharged into the city sewerage system and later on into artificial Bileca Lake what can produce significant troubles in the Lake water quality in the nearest future. The

Sewage treatment plant for the town is ruined. Raw water from the Lake is used as a source of drinking water for the town of Bileca and downstream settlements, as well. It is evident that Bileca Lake can be considered a hot spot. Population at Bileca amounts up to 15,000 inhabitants, but textile factory produces wastewater with over 30,000 PE, that is total loading of almost 50,000 PE.

## Conclusions

Referring to the MAP recommendation on nature of the hot spots which may be included in the national inventories - *"coastal cities and urban coastal agglomerates with considerable population (e.g. more than 100,000 taking also into consideration the size of each individual country)"*, it is necessary to point out that B&H, by its size, presents one of the smallest countries in the Mediterranean. Consequently, B&H's urban cities manly does not have more than 50 000 inhabitants. In fact, among all Mediterranean cities in B&H , only the city of Mostar has 130,000 inhabitants, all other towns are much smaller. But, inspite of that fact, in such small - size country like B&H, with also very short coastal strip, there are significant pollution sources (Hot Spots) which present:

- High potential for transboundary pollution;
- Significant risk for human health, ecosystems, biodiversity, sustainability and economy.

This is a consequence of the fact that all identified Hot Spots listed in this Report are situated in the watershed area of Neretva river, which:

- Is the longest and the water richest river in the karstic region of Balkan Peninsula, (total river length is around 215 km );
- Is discharged directly in to Adriatic sea;
- Neretva watershed area covers two countries - Bosnia and Herzegovina (upstream) and Croatia (downstream);
- Total of half million people live in the Neretva watershed where approximately 350 000 inh. is in the B&H's part of the watershed, while in Croatia's part there is around 150 000 inh.

Neretva watershed is very rich in water and with its tributaries, karstic valleys, agricultural fields and wetlands represents the key economic factor for majority of people living in that area. The high concern of both countries and their high priority is to assess and protect highly ruined environment of river Neretva watershed. The clean environment in the Neretva watershed is a pre-condition for microeconomic development for half a million people living and depending on water, soil, air, plants and animal life in this watershed spanning 10000 $km^2$ area.

*According to the all mentioned above, it could be concluded that all listed Hot Spots in B&H, excluding Neum, are the Land – based with high transboundary pollution potential as well as with significant risk for health, biodiversity and economy of the Region. Neum is the only real coastal Hot Spot, with transboundary effect as well.*

**Summary of conclusions concerning each individual hot spot in B&H is the following:**

- *Town MOSTAR* - Besides the pollution load generated by municipal waste waters (130.000 inhabitants in Mostar), industry pollution - textile industry and vine production located in Mostar municipality, increase the pollution load of Neretva river with additional – doubled loading, (100,000 PE and 30,000 PE, respectively).

- *Town KONJIC* - Upstream of Mostar, a small town of Konjic is worth while to be mentioned. Population of something over 20,000 inhabitants and industry, mostly of metal finishing type, with population equivalent of over 25,000 PE mean a lot of concentrated pollution. Without treatment all wastewater are being discharged to artificial Jablanica Lake used for recreational purposes. The level of pollution, risk for human health and expected changes in Lake water quality are the reasons to include the town of Konjic in the hot spot list.

- *Town BILECA* - Special environmental impact to Bileca Lake due to untreated communal and textile factory wastewater and requirement for permanent usage of Lake water in drinking water purposes, urge need to point out this problem as “hot spot” with high priority problem.

- *MOSTAR ALUMINA FACTORY* - Alumina factory sited near Mostar does not mean current hot spot. However, under unpredictable conditions or unforeseen accidents, existence of risk is evident. Outflow of highly alkaline red sludge, consisting of red soil and sodium hydroxide, may produce unpredictable damage and destruction of both surrounding soil and surface and ground water streams. Environmental impact assessment will help in better prevention of accident and in organizing proper activities in case of accident.

- *Town NEUM* - Coastal municipality Neum with its two bays: Neum-Klek Bay and Mali Ston Bay, has inadequate waste water treatment. Although the number of inhabitants is low (4. 300 inh.), it increases in the summer two to three times and thus, causes significant pollution impact, specially during three to four season months, every year. Neum-Klek Bay and Mali Ston Bay, penetrating deeply in to the land, can be considered almost as a large lakes. Besides, in these two bays there are a number of large shell nurseries, directly affected by pollution.

| Name | Type | Public Health | Drinking Water Quality | Aquatic Life | Recreation | Other beneficial use | Welfare and economy | Category | Nature of investment | Preliminary estimate financial requiremen (in US$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | (1) | (0.9) | (0.7) | (0.8) | (0.8) | (0.7) | | | |
| Hot spot 1.:Municipality of Konjic | Domestic + industrial + solid waste | 3 | 5 | 4 | 4 | 4 | 5 | B | WWTP + Construction of sewerage system | 8.8 million |
| Hot spot 2.: Municipality of Mostar | Domestic + industrial | 4 | 5 | 4 | 2 | 3 | 3 | C | WWTP + Reconstruction of sewerage system | 89.1 million |
| Hot spot 3.: Mostar Alumina Factory | Industrial | 2 | 2 | 6 | 5 | 5 | 6 | B | Environmental impact assessment + Reclamation of red sludge disposal site | 680,000 |
| Hot spot 4.: Municipality of Bileca | Domestic and industrial | 3 | 6 | 5 | 5 | 4 | 4 | B | WWTP + Reconstruction of sewerage system for municipality + Reconstruction of industrial WWTP | 2.15 million |
| Hot spot 5.: Regional System for Municipality of Neum | Domestic | 3 | 1 | 3 | 5 | 4 | 2 | D | Construction of regional sewerage system + Building of WWTP | 25.1 million |

# REVISION OF POLLUTION HOT SPOTS IN THE MEDITERRANEAN

Country report for

***C R O A T I A***

## ***Acknowledgements***

- *Mr. Nenad Mikulic, GEF Focal Point, who organized the collection of the necessary data*
- *Group of experts from the Public Water Authority "Croatian Water Resources" headed by Ms. Nena Hak, who filled out the necessary questionnaires*
- *Ms. Margita Mastrovic of the State Directorate of Environment, MED POL National Coordinator, for providing information on the sanitary quality of beaches*
- *Mr. Eugen Draganovic, also of the State Directorate of Environment, for providing information on protected areas.*
- *Ms. Fani Bojaniæ Head water pollution protection, in "Hrvatske vode" - Water Management Department – Split, for providing information on LBS in Zadar, Šibenik, Split and Dubrovnik Counties.*
- *Ms. Rajka Štajduhar, Head water pollution protection, in "Hrvatsk - Water Management Department – Rijeka, for providing information on LBS in Istria and Primorje Counties.*



**Prepared in 1997 by:** **Mr Ante Bariæ**
**Revised in 2001 by:** **Mr Tomislav Zvonaric**

## 1. INTRODUCTION

By its geographic situation, Croatia is a Central-European, Mediterranean country. Its population amounts to approximately 4,784.265 million inhabitants and it covers a surface area of 56.538 $km^2$.

The permanent population of the coastal area amounts to approximately 1 million inhabitants; while in summer months this number increases considerably due to temporary inhabitants and tourists. The largest towns on the coast are Split (207.147 inhabitants), Rijeka (206.229), Zadar (136.572), Pula (85.326), Sibenik (85.002), and Dubrovnik (71.419).

Towards the interior, the coastal strip is bordered by mountain range, which represents the end of the Alps. The coastal strip is fairly narrow, several kilometres on average, while in some places the mountains border directly on the sea (Velebit, Biokovo). In very few areas, this strip is over 10 km wide (Istria peninsula in the north, and Ravni Kotari in the central part of the coast). The mountain range is pierced in several places; either by the flows of carstic rivers (Zrmanja, Krka, Cetina, Neretva), or by mountain passes (Gornje Jelenje, Vratnik, Mali Alan, Klis, Vrulje).

One of the specific features of the Croatian coast is the great number of islands dispersed in one or more rows parallel to the coastline. There are 65 inhabited and 650 uninhabited islands, plus some 460 rocks and reefs. The total length of their coasts amounts to 5.790 km. The insular coast is indented by index of 1:7.5. while that of the mainland coast is 1:3.4. Such a high index indicates a wealth of geomorphological forms such as bays, capes, channels, isthmuses, straits, and passages, making this coast a unique geomorphological phenomenon. Numerous islands and peninsulas which have created various water units (channels, semi-enclosed bays) have made each island, bay and channel biologically unique. Owing to their great value some areas have been specially protected, for example, the Brijuni archipelago, Velebit, Paklenica, the Talascica Bay, Kornati archipelago, the island of Mljet, and Maloston Bay.

Generally speaking, the major part of the coastal sea is unpolluted. However, the coastal sea near larger urban agglomerations, and most of the northern Adriatic, are polluted. Economic changes followed upon the socio-political changes in the country and as a result most of the industries that were large polluters were either closed or now work at reduced capacity. The main source of pollution is urban wastewaters that are discharged through submarine outfalls. Industrial wastewaters treated either insufficiently or not at all, are discharged into the sea, mostly through surface outfalls. So far, the rivers have not been significant sources of pollution as most of them flow through sparsely inhabited areas. Exceptions are the river Krka and the river Neretva, which mostly flows through the Republic of Bosnia and Herzegovina.

The most serious consequence of sea pollution is accelerate eutrophication followed by changes in the plankton communities, blooming of selected phytoplankton organisms, reduced oxygen content in the bottom layers, and eventually, mass mortality of marine organisms. Changes also occur in the contents of the benthic communities, so that autochthonous species, such as nitrophilic sea algae species (green algae) become dominant.

Identification of hot spots has been made on the basis of analyses of available data, questionnaires, and interviews with representatives of the State Water Directorate, the “Croatian Waters”, and the Ministry of Environment Protection and Physical planning.

## 2. PROCEDURE FOLLOWED IN IDENTIFYING HOT SPOTS

For the review of hot spots according to existing lists (MAP Technical Reports Series 124) we used the proposed criteria: - towns with more than 100.000 inhabitants (Split, Rijeka, Zadar), together with those of approximately 70.000 if they were important tourist centres (Dubrovnik), or if they discharged untreated wastewaters into semi-enclosed bays (Sibenik, Pula, Ston) or channels (Zadar), as well as Kastela Bay in which the excessive pollution has caused considerable changes in living communities.

In the case of industry, attention focused on basic chemical plants located by the sea which discharge insufficiently treated wastewaters directly into the sea, as well as Kaštela Bay in which the excessive pollution has caused considerable changes in living communities.

Among the rivers flowing into the Adriatic Sea, Neretva river was selected due to present and possible future pollution.

## HOT SPOTS DEFINITION AND CRITERIA

## 3. CONTRIBUTIONS OF DIFFERENT SOURCES TO IDENTIFIED HOT SPOTS

Comparing the primary Hot Spots indicators from the previous report (No. 124) with the present data (Table 1), there have been established a certain improvements in Bakar, Zadar and Šibenik, and significant improvements in Kaštela Bay and Split. The main reason of these enhancements is closing of some industrial plants ("Cokery" - Bakar, "Tannery" - Zadar), pre-treatment of some industrial wastewaters (Brewery "Kaltenberg" in Kaštela Bay) and municipal wastewaters of Split.

According to the last obtained data (Table 2) noticeable Hot Spots could be considered cities of Rijeka and Zadar, and Oil refinery. Although discharge of BOD and COD has been significantly reduced in Kaštela Bay and Split they still receive high amount of TSS.

**Table 1.**
**MAIN POLLUTION LOADS**

| | | Supporting data extracted from the questionnaires | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Hot Spots** | **Population** | **Main Sources of pollution** | **BOD t/y (1.500)** | **COD t/y (4.500)** | **Total N t/y (2.000)** | **Total P t/y (570)** | **TSS* t/y (300)** | **TPB** kg/y** |
| Pula* | 63.979+ | D | 329 | 513 | - | 4 | 259 | Pb 11; Zn 279; |
| **> PULA** | **85.000+** | **D+I** | **555** | **-** | **130** | **16** | | |
| Rijeka and Kvarner Bay* | - | D + I | 1.927 | 121 | 201 | 33 | 1.728 | Cd 146; Pb 150; Zn 1.420; Oil 8.400; Phenols 172 |
| **>> RIJEKA and KVARNER BAY** | **206.000** | **D+ I Ó=** | **2.412 331 2.743** | **3.185 585 3.770** | **299 14.1 313.1** | **63.5 14.1 77.6** | **1.464 240 1.704** | **Pb 110; Cd 109; Cu 180; Zn 1.440** |
| Urinj* (Oil refinery) | | I | 32 | 121 | | | 25 | Oil 8.100 |
| **>> Oil refinery (MLAKA+URINJ)** | | | | | | | | **Oil 67.500 + Phenols** |
| Bakar (ex Cokery)* | | I | - | - | - | - | - | Accumulation of waste waters (17.000m$^3$) Phenols 100; Cyanides 600- |
| **-- BAKAR (Cokery)** | | **WW treated in Oil refinery Urinj** | | | | | | **Elimination of pollution sources** |
| Zadar* | 85.000+ | D+I | 1.056 | 3.940 | 154 | 26 | 1.410 | Pb 361; Cr 3.932; Zn 726; Oil 113 |
| **<< ZADAR** | **136.000+** | **D+I** | **538** | **1.282** | **83** | **14** | **2.250** | **Pb 84; Cr 96; Zn 518; Hg 10.3** |
| Zadar Tannery* | | I | | 68 | | | | Elimination of pollution sources |
| Zadar „Adria“ Cannery* | | I | 67 | 121 | | | 18 | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **<< ZADAR (Soya + Cannery)** | | **I** | **10.5** | **36.8** | **0.55** | **0.18** | **7.4** | |
| Šibenik* | 60.000+ | D | 201 | 410 | 89 | 20 | 240 | Cd 75; Pb 315; Zn 179 |
| **< ŠIBENIK** | **85.000+** | **D+I** | **121** | **374.5** | **140.5** | **12.7** | **230** | **Al 296** |
| Krka river* (Knin, Drniš, Skradin) | | D+I | | 232 | | | | Cd 94; Cr 73 |
| **KRKA RIVER** | | **METAP III study** | | | | | | |
| Kaštela Bay | | D+I | 5.006 | 11.095 | 594 | 129 | 8.481 | Cd 23.3 Pb 555.1; Zn 3.499 Temporary anoxic condition in a east part of the Bay |
| **<<< KAŠTELA BAY** | **See Split** | **D+I** | **458** | **1369** | **148** | **20** | **939** | **Cd 37; Pb 136; Cr 162; Zn 748** |
| Split* | 350.000+ | D+I | 1.643 | 3.286 | 411 | 115 | 1.232 | |
| **<< SPLIT** | **350.000+** | **D+I** | **740** | **1.479** | **302** | **37** | **738** | **Cd 104; Pb 224; Cr 130; Zn 1.894** |
| Neretva river* | | D+I+A | | 1.927 | 17 | 4.2 | | Cd 459 |
| **>> NERETVA RIVER PLOÈE+ METKOVIÆ** | **100.000** | **D+I+A** | **85** | **379** | **38** | **6.5** | **109** | |
| **STON (NEUM)** | | **D+I** | **207** | **457** | **53** | **7.8** | **136** | **Zn 426** |
| Dubrovnik | 50.000+ | D | 160 | 310 | 79 | 19 | 139 | Pb 1.916; Zn 151 |
| **> DUBROVNIK** | **71.000+** | **D** | **169** | **461** | **98** | **21** | **427** | |

***TSS: Total Suspended Solids**

****TPB: Toxic Persistent and liable to Bioaccumulate substances** (Hg,Cd,Pb,Cr,Cu,Zn,Ni, POPs /Persistent Organic Pollutants/ and others - mainly hydrocarbons

* Report No.124

**Table 2.**
**MAIN POLLUTION LOADS**

| | | *Supporting data extracted from the questionnaires* | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Hot Spots** | **Population** | **Main Sources of pollution** | **BOD t/y (1.500)** | **COD t/y (4.500)** | **Total N t/y (2.000)** | **Total P t/y (570)** | **TSS* t/y (300)** | **TPB** kg/y** |
| **PULA** | **85.000+** | **D+I** | **555** | **-** | **130** | **16** | | |
| **RIJEKA and KVARNER BAY** | **206.000+** | **D+I<br>Ó=** | **2.412<br>331<br>2.743** | **3.185<br>585<br>3.770** | **299<br>14.1<br>313.1** | **63.5<br>14.1<br>77.6** | **1.464<br>240<br>1.704** | **Pb 110; Cd 109; Cu 180; Zn 1.440** |
| **Oil refinery (MLAKA+URINJ)** | | | | | | | | **Oil 67.5 t/y + Phenols** |
| **ZADAR** | **136.000+** | **D+I** | **538** | **1.282** | **83** | **14** | **2.250** | **Pb 84; Cr 96; Zn 518; Hg 10.3** |
| **ZADAR (Soya + Cannery)** | | **I** | **10.5** | **36.8** | **0.55** | **0.18** | **7.4** | |
| **ŠIBENIK** | **85.000+** | **D+I** | **121** | **374.5** | **140.5** | **12.7** | **230** | **Al 296** |
| **KAŠTELA BAY** | **See Split** | **D+I** | **458** | **1369** | **148** | **20** | **939** | **Cd 37; Pb 136; Cr 162; Zn 748** |
| **SPLIT** | **350.000+** | **D+I** | **740** | **1.479** | **302** | **37** | **738** | **Cd 104; Pb 224; Cr 130; Zn 1.894** |
| **NERETVA RIVER (PLOÈE+ METKOVIÆ)** | **100.00+** | **D+I+A** | **85** | **379** | **38** | **6.5** | **109** | |
| **STON (NEUM)** | | **D+I** | **207** | **457** | **53** | **7.8** | **137** | **Zn 426** |
| **DUBROVNIK** | **71.000+** | **D** | **169** | **461** | **98** | **21** | **427** | |

***TSS: Total Suspended Solids**

****TPB: Toxic Persistent and liable to Bioaccumulate substances** (Hg,Cd,Pb,Cr,Cu,Zn,Ni, POPs /Persistent Organic Pollutants/ and others - mainly hydrocarbons

**>>>** **>>** **>**

## 4. EVALUATION OF HOT SPOTS

The updated list of hot spots related to pollution is shown in the Table 3.

Kaštela Bay is a semi-enclosed bay covering a surface of 60 $km^2$ and has a total volume of 1.4 $km^3$. The exchange rate of water masses with the open sea is comparatively low. For a considerable time, the Bay has been receiving some 40 percent of completely untreated urban wastewaters from the wider urban area of Split, and all of the industrial wastewaters, only partially treated, from the entire area surrounding the Bay. The consequence had been seen in drastic changes in living communities, yearly occurrence of mass mortality of marine organisms, and unsuitability of the Bay for tourism and recreation.

However, the closing of some industrial plants and pre-treatment of IWW (Brewery "Kaltemberg", Adriavinil and Adriachem) already gave some positive results. The "Kaltenberg" brewery in Split has wastewater pre-treatment; so its wastewaters don't contain large quantities of pollutants and their discharge into the enclosed and shallow part of Kaštela Bay has not serious consequences on that part of the Bay.

Since the construction of new sewerage system around the Kaštela Bay is in progress, that will enable treated wastewaters to discharge in Braè and Split channels.

The town of Split is situated on a peninsula that encloses the Kaštela Bay. About 60 percent of urban wastewaters used to be discharged untreated into the Braè channel through a submarine outfall at a depth of 35 m and numerous outlets. The result was changes in coastal benthic communities, as well as high faecal pollution in some parts of the coastal part of the channel. But now municipal waters are mechanically treated and are discharged through new submarine outfall (l=1.300 m) at a depth of 43 m, while numerous outlets are closed.

The town of Zadar is located on the central part of the Croatian coast. It has well-developed metal and food-processing industries. Until recently, most of the urban and industrial wastewaters were discharged into the harbour resulting in frequent occurrence of anoxic conditions. Today, most of the wastewaters, without any treatment, are discharged into a 5-6 km wide channel through numerous outlets and an inappropriate submarine outfall. As a result, the sea beside the urban area is of inadequate sanitary quality for bathing.

The tannery in Zadar which wastewaters contained large concentrations of cromium salts, COD and TSS is finally closed, and so one big source of pollution of the coastal sea is eliminated.

The wastewaters of the cannery "Adria" and Soya factory in Zadar are only subjected to mechanical treatment before direct discharge into the sea. Inasmuch as they contain certain quantities of organic matter, now their pollution of the coastal sea is reduced. Only in summer months, unpleasant smells spread over a wide surrounding area.

The town of Rijeka is situated in Rijeka Bay. It is an important harbour and industrial centre. Two-thirds of household wastewaters receive primary treatment and are discharged through a submarine outfall at a depth of 44m, while the remaining 1/3 is discharged untreated through numerous outlets at the coast itself. Consequently most of the town beaches are not of an adequate sanitary level.

The oil refinery of Rijeka is the largest in Croatia, with a capacity of 6 million tons of oil derivates, and is the only one situated on the coast. Although it has appropriate treatment equipment for industrial and rainfall waters, the refinery pollutes the sea and soil with accidental spills of oil and its derivates. Between 14.000 and 20.000 t of hydrocarbons also containing sulphides and mercaptans, are deposited in the soil. In 1993, soil recovery archives were launched. An additional threat is approximately 8.000 t/y of solid waste remaining in the production and wastewater treatment plants.

For 15 years, a cokery existed in the small semi-enclosed Bakar Bay, but it has now been closed down and is being dismantled. There were 17.000 $m^3$ of wastewaters rich in phenols and cyanides in the Bay, but after treatment in IWWTP of Oil refinery Urinj, this Bay pollution loads has been reduced.

The town of Sibenik is situated in a channel whose top layers receive the waters of the Krka river, while the bottom layers are sea water. The most important economic activity was the production of aluminium and ferrous alloys, but these activities ceased several years ago. All urban wastewaters are discharged untreated into the channel through numerous outlets. Consequently, there is a high degree of pollution and sea is not suitable for bathing in certain urban areas.

The town of Pula is situated at the southernmost point of the Istria peninsula, in a small semi-enclosed bay that, at present, receives approximately 40 percent of urban wastewaters without any treatment through a large number of outlets, together with most of the industrial wastewaters. The most obvious result is the regular yearly occurrence of the “red tide”. The remaining parts of the wastewaters are discharged, after primary treatment, into the open sea through a submarine outfall.

The town of Dubrovnik, an important cultural, historic and tourism site, is located on the very south of the Croatian coast. There are no important industries in the town, even though the wastewaters of the oil factory caused significant pollution of Gruz harbour. Most of the urban wastewaters are pre-treated and discharged into the open sea through a submarine outfall, but a small part is discharged untreated through a number of outlets, causing occasional pollution of the beaches.

The Neretva river rises in the Republic of Bosnia and Herzegovina, and only 28 km of its total length of 215 km are in the Republic of Croatia. Neretva and its tributaries receive untreated urban and industrial
Metkovia with a total population of about 100.000. The largest industrial polluters are alumina production and the aluminium smelter in the Mostar (Bosnia and Herzegovina) area. At the river delta, intensive agriculture has developed, so the waters are additionally polluted by pesticides and fertilizers.

Krka is a carstic river whose source is 4 km east of the town of Knin and it flows into the sea in the channel near Sibenik. Over its 63 km length it receives household wastewaters from the nearby settlements amounting to a total population of 80.000. The most significant industrial pollutant of the river is the metal processing industry located in the area of the town of Knin.

The Krka river estuary is a deep canyon (some 40 m) 12 km long, whose width ranges from between 200 m to 1.8 km, and it ends in Prokljansko lake. Krka flows into the sea in the Sibenik channel, so its surface layers contain fresh water, while the remaining part is seawater. The Sibenik channel is one of the most productive areas of the eastern Adriatic. It

is used for shellfish and aquaculture. Unfortunately, it is significantly polluted, as indicated *inter alia* by high concentrations of some heavy metals in the sediment. The channel is polluted by urban and industrial wastewaters from the town of Sibenik, and metal-processing industries located along the Krka river.

Due to the mayor importance of this area, METAP III has prepared the pre-feasibility study "KRKA RIVERA AND NATIONAL PARK SEWERAGE AND SOLID WASTE STUDY".

Malostonski Bay is 28 km long and has a maximum width of 6.1 km. Both the inner and outer coasts of the Bay are highly indented, so the overall length of the coastline is about 100 km. The greatest part is 29 m, but in more than 80 percent of the Bay the depth ranges from 20 to 29 m.

The ecological situation of the Bay depends primarily on influences from the land (Ston, Neum), and only to a lesser degree on those from the open sea. The fresh waters of the Neretva river occasionally affect the outer and central parts of the Bay and the inner part to a lesser extent, especially when there is high water in the river and strong western winds. An important hydro geological factor affecting the hydro-physical and ecological relations in the Bay is the presence of strong submarine fresh water springs in the inner part of the Bay. According to the concentrations of nutrient salts and quantities of phytoplankton, the Bay can be qualified as a natural, moderately eutrophicated system. The input of organic matter from the land plays an important role in ecological and productive relations. Because of favourable primary production and hydrographic characteristics, shell culture has been developed in the Bay since ancient times. At present, it is the most important shell culture site of Croatia. Owing to the fact that the surrounding areas are sparsely populated, the Bay has never been exposed to anthropogeneous eutrophication of any importance. Because of its high productivity and significance for shell culture, Malostonski Bay has been protected as a marine reserve.

The Lim channel is situated on the western coast of the Istria peninsula. It is narrow (600 m) bay cutting deep into the land (11 km). The greatest depth of 33 m is at the entrance to the Bay, while the inner part is considerably shallower. The shallow part is characterized by a great influence of underground fresh waters rich in organic matter. Intensive oyster and mussel farming has therefore developed in this part, while fish farming has developed in the deeper part. Depending on the input of fresh water, the salinity varies between 9 and 38 ppm, while the temperature range is between $9^0$ and $25^0$C. Because of its high productivity, the Lim channel has been protected as a marine reserve. Several years ago, a threat to the channel arose in the form of wastewaters from a slaughterhouse. Even though it is situated in the hinterland, the wastewaters reach the Bay through the highly porous carstic terrain.

Mljet national park covers the north-western part of the island of Mljet and all the small islands in front of it, including the natural phenomena of the Large and Small Lakes, and the Solinski channel. The total surface of the protected area is 30 $km^2$, of which the Large Lake accounts for 1.47 $km^2$ (length of 2.5 km, width up to 1 km, depth up to 31m), and the Solinski channel for 0.12 $km^2$ (length 2 km, width 60 m, depth up to 3.7 m). Sanitary wastewaters from the surrounding settlements leak into the lakes.

The Kornati archipelago, situated south of Zadar, has a total surface of some 300 $km^2$, and is composed of 150 large and small islands and rocks with a total surface of 62 $km^2$. The Bay of Talascica, 8 km long and between 200 m and 2 km wide, is situated on Long Island, which borders the Kornati archipelago. Owing to their geomorphologic and petrographic wealth, as well as their biological wealth and biodiversity, the Kornati archipelago and Talascica Bay have been given the status of national park and Nature Park respectively. The

archipelago is far from any land-based sources of pollution, but is threatened by intensive tourism and nautical activities. The entire area of Kornati and Talascica has been adequately investigated, so the true effects of tourism are as yet unknown.

## 5. IDENTIFICATION OF MAIN GAPS AND CONSTRAINTS

Due to the experience gained over many years in implementing the national programme for monitoring coastal sea quality, there is a large amount of data on the basis of which it is possible to determine the degree of pollution of most of the coastal sea. There are also numerous data on the quality of wastewaters, both urban and industrial, but, as a rule, data are on wastewater quantities are lacking. Since wastewaters are mostly discharged through numerous outlets, which also serve run-off and surface waters, the data on wastewater quality differ considerably from one location to another, and from one town to another. It is therefore difficult to determine precisely the pollution load of urban and industrial wastewaters.

Although there is a great quantity of various data for some areas, only a few researches have been done for other coastal areas. So it is difficult to identify sensitive and environmentally important sites. However, new investigations, which should be able to identify those areas, are planned.

## 6. PROPOSED OPTIONS FOR REMEDIAL ACTION

The above mentioned town's problems related to pollution by urban wastewaters can be removed by the construction of appropriate sewerage systems that would eliminate the numerous outlets through which the wastewaters are now being discharged in the immediate vicinity of the coast. These systems should include treatment plants to purify the wastewaters to the required degree, and submarine outfalls. All industrial plants have to treat their wastewaters at least to the level of urban wastewaters before discharging them into the urban sewerage systems or to the sea. In particular, toxic and persistent matter that could disturb the operation of treatment plants, or is prohibited from being discharged into the sea according to international and/or national regulations must be removed.

The urban and industrial wastewaters of the wider urban area of Split, which includes the towns of Split, Solin, Kaštela and Trogir, have until now been discharged into Braè and Split channel and into Kaštela Bay without any treatment. Appropriate collectors are going to be built in order to bring these waters to two locations at which treatment plants are planned to be built. After appropriate treatment, the wastewaters will be discharged into the Split and Braè channels through the planned submarine outfalls. The industrial wastewaters will be treated before discharge into the urban sewerage system.

The pollution problems of the Kaštela Bay will also be resolved by the planned construction of the sewerage system that will include the towns of Split North, Solin, Kaštela and Trogir, as mentioned above.

In the case of Rijeka, part of the present sewerage system should be reconstructed and a new part built so that all the urban wastewaters can be brought to the present treatment plant. The degree of treatment at the plant has to be increased first to the primary level, and later to the secondary level of treatment. The industrial wastewaters now discharged directly into the sea should be treated to the level of urban wastewaters and discharged into the urban sewerage network.

The ground waters polluted by the Rijeka oil refinery should be extracted to the surface and treated in a way that would not threaten the environment.

In the town of Zadar, the building and reconstruction of the sewerage network has to be completed so that all the urban and industrial wastewaters can be brought to the locations at which treatment plants should be built. At these plants, the wastewaters should be treated to the secondary level and discharged into the sea of the Zadar channel through two appropriate submarine outfalls to be built.

The problem of the wastewaters of the "Adria" cannery and Soya factory in Zadar should be resolved by building an appropriate treatment plant.

The urban wastewaters of Sibenik should be collected by the sewerage system and brought to the location at which they should be treated to the primary level, and then discharged into the open sea through a submarine outfall. To achieve that, the existing sewerage system will have to be reconstructed and the necessary collectors, treatment plant and submarine outfall built.

For the town of Pula, an additional part of the collection network should be built, and the capacity of the wastewater treatment plant increased. The industrial wastewaters now discharged directly into the sea should be treated to the level of urban wastewaters and discharged into the urban sewerage network.

The small part of the urban wastewaters of Dubrovnik that are now discharged untreated into the sea should be collected and appropriate collectors should be built for this purpose. They should then be brought to the treatment plant, and, after pre-treatment, discharged through the existing submarine outfall.

The Krka estuary should be protected by the construction of the sewerage system for the town of Sibenik as mentioned above and by implementation of the management plan for the river basin, which should include the construction of a treatment plan for the wastewaters of the industries discharging directly or indirectly into the Krka river, as well as by strict quality control of the waters discharged.

Some technical assistance (support), not previously quoted, for research, management and monitoring, and public participation mechanisms will be necessary. The amount is estimated at the level of US$ 1.5 million.

The establishment and implementation of a monitoring programme as part of an appropriate management programme for the entire Bay area should protect Malostonski Bay. Measures should also be taken to protect the entire watershed so as to prevent pollution of ground waters that leak into the Bay.

The Lim channel should be protected by preventing the polluted ground waters from reaching it, which requires the implementation of a comprehensive programme of watershed protection to include *inter alia* treatment and discharge of all household and industrial wastewaters. It is necessary to organize and implement a monitoring programme as part of an appropriate management programme for the entire channel area.

To protect the national park of Mljet, a programme to monitor the effects of tourism activities on the entire area should be elaborate, and an appropriate regime for the sustainable management of the park established.

In order to valorise and protect the Kornati archipelago and Talascica Bay further a detailed study of the entire area should be prepared and carried out. It is also necessary to elaborate a programme to monitor the effects of tourism activities on the entire area as a prerequisite for sustainable management of this highly valuable locality.

## 7. TRANSBOUNDARY EFFECTS

Although pollution loads from the existing Hot spots is of local range, which is confirmed by the analysis of seawater, living marine organisms and underlying sediments from the open waters of the Croatian part of the Adriatic Sea, we can not exclude the possibility of some transboundary effect.

Especially because such transboundary effects have been recorded along the western Istrian coast as a consequence of the Po river pollution load. The same effect has been recorded in the Neretva river estuary, which is mostly the result of the pollution from the Bosnia and Herzegovina.

**Table 3.**

**Pollution Hot Spots in CROATIA**

| Name | Type | Public Health | Drinking Water Quality | Aquatic Life | Recreation | Other beneficial use | Welfare and economy | Category | Nature of investment | Preliminary estimated financial requirement (in US$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | (1) | (0.9) | (0.7) | (0.8) | (0.8) | (0.7) | | | |
| **Kaštela Bay** | - Domestic<br>- Industrial | 5 | 1 | 5 | 5 | 3 | 6 | B | WWTP + sewerage system | See Split |
| **Zadar** | - Domestic<br>- Industrial | 5 | 1 | 4 | 4 | 3 | 5 | C | WWTP + sewerage system | 35 million |
| **Split** | - Domestic<br>- Industrial | 5 | 1 | 4 | 3 | 3 | 6 | C | WWTP + sewerage system | 66 million |
| **Rijeka and Kvarner** | - Domestic<br>- Industrial | 5 | 1 | 4 | 4 | 2 | 6 | C | WWTP extension | 25 million |
| **Oil refinery Rijeka (Mlaka + Urinj)** | - Industrial | 2 | 1 | 6 | 4 | 4 | 6 | C | Underground sanitation | 8 million |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Šibenik** | - Domestic<br>- Industrial | 5 | 1 | 3 | 4 | 3 | 5 | C | WWTP + sewerage system extension | 30 million |
| **Pula** | - Domestic<br>- Industrial | 4 | 1 | 3 | 4 | 3 | 5 | C | WWTP + sewerage system extension | 30 million |
| **Dubrovnik** | - Domestic | 3 | 1 | 2 | 4 | 1 | 5 | D | DWWTP and sewer extension | 6 million |
| **Neretva river (Ploèe + Metkoviæ** | - Domestic<br>- Industrial | 3 | 1 | 2 | 3 | 2 | 3 | D | Management plan and study of pollution sources | 700.000 |
| **Ston (Neum)** | - Domestic<br>- Industrial | 3 | 1 | 2 | 3 | 2 | 3 | D | Study of pollution sources in the Bay | |
| **Zadar (Soya + Cannery)** | - Industrial | 2 | 1 | 2 | 3 | 2 | 3 | D | IWWTP and WWTP reconstruction | 2 million |

**WWTP – Waste Water Treatment Plant**
**DWWTP – Domestic Waste Water Treatment Plant**
**IWWTP – Industrial Waste Water Treatment Plant**
**VTS – HAC – Vessel Traffic Service – Harbour Approach Control**

# REVISION OF POLLUTION HOT SPOTS IN THE MEDITERRANEAN

Country report for

***E G Y P T***

***Acknowledgements***

*The questionnaires used for compiling data for this report (23 in all) and the first drafts of this report were prepared in the Alexandria headquarters of the National Institute of Oceanography and Fisheries (NIOF) of the Academy of Scientific Research and Technology by a team made up of:*

- *Dr. Ali Ibrahim Beltagy: Professor of Marine Chemistry, Chairman of the Shore Processing Laboratory, NIOF, and National Coordinator for this activity (team leader)*
- *Dr.(Mrs.) Wafica Mohamed Aboul Naga: Assistant Professor, Marine Chemistry Laboratory, NIOF.*
- *Dr.(Mrs.) Thana'a Hanafy Mohamed: Assistant Professor, Marine Chemistry Laboratory, NIOF.*
- *Mr Khaled Abdel Aal Moussa, Shore Processes Lab., National Institute of Oceanography and Fisheries, for preparing this report*

**Prepared in 1997 by:** **Mr O.A. El-Kholy**
**Revised in 2001 by:** **Dr. Ali Ibrahim Beltagy**

# I- INTRODUCTION

Egypt has an area of 1.109 million $km^2$. It has a population of over 58 million. The climate is warm and dry. The rainfall is limited to the northern coastal area, while upper Egypt and the Red Sea-Sinai mountainous area are flooded from time to time. The coastlines of Egypt extend for over 3000 km along both of the Red and the Mediterranean Seas.

Agricultural contributes to 16% to GNP. Cultivation is concentrated in the Nile delta region, and only 6% of the total area of Egypt is cultivated. Livestock, farming and freshwater fishing are also important. Most of the production is highly labor intensive.

The industry sector contributes around 17.5% GNP. Agro-allied industry accounts for 40% of this amount. Development down stream include chemical and heavy industry like Hellwan area and steel complex, the Nagaa Hammadi aluminum plant and El-Dikhila industrial steel work. Other products include cement and fertilizers.

The mining sector is small and its activity concentrated on mining of iron, phosphate, gypsum, kaolin, limestone and silica. These activities are concentrated mainly on the Red Sea coast.

The oil sector is one of the most important industries where it contributes over 15% of the GNP and accounts for 55% of the export earnings.

The pressure of the human activity on the coastal resources of the Mediterranean and Red Seas are very intense. The Egyptian coasts receive the impact of the major part of the country's population. The enormous urban population and adjacent already formed agricultural lands, all, contribute to the pollution load reaching coastal waters, weather direct like the Alexandria region or via coastal lagoons (such as lake Manzala which receives the major part of the Cairo mixed waste water). Egypt industry also contributes to the pollution load in the coastal waters.

The Mediterranean Sea is a semi-enclosed water body that has limited exchange with the Atlantic Ocean, Black Sea, and to very small extent with the Red Sea.

The coastline of Egypt occupies ca. 1000 km on its southeastern part. The Mediterranean coastal zone of Egypt hosts a number of activities beside a long stretch of undeveloped areas. The Mediterranean coast of Egypt with different inland and offshore activities, the estuaries of the Nile, at Rosetta and Damietta, and the coastal lakes Maryut, Idku, Burullus, Manzalah and Bardawil pour ca. $8{,}000 \times 10^6$ $m^3/y$ of water some of which carries heavy load of pollutants. Major cities on the coast used to get rid of their waste through sea outfalls like Alexandria, and into lakes that pour its water into the sea like Port Said. The lakes of Maryut and Manzalah are heavily polluted, and parts of them are actually dead.

The maritime transport in the eastern Mediterranean, including oil tankers, commercial ships and passenger ships, affect the coast to a large extent. The entire beaches are permanently polluted by oil lumps, litter and plastic debris even in the very far remote areas of the coast where there are no known activities there.

The general pattern of circulation in the offshore area of the southeastern Mediterranean is from west to east, while in the near shore areas there are some deviations from this rule and some gyres and convergence zones exist.

This report illustrates the present situation of the extent of pollution in Egypt (particular in some hot spots). This environmental pollution originated from the discharge of a huge amount of wastewater (sewage, industrial and agricultural discharges) into the coastal water of the Mediterranean sea of Egypt.

The marine environment (as a part The coastal zone) is of great economic and environmental significance. This zone in Egypt is currently under severe and ever increasing pressure. A number of factors contribute to this situation: a) rapid urbanization of the coast; b) pollution from residential commercial and industrial activities, c) tourism development, d) resource users; e) continuous development in hazards prone areas.

The City of Alexandria is faced with a critical wastewater problem that stems from two causes, the high rate of population growth and the rapid industrial development.

Alexandria occupies a narrow stretch along the sea, extending for about 40 km from Agamy to the west to Abu Qir in the east, between the Mediterranean and lake Maryut. The city sewage is disposed of both north ward to the sea and south ward to lake Maryut, Figure(1). The old part of city, particularly, the heart of Alexandria is drained by the main pumping station at Kayet Bay. However, most of the industrial activities in Alexandria are concentrated in three main centers, Mex., Moharam Bey and Abu Qir Bay.

Abu Qir Bay receives a huge amount of industrial wastewater from three main industrial complexes. They are:

(1) Abu Qir complex that pump its water directly into the Bay (Fertilizer, Electricity , Rakta and National Paper, Kaha Factories ).

(2) Kafr El-Dawar complex (Textile Factories).which dumps its wastes in El-Amia drain,

(3) El- Siouf discharged its wastewater indirectly into the Bay through El-Gharbi drain which transfers the wastewater to El-Amia drain then to Abu Qir Bay. El-Siouf industrial activities working in food processing, paints and textile.

Along the Egyptian coast, there are a number of river mouths, canals and drains that discharge their water directly into the Mediterranean. These include Rosetta and Damiatta, Branches of the Nile, El-Umum Drain, El–Tabia Drain , Kayet Bey outfall, Nubariya and Mahmoudiah canals together with several other smaller ones.

**II-Terms of References:**

The terms of references adopted to accomplish the assigned task comprised the following:

(1) To update the country report on Mediterranean hot spots.
(2) Based on data on industrial and municipal discharges, to prepare a list of “hot spots”. These data are collected from published and unpublished reports, papers as well as Ph. D. and Master theses.

**III-Approach followed:**

1- Collection of data.
2- Preparation of short account of the state of receiving water.
3- Analysis of collected data.
4- Preparation of the list of hot spots following recommended criteria.

5- Propose remedial actions with estimated cost.

**III.1- Data collection:**

Sheets are prepared in tables.

**III.2- State of receiving water:**

Preparation of a short account of the state of receiving waters based on data available on the basic parameters of water and water quality parameters along the Mediterranean coast of Egypt. The following description is mainly based on large scale survey that was carried out in 1994-1995 (Beltagy *et al*. 1996) unpublished report.

**a-Nitrogen Forms**

In bulk, the N-forms were the highest off the west coast and decreased eastwards across the area. They were also most abundant in the top 20 meters of the water column and decreased downwards. On the other hand, the organic nitrogen forms were the dominant in waters of the area. They were higher in the far western part of the area than at east. They were also higher at intermediate levels in the water column than at the surface or depth. The inorganic nitrogen forms were the highest off El'Hamra and decreased both to east and west.

Nitrates were the major inorganic nitrogen form in waters of the area. They were at maximum off El'Hamra and decreased both to east and west. The decrease, however, was progressive eastwards and abrupt westwards. On the other hand, the $NO_3$ concentrations were mostly the highest at the surface and decreased with depth, except at far west where they were higher in the subsurface. The vertical variation in nitrate concentrations was minimum at east; maximum in the central part; and moderate at west.

The nitrite concentrations were higher in the eastern part of the area as west as Alexandria than to west of it. They were also higher deeper in the water column than at the surface; particularly in the eastern part of the area.

The ammonia levels showed a saddle-pattern of distribution with two highs at east and west and a low in-between. The concentrations were also higher at the surface than at depth in the water column in most parts of the area.

**b-Phosphate**

The reactive $PO_4$ were very low in the water column of the area. They are the highest at the western end of the area and drop rapidly to the east.

A small increase is observed at the surface and 50 depth off Alexandria, but this rather diminishes rapidly to the east. Vertical variations in the levels of reactive $PO_4$ down the water column are evident, but no consistent pattern can be identified across the area.

The total phosphate concentrations show a longitudinal distribution pattern similar to that of the reactive $PO_4$. However, they are usually higher in the surface layers of water than in the subsurface.

**c-Silicate**

The silicates are higher in the eastern part of the area than at west. They are also higher in the surface layers than at depth in the water column.

Pollutants in Different Components of the Coastal Waters:

The monitoring program for the levels of pollutants on the Mediterranean coast of Egypt, which was initiated as a part of the MEDPOL activities, comprised sampling and analyses of sediments, fish and bivalves at seven sites on the coast for the determination of levels of heavy metals and pesticides residues in these media. Sampling was done at Damietta, Gamasa, Baltim, Rosetta, El'Maadia, El'Mex and Fukah.

In the following sections, an account on the results of this monitoring program in the years 1992, 1993 and 1994 is given.

**d-Heavy Metals**

Five heavy metals were determined in sediments, fish and bivalves samples collected from the monitoring sites. These comprised copper, lead, zinc, cadmium and mercury.

The copper concentrations ranged between 2.980 (El'Maadia) and 61.110 μg/g (El-Mex)) in sediments; between 1.670 (Baltim) and 17.820 μg/g (Gamasa) in fish; and between 4.110 (Rosetta) and 84.830 μg/g (Baltim) in bivalves.

The lead concentrations ranged between 2.280 (Rosetta) and 30.310 μg/g (El'Mex) in sediments; between 0.160 (El'Maadia) and 3.500 μg/g (Damietta) in fish; and between 0.113 (Rosetta) and 9.990 μg/g (Gamasa) in bivalves.

The zinc concentrations ranged between 14.400 and 62.420 (both at Rosetta) μg/g in sediments; between 10.400 (Abu Qir) and 40.100 mg/kg (Damietta) in fish; and between 41.800 (Rosetta) and 112.000 μg/g (Abu Qir) in bivalves.

The cadmium concentrations ranged between 0.027 (Rosetta) and 0.461 μg/g (El'Mex)) in sediments; between 0.026 and 0.480 μg/g (both at Rosetta) in fish; and between 0.031 (Damietta) and 0.677 μg/g (Abu Qir) in bivalves.

The mercury concentrations ranged between 0.021 (Rosetta) and 0.863 μg/g (Baltim) in sediments; between 0.010 (Rosetta) and 1.670 μg/g (Gamasa) in fish; and between 0.067 (Rosetta) and 1.080 μg/g (Baltim) in bivalves.

**e-Organochlorine Pesticides and Polychlorinated Biphenyls:**

Over the study period, the hexachlorobenzene levels varied between nil and 7.10 ng/g (Baltim) in sediments; between nil and 8.60 ng/g (Damietta) in fish; and between nil and 7.10 ng/g (Baltim).

The lindane levels ranged between nil (Rosetta) and 7.20 ng/g (Gamasa) in sediments; between nil and 12.50 ng/g (El'Mex) in fish; and between nil and 5.50 ng/g (Damietta).

The levels of p,p' DDE ranged between nil and 5.80 ng/g (El'Maadia) in sediments; between nil and 13.00 ng/g (Gamasa) in fish; and between nil (Damietta) and 26.00 ng/g (Gamasa) in bivalves.

The levels of p,p' DDD ranged between nil and 20.00 ng/g (Gamasa) in sediments; between nil and 25.00 ng/g (El'Mex) in fish; and between nil (Damietta) and 35.00 ng/g (Baltim) in bivalves.

The levels of p,p' DDT ranged between nil and 14.00 ng/g (Rosetta) in sediments; between nil and 40.00 ng/g (Gamasa) in fish; and between nil (Damietta) and 18.00 ng/g (Rosetta) in bivalves.

The levels of Arachlor 1254 ranged between nil and 187.00 ng/g (El'Mex) in sediments; between nil and 100.00 ng/g (El'Mex) in fish; and between nil (Damietta & Baltim) and 165.00 ng/g (Baltim) in bivalves.

The levels of Arachlor 1260 varied between nil and 90.00 ng/g (Gamasa) in sediments; between nil and 129.00 ng/g (Rosetta) in fish; and between nil (Damietta, Gamasa & Baltim) and 50.00 ng/g (Baltim) in bivalves.

The Aldrin levels ranged between nil and 16.00 ng/g (ElMax) in sediments; between nil and 5.00 ng/g (Rosetta) in fish; and between nil and 19.00 ng/g (El'Maadia) in bivalves.

Some apparent trends of decrease in pollutants levels are observed. However, these need some more longer periods to be ascertained.

**III.3- Analysis of collected data:**

The collected data were analyzed according to tables given by UNEP.

**III.4- Preparation of the list of hot spots following recommended criteria**:

Finally, the updated list of hot spots on the Mediterranean coast of Egypt was compiled and prepared according to the updated data and evaluation criteria as well.

**III.5- Proposed option for remedial action:**

The main option available for remedial action at all sites is the construction or rehabilitation of wastewater treatment plants.

**Priority hot spots:**

The assessment of the hot spots was made according to its relative important index.
Identification of Main Gaps & Constraints:

The main gaps and constrains are as follows:

(1) The scarcity of data on different water quality parameters,
(2) The lack of quality assurance & control measures for the existing data, and
(3) Time available for preparing the report.

**Acknowledgement**

The help and efforts of Mr. Khaled Abdel Aal Moussa, Shore Processes Lab., National Institute of Oceanography & Fisheries, in preparing this report are acknowledged.

## Pollution Hot Spots in ……EGYPT……

| Name | Type | Public Health | Drinking Water Quality | Aquatic Life | Recreation | Other beneficial use | Welfare and economy | Category | Nature of investment | Preliminary estimated financial requirement (in US$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | (1) | (0.9) | (0.7) | (0.8) | (0.8) | (0.7) | | | |
| El'Mex Bay | Domestic+Industrial | 2 | 1 | 3 | 2 | 2 | 4 | D | WWTP Construction | 101.2+ |
| Alexandria | Domestic | 2 | 1 | 2 | 2 | 1 | 2 | E | WWTP Construction | |
| Abu Qir Bay | Industrial | 2 | 1 | 3 | 2 | 2 | 4 | D | WWTP Construction | 61.6 million+ |
| Lake Manzala | Domestic+Industrial | 2 | 1 | 2 | 2 | 2 | 5 | D | WWTP Construction | |
| Port Said | Domestic | 1 | 1 | 2 | 1 | 1 | 1 | E | WWTP Rehabilitation | |
| | | | | | | | | | | |

# REVISION OF POLLUTION HOT SPOTS IN THE MEDITERRANEAN

Country report for

***L E B A N O N***

***Acknowledgements***

- *Mr.Naji Kodeih, SAP-Coordinator (Ministry of the Environment), is sincerely thanked for his untiring efforts and Commitment during the visit to Lebanon.*
- *Mrs Dalai Barracked, Chief of Protection of the Urban Environmental Service, Mr.Talal Chartouni and Mr Naim Samaha from the Minister's Departmental Staff (Ministry of the Environment) are also thanked for their assistance and cooperation.*
- *The collaboration of Mrs Wafa Sharaf el Dine from the Programmes Division of the Council for Development and Reconstruction (CDR), who provided all the necessary data concerning the Lebanese Government's plans for remedial action is acknowledged with thanks.*

**Prepared in 1997 by:** **Mr Dimitrios Tsotsos**
**Revised in 2001 by:** **Dr. Naji Kodeih and Ms Alia Kaskas**

## 1. INTRODUCTION

The Government of Lebanon embarked upon a very ambitious Coastal Pollution Control and water Supply Project with the objectives to:

- Improve sanitary and environmental conditions in three major urban areas of the coastal zone, covering a population of about 1 million;
- Extend water supply and wastewater services in selected areas;
- Reduce groundwater and surface water pollution;
- Reduce sea pollution to restore beaches for recreational use;

This project consist of the following components:

- Extension and rehabilitation of water supply facilities in the Kesrouan and Nabatiye, and wastewater collection and disposal systems in the Kesrouan, Saida, Sour and Nabatiye sub-project areas, Jbeil, Batroun, Koura, Tripoli and Akkar;
- Operation, maintenance equipment and office facilities for the proposed five regional water authorities, or successor regional water and sanitation companies, and operational equipment for environmental monitoring;

Environmental Assessments were prepared for the water supply and wastewater facilities for each sub-regional area. Proposed mitigation measures address: impacts relating to project design and the sitting and routing of facilities; short-term impacts during construction; and long-term impacts during operations. A proposed environmental monitoring plan will, for each sub-project area, cover: physical oceanographic measurements, seawater chemical analyses, bathing water quality for beaches adjacent to the sea outfalls, and potential impact on fish, benthic and shellfish in proximity to the sea outfalls. Monitoring will commence prior to construction of the sea outfalls and continue during the periods of construction and subsequent operations.

The project will help insure preservation and protection of marine ecosystems. It is to provide the sound elements for further application as control, environmental impact assessment and mitigation or correction measures. One of the main tasks assigned to the project is to acquire the data for depicting the real environmental situation all along the coastal zone of Lebanon,, especially to monitor the coastal waters with specific geographical emphasis on the sea outfalls of Kesrouan, Saida and Sour and the main urban centers (Beirut and Tripoli).

The project objectives are to prepare and implement an environmental monitoring plan to monitor the coastal waters, and to provide specific environmental information including a long-term trend on environmental changes, and to alert in case of occurrence of hazardous conditions, and to determine timing for extension of improved wastewater treatment.

The Council for Development and Reconstruction (CDR), directly under the authority of the Prime Minister, is mainly responsible for the planning and execution of major infrastructure projects, including those for liquid-solid waste collection, treatment and disposal.

## 2. CHARACTERIZATION OF THE COASTAL AREA

### 2.1 Physical Context

Lebanon is about 217 km long and its width ranges between 40 and 80 km. The coast is a narrow strip extending along the Mediterranean Sea and bounded to the east by the West Lebanon Mountain Range. The width of the coastal plain attains its maximum at the northern and southern extremities of the country. The transition from the coastal plain to the high mountains is often abrupt.

### 2.2 Rainfall

The coastal area in Lebanon has a high mean annual rainfall (Beirut at 893 mm). Precipitation patterns show large seasonal variations with more than 80 percent of the annual rainfall occurring between November and March. The precipitation events are frequently violent downpours, which can result in serious flash flooding and erosion.

### 2.3 Oceanography

**Salinity:** Water salinity in Lebanon ranges from 34 to 39 per thousand with an average of 38. This is relatively high value compared to an average salinity of 36,5 in western Mediterranean basin.

**pH :** Monthly pH vary between 7,4 and 8,2. Minimums occur during winter and early spring when the fresh water inflow from rivers is the highest. During the rest of the year the pH is relatively constant at around 8,1.

## 3. ECOLOGICAL CONTEXT

The ecological context along the coastal zone is of utmost importance for monitoring program. Such context provides the current status of the littoral in terms of water and sediments quality. The major sources of pollution along the coastal zone are contaminated surface water, raw domestic and industrial wastewater discharges, agricultural runoff, solid waste dumps, and accidental oil spills. In addition, species biodiversity is being threatened by human activities such urbanization, deforestation, overgrazing, hunting and the excessive use of agrochemical resulting in a significant decline in coastal animals and plant species including woodlands.

Untreated sewage discharges are a source of pathogenic microorganisms, biochemical oxygen demand (BOD) that can lead to significant oxygen depletion, particularly in stagnant areas, and nitrogen and phosphorus inputs that can lead to marine eutrophication. Industrial discharges are a source of chemical contaminants.

The pollution of coastal water by sewage outfalls and industrial effluents and agricultural runoff are a major source of bacteriological, organic and inorganic chemical contamination.

Chemical pollutants present in the sea are introduced into the food chain at the lowest levels, and then transferred up the trophic ladder to higher organisms, including humans.

## 4. INPUTS IN COASTAL AREA

There are three major routes through which pollutants are transported to the sea, namely land sources, atmospheric sources, and marine sources.

The transport mechanisms include mainly coastal rivers, surface runoffs, domestic and industrial waste outfalls, and accidental or intentional waste disposal in the sea.
Average wastewater generation rate in Lebanon varies with location and season. For estimation purposes, the average rate is about 120 liter/capita/day. This average expected to increase with 1,5% yearly. Actually, we can estimate the average by 130 liter/capita/day. For Greater Beirut area we estimate 170 liter/capita/day.

Numerous projects are underway to construct treatment plants in Tripoli , Chekka, Batroun, Jbail, tabarja, Dora, Ghadir, Chouf, Saida and Sour (Tyr). It is expected, by the year 2005, that about 70% of the domestic and commercial wastewater generated in Lebanon will be collected and treated at a wastewater treatment facility before final disposal. The wastewater from the industry will find its way to the treatment facilities for commercial and domestic wastewater after in site treatment.

## 5. ELABORATING THE SURVEY

This survey has been elaborated on the basis of the information in the Ministry of Environment, Department of Prevention from the Impacts of Technology and Natural Hazards, and lengthy discussions with Dr. Naji Kodeih, appointed National Coordinator for the Strategic Action Programme, and with Mrs. Alia Kaskas, environmental and public health specialist in the Ministry of Environment, and relevant experts of the Ministry, as well on detailed overview of relevant documentation. Major input regarding the plans already existing for remedial action was provided by Mrs Wafa Sharaf el Dine of CDR.

The main report used for this review survey is the study " Coastal Pollution and Water Supply Project – Preparation of an environmental monitoring plan", prepared for the CDR by LACECO, SAFEGE and SAFEGE CETIIS (June 2000). This study systematically addresses and evaluates all the key issues of Coastal Management.

Moreover, we have used a great number of research papers and results of monitoring activities performed by several Lebanese scientific institutions, mainly the Marine Scientific Center and the National Council for Scientific Research.

## 6. IDENTIFICATION OF HOT SPOTS

### 6.1- Methodology

In identifying potential hot spots on the coast of Lebanon, the following selection criteria were utilized:

1- Coastal cities and urban coastal agglomeration with considerable population (more than 100,000 inhabitants taking into consideration the size of the country);
2- Main industrial facilities discharging directly into the Mediterranean;
3- Encountered health problems caused by environmental pollution.

When reviewing the list of hot spots set by the previous national report, consideration was given to some implemented mitigation measures that might had a role on the overall ranking of hot spots on the long run. These measures are implemented for the long term purpose of:

1- Reducing pollution loads in effluents and automatically in the recipient (sea),
2- Decreasing the different pollution sources.

In addition, we are used the definition and criteria mentioned in the document with reference HEV-MED 5022112 of 16 June 2001, namely: hot spots definition, hot spots indicators (primary), evaluation criteria of national hot spots, and the indicators of impacts on public health, drinking water quality recreation and other beneficial uses, aquatic life (including biodiversity), economy and welfare, transboundary effects, nature of investment and economic costs.

We respected the procedure mentioned in this document.

### 6.2- Selection of potential hot spots

The potential hot spots selected are listed in table 1.

**Table 1**

**Potential hot spots**

| Location | Main cities | Population equivalents (p.e) | Main activities |
|---|---|---|---|
| Greater Beirut area | Beirut and suburbs | 1,300,000 | Municipal, industrial, agricultural |
| Tripoli | Tripoli and Tripoli Caza | 360,000 | Municipal, agricultural |
| Batroun-Selaata | Batroun | 60,000 | Municipal, Industrial, agricultural |
| Jbail (Byblos) | Jbail | 75,000 | Municipal, agricultural |
| Jounieh | Jouniehh | 210,000 | Municipal, Industrial, agricultural |
| Saida-Gazieh | Ssaida and Saida Caza | 220,000 | Municipal, industrial, agricultural |
| Sour (Tyr) | Sour and Sour Caza | 200,000 | Municipal, agriculture |

## 7. POLLUTION SOURCES

### 7.1- Municipal wastewater

Microbiological pollution is mainly the result of residual waters from cities and domestic wastewater generated by habitants. The majority of coastal agglomerations discharge directly into the sea.

Independently of the physico-chemical elements, wastewater contains numerous microorganisms: bacteria, protozoa, etc.

In Table 2, the wastewater characteristics in Lebanon are shown.

**Table 2**

**Wastewater characteristics in Lebanon**

| Parameter | Range (mg/l) | Average (mg/l) |
|---|---|---|
| BOD | 30 - 230 | 128 |
| COD | 250 - 820 | 630 |
| Nitrate-N | 30 - 160 | 100 |

In Table 3, the hydraulic and pollution load figures for each hot spot are shown.

**Table 3**

**Assessment of pollution**

| Location | Main pollution sources | Hydraulic (m3/day) | Parameter: tn/year |
|---|---|---|---|
| Greater Beirut area | Municipal, Industrial, agricultural | 221,000 | BOD: 10183<br>COD: 50122<br>Nitrate-N: 7955 |
| Tripoli | Municipal, agricultural | 46,800 | BOD: 2156<br>COD: 10614<br>Nitrate-N: 1648 |
| Batroun-Selaata | Municipal, industrial, agricultural | 7,800 | BOD: 359<br>COD: 1769<br>Nitrate-N: 280 |
| Jbail (Byblos) | Municipal, agricultural | 9,750 | BOD: 449<br>COD: 2211<br>Nitrate-N: 351 |
| Jounieh | Municipal, Industrial, agricultural | 27,300 | BOD: 1258<br>COD: 6191<br>Nitrate-N: 983 |
| Saida-Gazieh | Municipal, industrial, agricultural | 28,600 | BOD: 1318<br>COD: 6486<br>Nitrate-N: 1029 |
| Sour (Tyr) | Municipal, | 26,000 | BOD: 1198<br>COD: 5897<br>Nitrate-N: 936 |

### 7.2- Industrial wastewater

The industrial sector evolved during the post war period whereby 57% of the establishments were founded between 1990 and 1995. Most of industries are located in Mount Lebanon in close proximity to coastal and surface water bodies.

With the absence of heavy hazardous industries except for tanneries, the majority of the industrial waste stream (96%) is non-hazardous. Moreover, 66% of industrial waste stream can be treated as domestic waste; whereas the remaining requires some pretreatment before discharge into domestic waste networks.

Industrial waste is not generally collected and is typically disposed of with domestic waste or stored on site whenever possible.

In Table 4, The heavy metal concentrations in the sea are shown.

**Table 4**

**Range of heavy metal concentrations in the sea**

| Heavy metal | Minimum (ì g/l) | Maximum (ì g/l) | Allowable level (ì g/l) |
|---|---|---|---|
| Barium | <10 | 5090 | 1000 |
| Cadmium | <10 | 20 | 5 |
| Chromium | <10 | 5490 | 100 |
| Cobalt | <10 | 70 | NA |
| Copper | <10 | 950 | 50 |
| Lead | <30 | 1820 | 50 |
| Manganese | <10 | 1710 | 100 |
| Mercury | <2 | 16 | 0,1 |
| Nickel | <10 | 150 | 100 |
| Vanadium | 20 | 5380 | NA |
| Zinc | 30 | 7770 | 100 |

In Table 5, BOD5 and heavy metal concentrations along the Lebanese coast.

**Table 5**

**BOD5 and Heavy metal concentrations along the Lebanese coast**

| Location | BOD5 (mg/l) | Nickel (microg/l) | Copper (microg/l) | Chromium (microg/l) |
|---|---|---|---|---|
| Sour (Tyr) | 8,20-20,33 | 3,5-7 | 12-14 | 18-20 |
| Saida – Gazie | 4-12 | 3,2-29 | 13-33 | 30-120 |
| Beirut | 7,6 –114 | 4 –26 | 12 –20 | 24 –80 |
| Jounie | 6,6-13 | 27 –36 | 5,7-26 | 81-160 |
| Jbeil (Byblos) | 5,6 | <2 | 11 | 5,4 |
| Batroun | 10,20 | 44 | 15 | 36 |
| Tripoli | 11,3-27 | 2,9-10 | 17-41 | 23-54 |

In Batroun, the concentration of mercury for the first six months of 2001 is between 110 – 325 ng/l.

## 8. Ranking of hot spots

### 8.1 Introduction

In this chapter, the selected hot spot have been prioritized by evaluating the potential risks exerted by the relevant point sources and the effects on public health, drinking water quality, recreation, other beneficial uses, aquatic life and biodiversity, and economy/welfare.

The weighted ranking system and relevant explanations (documentation) have been used for this purpose. Relevant factors and multipliers were used in this analysis. Were there was no satisfactory information, experience and documentary references were used in order to formulate a fairly reliable picture of the prevailing conditions.

### 8.2 Comments – remarks on criteria – explanations

On-shore uncontrolled dumping sites of solid wastes are considered as discharges with a high level of pollution (leached).

Table 7 summarizes the final results of the weighted ranking analysis and the preliminary cost estimations for remedial action.

## 9. General comments

In contrast to the previous national report where all the data were estimated, this updated version reports actual measured data based on actual assessment and laboratory analysis.

Moreover, receiving seawater quality measurements are now available and the Marine Sciences Institute upon a binding contract with the Ministry of Environment performed these for periodic monitoring of seawater quality along the Lebanese coast. This activity is under the MEDPOL Monitoring Program.

The Ministry of Environment is performing an environmental survey and a monitoring program to assess the quantity and the quality of the industrial effluents. Based on these activities industrial wastewater pretreatment units are being installed by the industries and the Ministry monitors treated discharges. This program is implemented progressively and five to ten industrial facilities are targeted at a time.

National Industrial waste inventories were estimated in previous studies and proved insignificant. Therefore, the Ministry of Environment focused on the hazardous waste quantity and quality. Therefore a project on Integrated Hazardous Waste Management was initiated in mid 2001 and expected to end up by mid 2002.

Data on population density and socioeconomic aspects are now available based on a projection study performed by the UNDP in 1998. The Lebanese population were estimated to be 3.5 million inhabitants.

## 10. Basic assumptions – findings

### 10.1- Municipal discharges

- Wastewater quantity: 130 l/cap.day,
  for Great Beirut area : 170 l/cap.day;
- BOD5-load: 80 g/cap.day;
- Permanent population: to be served by the sewer system;
- Quantity of suspended matter flow is :

- Sour: 10 tons/day
- Saida: 13 tons/day
- South Beirut: 104 tons/day
- Kesrouan: 22 tons/day
- Tripoli: 40 tons/day.

### 10.2- Industrial discharges directly into the sea

- Indirect discharges, via small streams rivers at a short distance from the shoreline, have been assumed.
- Effluents from tanneries have been assumed.
- Effluents from detergents have been assumed.
- Effluents from nutrition industry have been assumed.
- Effluents from electrical, pharmaceutical and nutrition industries were calculated.
- Effluents from fertilizer plant were taken into account.

## 11. Remedial Action

### 11.1- Conclusions

This survey's finding have shown clearly the urgent requirements for immediate infrastructural and organizational intervention in order to prevent any further negative impact on coastal waters and improve the environmental situation gradually.

The Lebanese Government is fully aware of these requirements and has launched major initiatives to cope with the present situation, namely, the creation of the Ministry of Environment, the launching of industrial effluent monitoring program, the setting of national environmental limit values, the follow up of environmental international conventions: Basel convention, Barcelona convention (Cleaner production, MAP, MEDPOL, LBS protocol etc.) Stockholm convention on POPs, the preparation of the most important projects for wastewater collection, treatment and disposal for the main coastal cities (Beirut, Tripoli, Jbeil, Saida, Jounieh and Sour ) by CDR.

### 11.2- Description of remedial actions – Cost figures

#### 11.2.1- Municipal discharges

In view of the current situation and the reconstruction priorities fixed, the installation of primary treatment plants (sedimentation), combined with long submarine outfalls, is the option adopted by the Government.

The rehabilitation and expansion of existing sewerage networks is an integral part of each project for the reduction of uncontrolled discharges into the marine environment.

Consequently:

- The el Gadir plant, serving 50 per cent of the Greater Beirut area is now operational, and a feasibility study is prepared on its eventual expansion to a secondary stage (biological);
- Studies/tender documents for each for the Dora plant, which serves the remaining part of the area are finalized.
- Studies/tender documents for each plant serving Tripoli, Jounieh, Saida, and Sour are finalized.
- Feasibility studies are prepared for the areas around the cities of Batroun and Jbeil (Byblos).

#### 11.2.2- Industrial discharges

As a follow up step to the master plan for industrial waste management, an Integrated Hazardous Waste Project was initiated at the Ministry of Environment with the following scope of work:

i) Review the existing studies available at the MoE and complete the hazardous waste inventory in order to have a more accurate figure on the quantity, quality and source of hazardous waste generated in Lebanon, particularly in the industrial and agro-chemical sectors;
ii) Organize an Industrial and hazardous waste team within the MoE, make the functional analysis of its tasks and determine its responsibilities;
iii) Assess the hazardous waste control systems in a few similar middle-income Mediterranean countries (Turkey, Tunisia) in order to draw form their experience in the design of a system for Lebanon;
iv) Develop an integrated approach for the management of all hazardous

waste in Lebanon, mainly for the storage, transportation, treatment, and disposal of the waste;

v) Develop guidelines for the management of hazardous waste based on the existing guidelines of Basel convention;
vi) Review the existing Lebanese legislation and prepare the following Decrees: The decree on waste definition and waste classification, decree on hazardous waste management (storage, transport, treatment, and disposal, including permits delivery and cost recovery), decree on inspections and enforcement.
vii) Prepare a manual for the classification and management of hazardous waste;
viii) Develop an action plan and, more generally, propose all measures and actions able to ensure the sustainability of the program at the end of the initial phase.

Cost figures: This project budget is of 180,000 USD made available by METAP threw the Italian trust fund of the WB.

### 11.2.3- Capacity building

In its present condition, the Ministry of Environment is not in a position to carry out time efficient monitoring or control compliance by enterprises with set effluent quality standards (lake of personnel). It is therefore urgently necessary to improve its organization and develop it further.

The following main activities are fulfilled recently:

- Establishment of an integrated framework for issuing permits (Measurable effluent standards, penalties for non-compliance, etc.), (300,000 USD. Made available by EC);
- Organization of central-regional laboratories;
- Initiation of water quality monitoring program for water at rivers-coastal areas.

Cost figures, based on the existing plans-studies (source: CDR), are shown in Table 6.

**Table 6**

**Cost of remedial action (studies-construction) for municipal discharges**

| City | Type of action | Cost (millions of US$) |
|---|---|---|
| Beirut | Main collector, primary treatment, submarine outfall | 47 |
| Tripoli | Main collector, primary treatment, submarine outfall | 106 |
| Jounieh | Main collector, primary treatment, submarine outfall | 51 |
| Saida | Main collector, primary treatment, submarine outfall | 32 |
| Sour | Main collector, primary/secondary treatment, submarine outfall | 19 |

The costs of the feasibility studies for Batroun and Jbail are USD 500.000. Cost of secondary treatment for Sour estimate as follows:

- Total cost for Sour plant: US$ 15 million;
- Cost for secondary stage: US$ 10,5
- Cost/cap in Sour: US$ 58

The cost of upgrading the planned primary plants to secondary treatment is roughly the following:

| | |
|---|---|
| Great Beirut area: | 93 Million US$ |
| Tripoli: | 20,5 Million US$ |
| Jounieh: | 11,6 Million US$ |
| Saida | 12 Million US$ |
| Jbail: | 7 Million US$ |
| Batroun | 5,4Million US$ |

**Table 7**

**Priority hot spots**

| Country | Name | Type | Public health | Drinking water quality | Aquatic life | Recreation | Other beneficial uses | Welfare and economy | Category | Nature of investment | Transboundary aspects | Preliminary estimated financial requirement (Million US$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lebanon | Greater Beirut area | Municipal, industrial, agricultural HS | 6 | 1 | 3 | 5 | 4 | 4 | C | -WWTP-Construction: Primary & secondary (CDR)<br>-On site industrial pre-treatmnet units<br>-Intgrated Pest management Program, current Project within MoE, Awereness and demonstration pilot project | L | -Construction Dora plant: 47<br>-Upgrading to sec. Treatment: 93<br>-Estimate fiture investment: average of 60.000US$ by unit<br>-Phase 1: 328.000US$<br>-Phase 2: 4421.000 US$ |
| | Saida – Gazieh | Municipal, industrial, agricultural HS | 4 | 1 | 4 | 5 | 4 | 4 | C | WWTP-construction: primary & secondary | L | Construction : 32<br>Upgrading to sec. Treatment: 12 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tripoli | Municipal, agricultural HS | 5 | 2 | 3 | 4 | 4 | 2 | C | WWTP – construction: primary & secondary | L | Construction : 106 Upgrading to sec.Treat.: 20,5 |
| Lebanon | Batroun –Selaata | Municipal, industrial, agricultural | 4 | 1 | 4 | 3 | 3 | 2 | D | WWTP: construction: Feasibility & secondary | L | Feasibility stufy: 0,5 - Sec. Treatment: 5,4 |
| | Sour (Tyr) SA | Municipal, agriculture | 3 | 1 | 3 | 3 | 3 | 2 | D | WWTP-Constraction: secondary | L | 19 |
| | Jbail (Byblos) SA | Municipal, agriculture | 2 | 1 | 2 | 3 | 3 | 2 | D | Feasibility study, Secondary treatment | L | Feasibility study : 0,5 Sec. Treatment: |

# IDENTIFICATION OF POLLUTION HOT SPOTS AND SENSITIVE AREAS IN THE MEDITERRANEAN

Country report for

***L I B Y A N  A R A B  J A M A H I R I Y A***

**Prepared in 1997 by: Mr Abdul Fattah Boargob**

**Note: It was not possible to obtain a revised country report for 2001 from Libyan Arab Jamanhiriya**

## 1. INTRODUCTION

Libya lies on the African coast of the Mediterranean Sea. It is bordered by Egypt and Sudan in the east, Chad and Niger in the south, Algeria and Tunisia in the west.

The country covers an area of 1.76 million $km^2$, over 85 per cent of which is barren desert, about 13 per cent is semi-desert and only 2 per cent is suitable for agriculture. According to the 1994 census, Libya's population was 4.6 million. With an annual growth rate of 4.1 per cent, the present population is estimated to be 5 million.

Most of the people reside in urban and semi-urban communities along the 1,900 km of coastline.

About 46 per cent of the population live in the country's two major cities, Tripoli and Benghazi. Tripoli, the largest city, has a population of about 1.2 million and is located on the West Coast. Benghazi, the second largest city, is on the East Coast and has a population of about 880,000.

The Mediterranean region is hot and relatively dry in the summer, and wet in winter. Temperatures ranges from a maximum of around 46 $^oC$ to a minimum of 7 $^oC$. Rainfall may be as high as 600 mm annually and as low as 100 mm annually in the coastal regions, and dwindles to zero in the rest of the country.

## 2. DOMESTIC WATER SUPPLY AND SANITATION

About 95 per cent of the total water supply for domestic use in Libya is obtained from ground water reservoirs. The part refilled by rainfall can be considered as renewable, but the major part is non-renewable.

Many coastal cities are supplied with water for domestic and industrial use by more than 100 desalination units. The overall design capacity of the coastal desalination plants is in excess of 40,000 cm/day. However, the actual volume of desalinated water is significantly less, because of the many operational problems affecting these plants.

According to the Libyan census and statistical department, in 1969, 58 per cent of Tripoli's population and 15 per cent of Benghazi's population were connected to municipal sewers. A further 28 per cent in Tripoli and 81 per cent in Benghazi used cesspools, and the rest had no sewers at all.

At present more than 80 per cent of the inhabitants in Tripoli, Benghazi and all other major towns and cities with moderately large populations and with populations as small as 3,000 inhabitants enjoy the benefits of sewerage and sewage disposal systems.

During the past three decades, attention has been paid to environmental pollution and action has been taken to execute many wastewater treatment plants for both domestic and industrial wastewater.

The most comprehensive environmental legislation, Law no. 7 for the protection of the environment, was issued in 1982. In chapter 3, (P*rotection of the seas and marine resources*), section 35 prohibits the discharge of polluted water directly into the sea through pipes leading to or from the coast, or through channels and sewers, including underground or surface drainage systems, before such water has been treated in accordance with the legislation in force and with the regulations promulgated pursuant to this act.

## 3. CURRENT SITUATION

The total number of wastewater treatment plants in the Libyan Arab Jamahiriya is approximately 56, ranging from 3,000 cm/day to 110,000 cm/day for dry weather flow. Of these, 16 are located on the coastline, eight of which are for domestic wastewater.

In the coastal region there are six major industries, all using well-operated treatment plants with the exception of one plant, which is at present being maintained.

## 4. INFORMATION OBTAINED

The Technical Centre for Environment Protection distributed a questionnaire on the status of the treatment plants during the past six months. The final result is expected at the end of this year.

The information in this report is based mainly on investigation reports after site visits to the existing treatment plants in the Libyan Arab Jamahiriya, as well as on various studies conducted during the last few years.

The information on new treatment plant projects was obtained from the project department of the Secretariat of Housing and Utilities as well as the cost estimation for the investments.

The information gathered on the treatment plants and their operating lives, as well as the comprehensive analysis (physical, biological, and chemical) may not be as reliable as desired because of the nature of the data available.

The economic situation of the Libyan Arab Jamahiriya allows the country to make investments in the construction or maintenance of treatment plants in the coastal region.

The resource is the swimming areas near the main cities of Tripoli and Benghazi, where the overflow is discharged. It is essential to maintain the treatment plants and bring them up to full capacity. With regard to public health, people avoid such areas. Fishing areas are very far from the coast so there is no problem.

Capacity building is very important to improve the work of existing institutions and the wastewater treatment plants.

## 5. IDENTIFICATION OF MAJOR GAPS AND CONSTRAINTS

At present, the only obstacle facing the continuous operation of the treatment plants is the lack of skilled labour, (technicians, electromechanical engineers and lab-technicians) so that priority is concentrated on providing assistance for training of Libyan personnel locally and abroad.

Table 1

Contribution of different sources

| Locality | Pollution sources | Principal supporting data from questionnaires |
|---|---|---|
| Zawia | Domestic | Site investigation and previous studies |
| Zanzur | Industrial | Site investigation and previous studies |
| Tripoli | Domestic | Site investigation and previous studies |
| Benghazi | Domestic | Site investigation and previous studies |
| Tobruk | Domestic | Site investigation and previous studies |

Table 2

Assessment of priority pollution hot spots in Libya

| Country | Name | Type | Public health | Drinking water quality | Aquatic life | Recreation | Other beneficial uses | Welfare and economy | Weighted total | Relative importance index | Nature of investment | Transboundary aspects | Preliminary estimated financial requirement (in US$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LIBYA | Zanzur | Industrial | 4 | 1 | 4 | 6 | 3 | 3 | 17 | 90 | Capacity-building (training) | | 100,000 |
| | Tripoli | Domestic | 3 | 1 | 4 | 6 | 3 | 2 | 15,3 | 96 | Extension | | 12 million |
| | Benghazi | Domestic | 3 | 1 | 3 | 5 | 3 | 2 | 13,8 | 95 | Extension | | 1 million |
| | Zawia | Domestic | 2 | 1 | 3 | 5 | 2 | 2 | 12 | 95 | Capacity-building (training) | | 2 million |
| | Tobruk | Domestic | 2 | 1 | 3 | 5 | 2 | 2 | 12 | 93 | Capacity-building (training) | | 1.5 million |

# REVISION OF POLLUTION HOT SPOTS IN THE MEDITERRANEAN

Country report for

***M O R O C C O***

**Prepared in 1997 by:** **Mr Mohammed Benyahia**
**Revised in 2001 by:** **Mr Yahia Sabhi**

## I. INTRODUCTION

Le Maroc jouit d'abondantes ressources naturelles, d'importantes surfaces de terres arables, d'un long littoral propice au tourisme et des ressources maritimes considérables.

Le Maroc Méditerranéen qui s'étend sur 512Km recèle une multitude d'écosystèmes écologiquement très riches et diversifiés, dont on peut citer : Marais Chararba, Embouchure de la Moulouya, Sebkha BouAreg, Cap des Trois Fourche, Parc National d'Al Hoceima, Lagune de Smir, Baie de Beni Youneche etc. Ces milieux à fort indice paysager contiennent des zones de refuge pour une faune très diversifiée notamment les poissons, les oiseaux migrateurs et rapaces, sans oublier le phoque moine entre autre.

La région dispose également de plusieurs sites archéologiques de grande importance qui méritent d'être protégés et valorisés. De même, le littoral de la région représente un pôle socio-économique de grande importance pour le développement du pays.

Cependant, la croissance économique et démographique, l'urbanisation rapide, la sécheresse et l'exploitation inconsidérée des ressources naturelles depuis un certain nombre d'années sont autant de facteurs qui contribuent à la dégradation de l'environnement et à l'épuisement et/ou la contamination de certaines ressources naturelles telles que l'eau, le sol, les forêts et la biodiversité.

Cependant, le littoral marocain soumis à la pression démographique sans cesse croissante des agglomérations urbaines, subit l'influence des différentes activités industrielles, portuaires ou touristiques. Il reçoit, en plus, les apports des bassins versants des rivières et des cours d'eau qui drainent pour leur part, une bonne partie des eaux pluviales chargées en matières en suspensions et en eaux usées engendrées par les agglomérations continentales.

L'hydrologie de la région se caractérise par la présence d'un réseau hydrographique composé de cinq grandes unités hydrauliques à savoir : celle de (i) Tanger, Tétouan, (ii) la zone d'Al Hoceima, (iii) le bassin de l'oued Kert, (iv) la basse Moulouya et la région de Nador et (v) le plateau de El Ayoun et plaine des Angads où les variations pluviométriques inter annuel sont de : 1500mm sur le Tangerois (bassin de l'oued Hachef) ; 950mm sur les bassins côtiers Méditerranéens ; et 150mm sur la basse Moulouya et la région de Nador.

Les provinces du Nord, dont l'équilibre écologique est déjà fragile subissent des pressions sur leur environnement ; ces pressions sont provoquées par l'urbanisation accélérée et parfois même anarchique, par l'impact des activités agricoles, touristiques et industrielles et par de l'érosion pluviale et éolienne.

Dans la zone occidentale qui couvre le littoral des provinces de Tanger et de Tétouan, on distingue d'une part la partie Ceuta et Tanger qui se caractérisent par une forte érosion et par une urbanisation souvent anarchique des petites baies. Et d'autre part, le cordon bas marécageux entre Ceuta et Tétouan qui est marqué par son urbanisation galopante (opérations immobilières et touristiques) sans aménagement préalable et sans la prise en compte des impacts sur l'environnement.

Quant à la méditerranée centrale, jusqu'à une époque récente, son enclavement l'a relativement épargnée des effets de l'urbanisation. Mais la zone dont fait partie le Parc National d'Al Hoceima, connaît une forte érosion des sols due aux défrichements et déboisement des forêts.

La méditerranée orientale se présente pour sa part, comme une zone hétérogène dotée de la succession des montagnes, des cuvettes et des plaines. Elle connaît une amorce

d'industrialisation accompagnée d'une urbanisation excessive, rapide et désordonnée, dont l'essentiel se localise sur les bords de la Marchica: étang marin de 114Km$^2$ presque fermé.

En général la vulnérabilité aux activités humaines du littoral de la région est aussi influencée par le taux des apports fluviaux continentaux.

## II. ASPECTS NATURELS DU LITTORAL MEDITERRANEEN MAROCAIN

### II.1. Domaine rifain

#### II.1.1. Cadre morphologique

La chaîne rifaine est dotée d'accidents et morcellements du relief relativement peu élevés. La complexité de sa structure orogénique et la compartimentation de son relief, montrent des crêtes (souvent escarpées) et des vallées profondes. La complexité morpho-structurale de la chaîne se manifeste par des alternances de charriages et de plissements. Quant au profil géomorphologique actuel, celui-ci résulte d'une érosion "surexcité" (défrichement.) et intense (pluviométrie importante).

Situé sur l'extrême nord du Maroc, le Rif a la forme d'un arc, dont la concavité est orientée vers le nord, et épouse parfaitement le tracé de la côte méditerranéenne. Il couvre dans sa totalité une superficie d'environ 32 000 km$^2$. Les plaines sont inexistantes. Les quelques espaces qui s'offrent à l'agriculture sont formées par des dépôts alluviaux situés sur l'embouchure des oueds, ou, dans des cas très rares, au fond de quelques vallées élargies par l'érosion. On estime à 700 km$^2$ la superficie totale des plaines, ce qui correspond à 2% du domaine rifain. L'effet de pente est partout présent ce qui a permis de distinguer trois sous-régions :

(i) Une zone de basses montagnes et de collines. Elle occupe tout le nord de la péninsule de Tanger (600 à 1000m d'altitude), et s'ouvre aussi bien sur l'Atlantique que sur la Méditerranée;
(ii) La partie centrale de la chaîne riche en sommets de 1500 à 2000 m ;
(iii) Le Rif oriental présente des altitudes moyennes avec une forte compartimentation du relief.

#### II.1.2. Cadre géologique

Trois zones géologiquement homogènes se présentent :

- Une zone gréso-schisteuse à schisto-marneuse, occupe la plus grande partie du Rif. Elle s'étend de la région de Tanger au Rif oriental;

- Une dorsale calcaire : Celle-ci est charriée et ne constitue donc pas une unité autochtone. Elle s'étend d'une façon discontinue de Jbel Moussa (côte du détroit) à AL Hoceima;

- Une zone paléozoïque : Cette zone, de terrains primaires s'étend de Sebta à Jebha. Elle s'installe entre la mer et la dorsale calcaire.

### II.2. Zone côtière méditerranéene

La côte méditerranéenne est caractérisée par l'hétérogénéité morpho-structurale : " morcellement du relief, la vigueur et la multiplicité des dénivellations, les faibles dimensions de chaque unité morphologique. Plainettes et blocs montagneux s'enchevêtrent et le paysage demeure rarement homogène sur plus de 50 km"1.

### II.2.1. Côte du Détroit

Longue de 60 km, la côte du détroit s'étend de Cap Spartel (Tanger) à la pointe Almia (Sebta). C'est une côte accidentée, faite d'une succession de "capa" et de baies. Taillées d'un matériau formé de flysch à faciès gréseux- sauf dans sa partie Est où des assises calcaires et des terrains primaires occupent une infime partie. Cette côte ne comporte que très peu de plages. Elles se localisent dans des baies situées aux embouchures des oueds et sont de petites tailles (200 à 500 m de développement moyen). Seule la plage de Tanger (3,5 km de long) est importante, et fait l'objet d'un important programme d'aménagement touristique. La dynamique des apports fluviaux a considérablement comblé les fonds marins situés aux embouchures, et les profondeurs de plus de 1 m, sont généralement situées à 50 ou 100 m des rivages. Cela est lié à la nature des paysages rétro-littoraux proches : la couverture végétale ne subsiste que sous forme de maquis. Les quelques périmètres de reboisement situés à l'Est de la côte font exception à la règle. Avec des déclives qui sont importantes (des pentes de l'ordre de 20 à 40% en moyenne). L'érosion dans cette région est active[1].

### II.2.2. Côte Tétouanaise

C'est une côte qui s'étend sur une quarantaine de Kilomètres. Elle est constituée de terrains primaires et de roches métamorphiques (gneiss), sur lesquels sont venus s'accumuler des alluvions récents, déposés par une multitude de petits cours d'eau qui descendent de la dorsale calcaire. Ils y ont aménagé de petites plaines souvent marécageuses. La présence d'espaces aérés et plats, explique en partie, la prolifération de petites stations touristiques (Restinga-Smir, M'diq, Cabo-negro, Martil...), le long de cette côte. C'est aussi un des secteurs les plus urbanisés du littoral méditerranéen.

### II.2.3. Côte du Rif Central

Il s'agit d'une région littorale, dominée directement par les versants Nord des hautes montagnes rifaines. Elle s'étend de Cap Mazari à Al Hoceima (120 km environ). Les paysages côtiers de ce secteur n'offrent que très peu de conditions favorables à l'implantation humaine. La topographie de cette zone fait de ce tronçon littoral un espace enclavé. Les versants qui surplombent la côte sont raides voire même très raides (déclivité de 30 à 60%). En outre, la ligne de partage des eaux se situe entre 20 et 40 km des rivages. La dégradation de la couverture végétale par l'action de l'homme a atteint des seuils critiques ; ce qui accentue - vu la topographie régionale - la fréquence des solifluxions et des ravinements.

Le secteur Cap Mazari - Pointe des pêcheurs est un domaine de roches primaires et métamorphiques (micaschistes, schistes gneiss...). les effondrements ont supprimé les falaises vives, et ont donné naissance à des pentes de 30 à 60 %, se terminant au niveau de la mer et par endroit seulement - par des plages de sables grossiers ou de galets, de couleur sombre.

### II.2.4. Secteur maritime central

Ce secteur comprend deux sous-secteurs. Le premier Long de 90 km environ), s'étend de Ras-Tarf à Nador. Il est plus ou moins hétérogène (succession des dernières montagnes rifaines, des cuvette, des plaines et des massifs volcaniques...). A l'Est de Nador, le deuzième sous-secteur est une côte à potentialités socio-économiques très importantes. On distingue la

1 INAU, 1993

sebkha Bou Areg (Mar chica), située à l'Est de Nador, formant un écosystème à part avec d'importantes potentialités touristiques et halieutiques sans aucune exploitation rationnelle. Cet étang marin (fermé 9114 $km^2$) risque de connaître une grave pollution à cause des différents rejets non reliés à la station d'épuration, en provenance de la ville de Nador.

### II.2.5. Nador-Saïdia

Les plages de Kariat Arekmane et de Saïdia sont à la fois les plus étendues et les plus accessibles de tout le littoral situé à l'Est de la côte de Tétouan :

- La plage de Kariat Arekmane, vide de toute installation touristique, est un vaste cordon littoral qui s'étend sur 17 km, depuis la Sebkha Bou Areg Jusqu'aux falaises de Jorf Arroum.

- La plage de Ras El Mâa, s'étend sur 9 km entre Ras El Mâa et l'embouchure de la Moulouya (plage abritée à l'ouest par des falaises de 40 m).

- La plage de Saïdia, constitue le dernier tronçon méditerranéen du Maroc oriental avant la frontière algérienne (Oued kiss...).

## III. CLIMAT DE LA CÔTE MÉDITERRANÉENNE ET DE SON ARRIÈRE PAYS

Du point de vue macroclimatique, l'ensemble des régions situées au Nord des chaînes atlasiques s'inscrivent dans le climat méditerranéen. Cependant il existe une série de micro et de méso-climats qui résultent d'une trilogie géographique Altitude Exposition et océan. Ce dernier étant la principale source de précipitations de la région, dotée de perturbations atlantique de l'anticyclone des Açores en tant que centre d'action pour le climat de toute la Méditerranée occidentale. Les altitudes, quant à elles, sont responsables de la distribution inégale des précipitations. Etant donné que le régime dominant provient de l'ouest (influence océanique), les hautes terres de la région du Rif Central (1500 à 2000 m d'altitude) constituent une sorte de barrière qui entrave la progression des nuées humides en provenance de l'atlantique, provoquant ainsi un effet d'abri pour tout le littoral méditerranéen. Il en résulte une dissymétrie climatique : Les versants exposés aux vents d'Ouest ou du Sud-Ouest, ainsi que les hauts sommets sont bien arrosés 800 à 1500 mm/an, alors que ceux qui sont orientés vers l'Est ou vers le Nord Est- avec leur piémont en situation d'abri forment des rubans semi-arides, (300 à 700 mm).

## IV. HYDROLOGIE ET HYDROGRAPHIE

### IV.1. Ressources en eaux superficielles

Les cours d'eaux (cf. Tableau N°1) qui déversent dans la Méditerranée sont caractérisés par :

* Les faibles superficies de leurs bassins et la forte déclivité. En ne tenant compte que des plus importants, deux seulement sur 14, possèdent des bassins d'une superficie supérieure à 1000 $km^2$ .
* Le ruissellement dans ces bassins est abondant, étant donné que l'infiltration et l'évaporation sont très faibles, à l'exception du secteur de Nador.

L'abondance et la violence des précipitations, la prédominance du faciès et le relief accidenté est caractérise par de fortes pentes qui favorisent le ruissellement et limitent l'importance des réserves d'eau souterraine. Le régime des cours d'eau est irrégulier et doté

d'un caractère torrentiel. Ainsi, les écoulements se caractérisent par l'importance des débits spécifiques journaliers des crues et par des débits d'étiage faibles ou nuls. Du point de vue temporel, les débits du mois le plus sec (mois d'Août généralement) sont presque nuls1.

**Tableau N°1: Principales caractéristiques des cours d'eau du domaine rifain.**

| Nom des Oueds | S | P | Q | N | Qs | Qe |
|---|---|---|---|---|---|---|
| Martil | 1220 | 935 | 14,7 | 0,41 | 12,1 | 0,20 |
| Amsa | 125 | 900 | 1,4 | 0,41 | 11,6 | 2,0 |
| Laou | 915 | 980 | 13,0 | 0,46 | 14,2 | 0,8 |
| El Had | 605 | 825 | 7,2 | 0,46 | 12 | ? |
| Mter | 295 | 805 | 3,4 | 0,45 | 11,5 | ? |
| Ouringa | 510 | 790 | 5,1 | 0,40 | 10,1 | ? |
| Mestassa | 250 | 720 | 2,3 | 0,40 | 9,3 | 0,01 |
| Boufrah | 175 | 635 | 1,4 | 0,40 | 8,1 | 0 |
| Bades | 180 | 385 | 0,8 | 0,35 | 4,3 | 0 |
| Bousicour | 210 | 300 | 0,7 | 0,35 | 3,4 | 0,8 |
| Rhis | 805 | 595 | 7,7 | 0,51 | 9,5 | 1 |
| Nekor | 960 | 590 | 9,1 | 0,51 | 9,5 | 0,15 |
| Amekrane | 345 | 510 | 2,2 | 0,40 | 6,5 | 0,5 |
| Kerte | 3080 | 355 | 8,0 | 0,23 | 2,6 | |

S: Superficie du bassin versant (en $km^2$).; P: Pluviométrie annuelle moyenne du bassin (en mm); Q: Débit moyen annuel (en $m^3/s$); N: Coefficient de ruissellement; Qs: Débit spécifique (en litre/s/$km^2$); Qe: Débit moyen du mois le plus sec (en $m^3/s$).

### IV.2. Ressources en eaux souterraines

Le Rif représente la zone la plus pluvieuse au Maroc (800-1500 mm/an), avec une très faible capacité de "stockage" des eaux, comparativement aux réserves du Moyen Atlas (800-1000 mm/an). En effet, les roches qui composent la chaîne rifaine-exception faite des massifs calcaires- sont des roches imperméables (grès, schistes, marnes et flysch...) ce qui explique la puissance du ruissellement diffus ou concentré.

Seules les zones calcaires forment de petits "réservoirs karstiques fracturés par une tectonique cassante". Les bras versants et les piémonts de ces chaînes calcaires comportent un vaste réseau de sources. Les plus importantes se localisent dans la dorsale calcaire avec des débits variant entre 100 et 800 l/s par unité.

Entre ces ensembles calcaires et la mer se présentent les terrains primaires qui sont généralement imperméables (schistes et gneiss...). "Les disponibilités en eau souterraine de cette zone paléozoïque de 2600 $Km^2$ est évaluée entre 300 et 450 millions de $m^3$/an, dont plus de la moitié sont perdues en mer, faute de pouvoir les utiliser surplace, en raison de la nature montagneuse de la région".

La zone gréso-schisteuse qui s'étend de Tanger à Al Hoceima "domaine rifains" d'une superficie de 1200 $km^2$ se caractérise par la faiblesse de ses réserves et le caractère torrentiel de ses cours d'eau. Les principales nappes sont situées dans la province d'Al Hoceima (15 à 20

1 INAU, 1993.

millions de $m^3$/an). Mais les différents sels contenus dans ces eaux les rendent peu potables (2 à 4 g/l).

Le Tangerois constitue un îlots (900$km^2$). Au sud-ouest de Tanger la nappe phréatique contenue dans une cuvette gréso-sableuse (profondeur maximale 400 m) représente une ressource appréciable en eau pour l'alimentation de la ville de Tanger ; avec des réserves de 200 à 300 millions de $m^3$/an (essentiellement eau superficielle).

La dernière zone (secteur maritime oriental) se compose de 4 bassins aquifères dont les réserves sont estimées à 200 millions $m^3$/an, dont 20 millions environ proviennent des nappes phréatiques.

A l'Est du Kerte moyen, le bassin des plantes du Gareb et du Bou Areg constitue un espace agricole. Il est doté d'une importante nappe phréatique qui s'étend d'une façon continue du Gareb jusqu'à Bou Areg. Les ressources en eau de cette région sont quasi-souterraines (20 à 22 millions $m^3$/an).

Cependant, la Moulouya (qui prend sa source dans la Moyen Atlas) demeure la principale ressources en eau pour l'irrigation, avec 260 millions $m^3$/an (Gared 120 millions/$m^3$/an et Bou Areg 140 millions/$m^3$/an).

Le troisième bassin aquifère est situé dans la chaîne des Béni Snassene, prolongée à l'Ouest par la chaîne des Béni Bou Yahi (320 $km^2$). Cependant, les ressources en eau de cette région sont presque inexploitables à cause de la forte salinité de leurs eaux (4 à 8 g/l)1.

## V. IMPACT DE L'ACTIVITE HUMAINE SUR LE LITTORAL MEDITERRANEEN

Les impacts majeurs du développement urbain sur l'environnement résultent de la croissance démographique rapide, de la densité grandissante des agglomérations urbaines, du trafic et de l'occupation des zones urbaines exposées au glissement des terrains, aux inondations et aux autres risques naturels. Trois éléments importants ont contribué à l'amplification de ces impacts, il s'agit de :

- La pauvreté ;
- Le risque de pollution biologique, physique et chimique de l'air, de l'eau et de la terre par suite de l'élimination insuffisante de déchets commerciaux et domestiques, et enfin,
- L'insuffisance de ressources humaines et financières des villes par rapport aux besoins en infrastructures et en services de base.

A la dégradation de l'environnement urbain, lié en grande partie au mode d'urbanisation et à la défaillance de la gestion urbaine, et compte tenu des limites financières des collectivisés locales, il faut ajouter dans le cas du littoral méditerranéen, le risque de pollution marine, les mutations et les agressions que subit la bande côtière et le dérèglement des écosystèmes.

Le mode d'urbanisation se fait souvent par extension à la périphérie des grandes villes littorales. Cette littoralisation souvent incontrôlée, tout en consolidant le phénomène de densification de la bande côtière, fait émerger de nouveaux problèmes de planification et de nouvelles formes de dégradation de l'environnement. En plus de l'indigence des équipements de base, l'accroissement de la demande immobilière, industrielle, touristique et la pression démographique, s'ajoute une organisation inadaptée de l'espace qui aboutit à des formes

1 INAU 1993.

d'occupation ''en linéaire'' ou par ''mitage''. Par ailleurs, au niveau du littoral méditerranéen, l'essentiel des flux migratoires est circonscrit spatialement dans les frontières de la zone nord.

Les quatre grandes villes du littoral méditerranéen : Tanger, Tétouan , Oujda et Nador concentrent les 2/3 de la population urbaine de la zone. Leur poids démographique reste ainsi déterminant malgré la multiplication des petits et moyens centres.

En effet, le phénomène de l'urbanisation se traduit aussi par l'émergence de plusieurs centres urbains dans la bande littorale. Le nombre de ces centres a plus que doublé de 1971 à 1994. Ceci est dû particulièrement aux petites et moyennes villes qui ont augmenté respectivement de 2 à 14 et de 16 à 30 durant la même période.

La part de la migration dans la croissance urbaine du littoral a été de 26% pour la période 1960-2002.

## V-1. Activités économiques

### V.1.1. Industrie

Au niveau du Littoral méditerranéen, on constate que les régions de Tanger et Nador représentent les deux pôles industriels de la Région, dominés notamment par l'industrie sidérurgique, textile, la confection et par la petite et moyenne industrie. La création du port de Béni-Ansar, et le statut de zone franche de Tanger, avec le grand projet de construction du nouveau port sur la façade atlantique, ont stimulé les investissements dans la région. Les emplois générés par l'activité industrielle sur l'ensemble de la côte ont enregistré un taux de croissance annuel de 3,9% entre 1982 et 1990. Cette croissance semble traduire un nouveau redéploiement de l'activité industrielle dans la région, qui tend à profiter à la ville de Tanger, celle-ci occupe désormais une position importante après Casablanca (Littoral atlantique).

Toutes les unités industrielles de la côte méditerranéenne rejettent leurs effluents liquides soit dans les cours d'eau, soit directement en mer via les égouts ; c'est le cas de :

- La ville de Tanger, où les effluents de la zone industrielle située sur la route Tanger Tétouan, des rejets industriels de la zone de Mghorha, du quartier Moulay Ismaïl, de l'Oued Lihoud du rejet au niveau du Port, sont déversés en mer sans aucun traitement préalable ;
- Tétouan avec l'oued Martil qui sert de déversoir à toutes les usines situées dans sa vallée, et enfin
- Nador, où la Mar Chica reçoit la majorité des effluents industriels, et certains centres non encore doté de station d'épuration des eaux usées.

### V.1.2. Transport maritime

Le transport maritime des hydrocarbures se trouve au premier rang des sources de pollution des côtes marocaines s'y ajoute les risques de pollution provoqués par la navigation maritime internationale. En effet, sur l'axe méditerranéen, quelques 200 navires par jour transitent par le Détroit de Gibraltar ; d'autre part, le sixième de la flotte commerciale transitant par les côtes marocaines est constituée par des transporteurs de produits chimiques et autres substances nocives.

Parmi les incidents les plus graves qui se sont produits au large des côtes marocaines, on citerait le naufrage du bateau SAMIR en novembre 1982, celui du Tanker iranien KHARG 5 en décembre 1989 et l'accident du SEA SPIRIT en Août 1990, qui est entré en collision avec un méthanier ''l'HESPERIS'' au large d'Al Hoceima.

### V.1.3. Pêche

Le littoral méditerranéen est de loin moins doté en infrastructure portuaire que le littoral atlantique. A côté des principaux ports (Nador, Al Hoceima, Jebha, M'diq, Tanger) de nombreux petits ports et des villages de pêche artisanale jalonnent la côte.

Toutefois au niveau national, les quantités de poissons débarquées sont faibles et ne cessent de décroître, notamment au cours de cette dernière décennie. Cette régression s'explique non seulement par les différentes agressions que subit le milieu marin (pollution, dragage de sable , etc…) mais surtout par les méthodes de pêche illicite (utilisation de la dynamite, maillage de chalut inadéquat, etc.) et à la forte pression exercée sur les nourriceries par les petits chalutiers et les barques.

### V.1.4. Tourisme

Activité récemment importée, le tourisme balnéaire est venu accuser le basculement des centres d'intérêt économique de l'intérieur vers les côtes, ce qui s'est traduit par une forte littoralisation de cette activité.

En outre les modes d'aménagement et la recherche des localisations pied dans l'eau et la vue panoramique se traduisent par la durcification des dunes des plages. C'est le cas des plages de Ksar Es Sghir, de Martil, de Sâdia où la dune sableuse est le lieu privilégié pour l'édification des résidences secondaires, alors que le rôle de celle-ci est le maintien d'un équilibre écologique fragile. La conséquence la plus visible de cette forme d'emprise sur le cordon littoral est l'amaigrissement progressif des plages et la réduction des espaces forestiers côtiers.

Il s'ensuit que le tourisme dont les possibilités de croissance, sont encore beaucoup plus importantes, n'est pas neutre notamment sur le plan écologique car les formes de redéploiement des structures d'accueil et de la demande sont à la base de la réduction progressive du potentiel mobilisable à des fins récréatives , avec un processus continu de dégradation du milieu dans les espaces de forte concentration

Les facteurs de dégradation sont multiples, et parmi les facteurs majeurs, on peut citer :

- Les eaux usées émanant des opérations immobilières et touristiques qui sont véhiculées vers les cours des oueds avoisinants ou directement en mer . L'exemple est fourni par le cas de la côte Tétouanaise qui connaît actuellement une série de stations balnéaires à gestion et clientèles étrangères :

- La privatisation progressive du littoral de Tétouan par le biais d'acquisition particulières de résidences a abouti à trois importantes conséquences :

1. Une marocanisation presque totale de la fréquentation du littoral ;

2. La durcification progressive du fond marin compris entre Martil et Fnideq ;

## V-2. Impact des activités humaines concurrentes

### V.2.1. Analyse des conflits humains concurrents pour l'espace

Du fait que les régions littorales marocaines attirent depuis plusieurs décennies les populations bien plus fortement que les terres intérieures, la compétition pour l'allocation et

l'utilisation des ressources du littoral, incluant l'espace, est de plus en plus vive. De ce fait, les conflits qui s'n suivent concernent :

- L'accès au rivage pour certaines activités, telles que les ports de plaisance qui exigent des sites à l'interface entre la mer et la terre;
- Les usages incompatibles qui ne peuvent pas se juxtaposer, tels que les activités de loisir et l'aquaculture dans les zones marines;
- La propriété privée qui empêche l'utilisation ou l'accès publics aux ressources du littoral;
- Les objectifs à long terme de conservation qui inhibe les intérêts économiques immédiats, par exemple quand il faut choisir entre préserver ou drainer les zones humides;
- La disponibilité d'infrastructures protégeant l'environnement, en conformité avec le niveau de développement économique, par exemple, l'extension du réseau d'assainissement en phase avec la construction de nouveaux hôtels.

L'exploitation durable des ressources est actuellement affectée par un ensemble d'évènements, ou des processus, naturels ou causées par l'homme, tels que:

- L'impact des grands projets de développement;
- L'impact conjugué de nombreux projets de développement qui, individuellement, peuvent être significatifs mais qui, lorsqu'ils sont simultanés, peuvent précipiter la dégradation de l'environnement;
- Les changements progressifs, tels que les changements climatiques qui induisent une élévation globale du niveau de la mer particulièrement affectant les zones basses;
- Les catastrophes inattendues causées par l'homme, tels que les déversements d'hydrocarbures ou le rejet accidentel de déchets industriels.

L'interdépendance entre les activités et les ressources du littoral explique pourquoi l'approche sectorielle dans la gestion des régions littorales marocaines n'a pas donné de résultats satisfaisants. Chaque secteur économique produit une série d'impacts sur les différentes ressources côtières et marines; lorsque ces impacts se combinent, ils induisent des perturbations aiguës pour les ressources dont dépend la survie de ces secteurs et causent des conflits entre les intérêts sectoriels. Une solution économiquement intéressante pour un secteur peut être nuisible à un autre, des points de vue économique et environnemental.

### V.2.2. Impacts des usages de la terre et de la mer

**a. Urbanisation et habitat :**

- ***(i)*** Les impacts irréversibles comprennent l'empiètement des constructions sur les terres arables, les forêts, les espaces libres, les plages et les habitats de valeur, tels que les zones humides, ce qui génère souvent les modifications de la ligne de côte imploiquant le remplissage à sa proximité ;
- ***(ii)*** Les impacts réversibles comprennent la production d'effluents, d'émissions, des déchets et de nuisances sonores, qui peuvent être prévenues, éliminée ou réduite grâce à des mesures de prévention prises à la source ou au moyen d'équipement appropriés de collecte, de traitement et d'élimination saine.

**b. Tourisme et loisir:** C'est une activité plus récente mais le développement est actuellement le plus vigoureux, grand consommateur d'espace.

Les impacts physiques irréversibles de ce genre de développement risquent de dégrader les ressources qui attirent les visiteurs, telles que les écosystèmes fragiles, les paysages vulnérables et les sites de haute valeur historique et archéologiques, le meilleur exemple, est fournis par les aménagements réalisés le long de la Baie de Tanger et d'Al Hoceima, Mohammedia, Casablanca.

Les niveaux d'apports d'effluents sont étroitement liés à la nature de la saison. La mise en place d'installations de traitement répondant à l'afflux massif de touristes pendant une saison relativement brève, a souvent été considéré comme peu rentable et injustifiée par les collectivités du littoral. Cependant, le secteur touristique devient de plus en plus conscient du fait que la protection de la qualité de l'environnement est essentielle pour sa réussite. Le tourisme peut ainsi avoir un impact positif du fait de sa demande en équipements adéquats pour la prévention et le traitement de la pollution.

**c. Industrie :** Le conflit est généralement causé par la proximité de certaines matières premières importantes et pour les débouchés des marchés intérieurs et/ou extérieurs.

La localisation d'installations industrielles sur le littoral, dans des paysages écologiquement sensibles ou de haute valeur visuelle, ou dans des régions ayant un potentiel touristique ou de loisir, produit un impact irréversible, semblable à celui provoqué par l'urbanisation.

**d. Pêche et aquaculture :** La pêche demeure une source majeure d'alimentation pour les populations des régions côtières marocaines. Elle a souffert d'un déclin dû à une mauvaise gestion, notamment la pêche excessive; certaines espèces de mollusques, par endroits, ont été atteints par des niveaux significatifs de pollution, ce qui les a rendu non comestibles à maintes reprises. La nécessité de disposer d'un milieu marin salubre pour la pêche à lui seul représente un motif pour initier les investissements pour des programmes de gestion du littoral.

L'aquaculture est une activité en développement continu, qui exige un milieu salubre. Toutefois, elle peut induire des pollutions et des maladies affectant les populations locales de poissons, à cause de la présence de déchets et de nutriments, et peut ainsi bouleverser l'équilibre écologique des autres espèces. La lagune de Nador et quelques sites très localisés (M'diqu, Amsa…) développent cette activité d'aquaculture, mais ne sont pas encore au stade d'induire ce genre de pollution.

**e. Transport :** Le transport maritime risque de produire des impacts significatifs sur les ressources du littoral, du fait de la construction et de l'entretien des ports et des chenaux d'accès, du fait des voies de navigation et autres utilisations de la mer. Les impacts durant le fonctionnement comprennent le bruit et la pollution atmosphérique, ainsi que les risques de transport de déchets

dangereux ou de déversement d'hydrocarbures, de même que certains échouements de navires reste sans suite .

**f. Agriculture :** les impacts de l'agriculture vis-à-vis de l'espace sont limités, malgré le fait que le drainage des zones humides à des fins agricoles est un exemple d'impact physique irréversible. L'agriculture est surtout responsable de la dispersion de sources diffuses de pollution due à l'utilisation exagérée d'engrais, de pesticides et d'épandages chimiques qui pénètrent dans les eaux douces, l'eau de mer et les sols, et les polluent. Le pompage excessif des eaux souterraines pour l'irrigation a pour conséquence la pollution des aquifères par intrusion saline . Dans certaines régions elle est irréversible.

**h. Forêts :** Un phénomène commun subi par les forêts de nombreuses régions littorales marocaines se présente dans leur déforestation accélérée, dont les causes majeures sont :

- La surexploitation : le pâturage excessif et la surexploitation du bois pour le chauffage, y compris la production du charbon de bois et de bois d'œuvre ;
- L'abattage des arbres pour gagner des terres agricoles, ainsi que des surfaces pour les développements industriels, touristiques, et celui des infrastructures ;
- Les incendies de forêt : naturels ou causés par l'homme ;

Il résulte de ce qui précède que les impacts conjugués de plusieurs secteurs économiques sur les ressources du littoral peuvent être beaucoup plus importants que les impacts produits par ces secteurs pris individuellement. De plus, la dégradation ou la détérioration des ressources du littoral causées par un secteur, peuvent diminuer le potentiel des ressources à la disposition d'un autre secteur et même remettre en question la survie de celui-ci. Certains impacts peuvent être irréversibles et altérer de manière permanente la quantité ou la qualité des ressources du littoral. D'autres sont temporaires et peuvent être atténués ou éliminés avant qu'ils ne causent des effets à long terme ou n'altèrent les ressources du littoral.

### V-3. Interactions entre activités humaines et environnement

**a. Pollution de la mer :** la majeure partie de la pollution marine est causée par des sources d'origine tellurique : eaux usées domestiques et industrielles, drainage agricole, drainage pluvial des zones urbaines, décharges de déchets solides et transport solide résultant de l'érosion ou de la mise en valeur des terres. Les sources de pollution situées en mer (Offshore) sont les rejets réguliers d'exploitation (déchets et ballasts) à partir des moyens de transport maritime, et les rejets accidentels, y compris les déversements volontaires.

**b. Pollution de l'eau douce :** Les eaux douce risquent d'être polluées par les mêmes sources d'origine telluriques que l'eau de mer, et en plus, par les sources diffuses provenant de l'agriculture ou par l'intrusion de l'eau de mer dans les nappes aquifères du littoral.

La conséquence la plus grave de la pollution de l'eau douce est la pénurie d'eau potable. La pollution des eaux de surface peut également présenter des risques pour la santé publique et, lorsqu'elle s'accompagne d'odeurs désagréables ; elle peut réduire l'agrément pour les activités de loisir.

Une prévention adéquate, ou la collecte et le traitement de tous les déchets et effluents, sont essentiels. Des mesures supplémentaires devraient être prises pour protéger les champs de captage d'eau douce contre les activités polluantes, en imposant les restrictions à l'utilisation d'engrais et de pesticides, et en limitant le pompage excessif dans les aquifères, dont la dépollution peut nécessiter des décennies.

**c. Régression de ressources marines :** Les atteintes physiques aux ressources marines, causées par la mise en valeur des terres et les activités de construction, ou par une pollution grave, peuvent

induire leur disparition irréversible. La dégradation des ressources biologiques peut diminuer les revenus dans le secteur de la pêche et causer la perte de ressources de valeurs écologiques pour la conservation de la nature.

Les zones humides ,lagunes (Nador), estuaires (Moulouya), sebkhas... et herbiers marins sont vulnérables aux altérations de surface, provoquées par les activités humaines et aux changements hydrologiques qui dérangent leur fonctionnement. Des investissements de protection par des modes de gestion bien définis et contrôlés sont requis en tant que système de prévention et de sauvegarde de ces ressources.

L'exploitation anarchique de sable ou autre matériau sur les plages représente également une menace pour les ressources marines. Elle est souvent la conséquence directe de l'extraction de matériaux pour la construction, ou la conséquence indirecte de l'intrusion humaine dans les processus naturels se déroulant sur les plages (corniches, constructions et installations touristiques). En effet, la construction d'ouvrages de protection de la côte et de la défense contre la mer, de ports et de brise-lames pour le transport maritime et les ports de plaisance, peuvent facilement interrompre le transport des sédiments, réduisant ainsi l'apport de matériau sur les plages, diminuant la largeur de ces plages et exposant les biens aux risques d'inondation.

**d. Menaces des sites de haute valeur naturelle et visuelle :** Les sites littoraux méditerranéens de haute valeur naturelle et visuelle comprennent (en plus des zones humides) les embouchures de rivière, les forêts, les dunes et les côtes rocheuses avec promontoires et baies. Les développements urbain, touristique, industriel ou autre peuvent en perturber ou dégrader les caractéristiques particulières, par des terrassements ou par une constructions incongrue ou monotone. Ils peuvent aussi diminuer les espaces verts séparant les construction et réduire les options laissées aux générations futures en matière d'aménagement de l'espace. D'autres activités détruirent définitivement ces ressources (Sites d'exploitation de sables côtiers d'Azla, Amsa O. Laou..). L'opinion générale reconnaît aujourd'hui l'importance de la protection des espaces verts et ont placé une proportion considérable d'espaces verts et d'espaces littoraux protégés pour les générations actuelles et futures.

**e. Atteintes de sites historiques et archéologiques:** Le patrimoine culturel se rencontre aussi bien sur terre qu'en mer, où chaque civilisation a laissé ses vestiges. Les formes anciennes ou traditionnelles d'édifices, les sites et les monuments historiques et les vestiges archéologiques, peuvent facilement être dégradés par :

- La démolition, quand leur importance n'a été reconnue ou que la valeur du foncier est élevée;
- L'abandon ou le manque de moyens pour leur entretien;
- Les ajouts inappropriés là où la densité démographique exige la création d'espaces de vie supplémentaires;
- Le recouvrement par des constructions nouvelles, et
- La corrosion de la structure naturelle en pierre.

**f. Accès public à l'espace et aux ressources :** Les nombreux problèmes et les conflits dans les régions littorales qui sont liés à la notion du domaine public. Au Maroc, la servitude est assurée aussi bien perpendiculaire que longitudinale au littoral par les législation en vigueur. Cependant , ce droit se trouve non acquis dans plusieurs sites côtiers suite à l'édification de zones urbanisées continues. L'utilisation de la mer, comme réceptacle collectif pour l'évacuation des déchets, reflète l'attitude qui considère les ressources du littoral comme une propriété collective.

Le droit d'accès public aux ressources du littoral (poissons, eaux, minéraux) doit être réglementé pour prévenir leur mauvaise gestion et la surexploitation, c'est dans ce sens que les projets de lois sur le littoral, les carrières, et la pêche sont élaborés en vue d'y pallier.

La restriction de l'accès public à l'espace et aux ressources du littoral peut engendrer des coûts et des bénéfices environnementaux. La perte d'accès public diminue les opportunités s'offrant à la population locale et aux visiteurs mais certaines restrictions à l'accès public peuvent être profitables à l'environnement, notamment lorsqu'elles contribuent à la protection des ressources fragiles.

Toutes ces activités exercent sur les ressources et sur le milieux (sols, eaux, végétation) des pressions qualitatives considérables aux conséquences parfois irréversibles, notamment:

- L'imperméabilisation des sols à la perte définitive des sols agricoles;
- La salinisation des nappes phréatiques aux rejets d'eaux usées et de substances toxiques;
- La dégradation à la destruction de paysages séculaires;
- La perturbation à la destruction physique des niches écologiques par la variation de la turbidité dues aux rejets industriels, ou à la température des rejets en mer des centrales thermiques, ou encore à la disparition des herbiers;
- La perturbation des processus géomorphologiques (disparition des plages par exemple) à la destruction mécanique des organismes par la surpêche.

## VI. SOURCES DE POLLUTION DE LA ZONE COTIERE MEDITERRANENNE

### VI.1. Production et caractéristiques des déchets solides

La production quotidienne moyenne des déchets solides produits par habitant dans les régions de Tanger, Tétouan, AL Hoceima et Nador est estimé à 0,7 Kg /hab /j. Actuellement cette production devient de plus en plus importante et variée. Cette augmentation est liée essentiellement à la progression de l'urbanisation et du le mode de vie de la population ainsi qu'au progrès industriel.

La production des déchets solides connaît son apogée pendant la saison estivale et pose parfois des problèmes d'hygiène par suite des difficultés de collecte, de traitement, d'évacuation et d'élimination.

La grande partie (80%) des déchets produits est formée de déchets ménagers, de déchets d'abattoirs, hospitaliers, de commerce et de voiries les 20% restant sont des déchets industriels.

**TABLEAU N° 2 Gestion des déchets municipaux en 19951**

| Ville4 | Kg/Hab/J | Nombre d'habitants | Production T/an | Collecte T/an | Recyclage-Compostage T/an | Déchets non-collectés T/an | Décharge sauvage T/an |
|---|---|---|---|---|---|---|---|
| **Tanger (MORI)** | 0,6 | 526 215 | 11 8479 | 77 011 | 2 370 | 41 468 | 74 641 |
| **Tétouan (MOR II)** | 0,6 | 404 000 | 88 476 | 57 509 | 1 770 | 30 967 | 55 740 |
| **Al Hoceima** | 0,85 | 122 000 | 37 651 | 24 603 | 757 | 13 248 | 23 619 |
| **Nador (MOR IV)** | 0,74 | 269 000 | 72 657 | 47 227 | 1 453- | 25 430 | 45 337 |
| **TOTAL** | | 1 321 215 | 317 463 | 206 350 | 6 350 | 111 113 | 199 337 |

## VI.2. Gestion des détritus dans les zones côtières

Le Maroc, à l'instar de la plupart des pays riverains du Bassin Méditerranéen et Parties Contractantes à la Convention de Barcelone est confronté aux problèmes de gestion des déchets solides en général et les détritus côtiers en particulier. Dans le souci d'aider à l'élaboration d'un plan d'action régional ce volet est traité dans le présent rapport pour apporter un supplément d'informations sur les sources diffuses de pollution d'origine terrestres qui doivent être mises en vue d'une manière efficace pour l'exécution du Plan d'Action Stratégique (PAS).

Il existe un recyclage traditionnel et informel des ordures ménagères et industrielles. Au niveau des décharges, cette activité informelle occupe une population estimée à des centaines de familles. Cette forme d'utilisation présente des risques sanitaires considérables pour la santé humaine.

Ces problèmes risquent fort de s'aggraver car les quantités de déchets solides augmentent avec la population et l'amélioration du niveau de vie. En 2020, la production annuelle d'ordures ménagères sera le double de ce qu'elle est actuellement[2,3].

A ces déchets solides s'ajoutent les déchets des activités minières et industrielles qui génèrent des quantités importantes des déchets solides qui sont déchargés dans des terrains environnants et présentent des risques de pollution surtout pour les eaux souterraines par effet de lixiviation et infiltration.

Actuellement, l'impact de drainage du lixiviat ou déchet brut sur les eaux côtières n'a pas encore lieu. Mais le risque demeure, en cas de pluies torrentielles et des crues qui s'en suivent.

### VI.2.1. Gestion des détritus et politique nationale en matière d'environnement :

Un projet de loi relatif à la gestion des déchets et à leur élimination a été élaboré et soumis en vue de son approbation par les autorités gouvernementales. Ce projet consiste à résoudre les problèmes suivants:

- Multitude d'intervenants ;
- Dilution des responsabilités des producteurs des différents types de déchets ;
- Absence de normes et de moyens de contrôle ;

1 Source : Monographie de l'Environnement de la région Economique du Nord-Ouest juin 1996

2 Stratégie nationale pour la protection de l'Environnement, 1995
3 Rapport sur l'Etat de l'Environnement, 2001, MATUHE/DE
4 %collecte = 65% de la production totale ''PT'', % recyclage = 2%''PT'', % Mise en décharge = 63%''PT''.

- Absence d'une ligne budgétaire spécifique à la gestion des déchets au niveau des collectivités locales . Au niveau national, la quantité totale de déchets produite est de 5,7 millions de tonnes par an (4 million T/an en milieu urbain et 1,7 million de T/an en milieu rural). La part des déchets ménagers est estimée à 11 000 tonnes par jour.
- La production de déchets par habitant et par jour est très variable d'une région à une autre et elle est de 0,4 à 0,9 kg/hab/jour ;
- Le taux de collecte de déchets quant à lui est estimé à 70-90% ;
- Sur le plan financier, il est estimé que les frais des services de gestion des déchets varient entre 0,54 et 0,72% du PNB et que seuls les coûts de la collecte des déchets solides varient entre 250 à 330 DH/Tonne. Cependant, l'amélioration de la gestion des déchets engendrera des dépenses supplémentaires que les collectivités locales sont appelées à couvrir dans le cadre d'un nouveau système financier.
- Ce projet prévoit une planification nationale pour les déchets domestiques et régionale (Wilaya et provinces) pour les autres types de déchets.

| **Domaine** | **Actions menées en matière de gestion des déchets** |
|---|---|
| ***- Zones côtières*** | * Projet de loi sur le littoral ;<br>* Projet de loi sur les déchets |
| - Plages | * Projet de loi sur le littoral ;<br>* Projet de loi sur les déchets ;<br>* Projet de code sur la pêche |
| - Eau de mer | * Projet de code sur la pêche |
| - Fond de la mer | * Projet de code sur la pêche |
| - Ports | * Projet de code sur la pêche<br>* Arrêté n°90 du 28 avril 1961 sur la police des ports maritimes de commerce ;<br>* Dahir portant loi du 23 novembre 19973 formant règlement sur la pêche maritime (cf. annexe 1). |
| - Navires de commerce | |
| - Bateaux de plaisance (marinas) | |
| - Ports de pêche ou terminaux | |
| - Cours d'eau | |

**VI.2.2. Indicateurs économiques** : Sur le plan financier, le secteur des déchets souffre de grandes contraintes :

- Absence d'une ligne budgétaire spécifique à la gestion des déchets municipaux et industriels ainsi que d'une comptabilité analytique dans les communes ;
- Faible taux de couverture de la taxe d'édilité qui est calculée en fonction du montant des locations ;
- Vétusté de la valeur de la taxe d'édilité ;
- Sanctions non dissuasives (Code pénal/Municipale) ;
- Droit de douane sur le matériel de gestion des déchets élevé.

### VI.2.3. Indicateurs institutionnels et juridiques :

Sur le plan institutionnel, la responsabilité des producteurs des différents types de déchets (ménagers, industriels et hospitaliers) n'est pas bien définie. Ainsi l'absence d'un tri de déchets en amont et l'inexistence de filières spécialisées dans l'élimination des déchets industriels ou médicaux engendrent une confusion dans les responsabilités d'élimination des déchets par les producteurs de ces déchets.

Sur le plan juridique, la législation des déchets reste encore à élaborer. En effet, il n'existe pas de texte spécifique dédié aux déchets. L'analyse du cadre juridique actuel montre qu'il existe un bon nombre de textes et de dispositions qui traitent indirectement des déchets. Toutefois, ces dispositions dont la plupart ont été adoptés à l'époque du protectorat, sont éparses et ne présentent qu'un caractère général et par conséquent ne sont plus adaptés au contextes économique et social actuels .

D'autre part, le Maroc est partie à un nombre d'instruments juridiques internationaux traitant des déchets notamment la convention de Bâle sur le contrôle des mouvements transfrontières des déchets et leur élimination ratifiée par le Maroc le 22 décembre 1995, et qui prévoit l'obligation de réduire les mouvements transfrontières des déchets et de réduire au minimum la production et la toxicité des déchets dangereux.

Ainsi les principales lacunes du dispositif juridique actuel relatif aux déchets peuvent être résumées comme suit :

- L'inexistence d'une définition juridique des déchets ;
- L'absence de dispositions définissant la responsabilité du producteur ou du détenteur des déchets en cas de leur élimination ;
- L'absence de dispositions relatives à l'organisation du service public d'enlèvement des ordures ménagères et l'obligation d'établir des schémas de collecte ;
- L'absence de dispositions relatives à la planification à l'échelle nationale ou régionales e, matière de gestion des déchets ;
- L'absence de dispositions relatives au contrôle at aux sanctions spécifiques aux déchets.
- Ainsi, le projet de loi relative à la gestion des déchets et à leur élimination introduit les principes de base mondialement reconnus, tel le principe de prévention, le principe de pollueur-payeur et le principe de correction par priorité à la source, dans la gestion des déchets afin de garantir la prévention de la santé de l'homme et l'environnement des effets néfastes des déchets dans l'esprit d'un développement durable. Le présent projet de loi, se propose d'atteindre les objectifs suivants :
  - Harmoniser et combler le vide juridique en matière de gestion des différents types de déchets ;
  - Mettre en place l'idées de la responsabilité partagée entre les différents acteurs concernés ;
  - Prévenir la pollution, protéger la santé de l'homme et l'environnement contre les effets nocifs dus aux déchets ;

Cette loi s'applique aux déchets ménagers, industriels, médicaux et inertes ainsi qu'aux déchets dangereux. Elles s'applique également aux véhicules abandonnés sur la voie publique, aux épaves maritimes et d'aéronefs et aux cadavres d'animaux ainsi qu'aux immersions et aux rejets provenant des navires prévus dans les conventions et protocoles ratifiés par le Maroc. Elle exclut de son champ d'application les déchets radioactifs, les effluents gazeux, les dépôts ou rejets liquides couverts par l'article 52 de la loi nationale 10-95 sur l'eau.

Concernant les déchets ménagers et conformément à la charte communale, leur gestion est la charge des communautés urbaines, des communes urbaines ou rurales qui en assurent la collecte et la mise en décharge contrôlée.

Afin de réaliser ces missions les communes peuvent collaborer avec les communautés urbaines ou se constituer en syndicats de communes, comme elles peuvent confier la gestion de leurs déchets ménagers à des tiers. Par ailleurs, le projet prévoit que le détenteur du déchet ménager doit utiliser le système de collecte et de tri mis sa disposition par la collectivité locale, la mise en place des décharges contrôlées et l'élaboration de plans régionaux de gestion de déchets ménagers ainsi qu'un système d'affectation spéciale de la taxe d'édilité. ;

En égard de la particularité des déchets industriels, le projet de loi prévoit que les déchets industriels non dangereux peuvent être assimilés aux déchets ménagers en tenant compte de leurs particularités au niveau du site de décharge. Alors que la collecte, la valorisation ou l'élimination des déchets dangereux sont soumises à un système d'autorisation spéciale.

Le dépôt en dehors de décharges spéciales et l'enfouissement ainsi que le mélange des déchets dangereux avec d'autres types de déchets sont interdis. Le projet de loi prévoit également l'élaboration de plans de gestion des déchets dangereux par l'autorité gouvernementale chargée de l'environnement en collaboration avec les autorités concernées.

Le projet de loi prévoit que les déchets provenant des soins médicaux, vétérinaires ou de la recherche scientifique doivent être gérés de manière spécifique afin d'éviter toute atteinte à la santé de l'homme et à l'environnement. A cet effet, les Centres Hospitaliers Universitaires, les hôpitaux, les dispensaires et cabinets médicaux et vétérinaires … doivent les éliminer par des moyens appropriés. Les modalités de gestion des déchets médicaux tels le transport, le tri, la collecte, l'emballage ainsi que le contrôle des installations d'élimination seront fixés par voie réglementaires.

Le projet de loi prévoit la création de décharges contrôlées en fonction de la nature du déchet. Il prévoit également que l'ouverture, le transfert et la fermeture d'une décharge contrôlée sont subordonnées à autorisation délivrée par l'autorité gouvernementale chargée de l'environnement.

Les installations de valorisation, de traitement, de stockage et d'élimination quant à elles, sont soumises aux dispositions du dahir du 25 août 1914 portant réglementation des établissements insalubres, incommodes ou dangereux.

Le projet de loi prévoit que le contrôle ainsi que la constatation des infractions sont assurés par tout officier de police judiciaire et par tout agent commissionné à cet effet par le département de l'environnement pour les déchets dangereux, ménagers et assimilés, le département de la santé pour les déchets médicaux autre que ceux produits par les établissements hospitaliers publics, le département du transport pour le transport des déchets dangereux.

Concernant les sanctions le projet de loi instaure un système gradue de sanctions en fonction de la gravité des infractions.

### VI.2.4. Indicateurs techniques :

Les déchets solides municipaux comprennent les ordures ménagères et autres déchets urbains collectés par la municipalité ou la collectivité locale, tels que déchets commerciaux (marchés, hôtels, restaurants, magasins, boutiques…). La population urbaine, selon les statistiques de 1994 est d'environ 15 millions d'habitants. En supposant un taux de production individuel de 0,8 Kg/Hab/j, cela amène à une production annuelle de 12000 tonnes en 1994 ; cette production est concentré dans les grands centres urbains.

Les déchets municipaux comprennent 65 à 70% (du poids humide) de matière organiques, 18 à 20 % de papier-carton, 2 % de plastiques et des éléments divers tels que sables, pierres, verre et métal.. Leur teneur en eau varie entre 60 et 70%. L'importante teneur en matière organique de ces déchets entraîne une fermentation importante et rapide, une densité plus forte (0,4 à 0,6) et une faible valeur calorifique.

Sur le plan technique, la situation nationale en matière de gestion des déchets se caractérise par des taux de collecte non satisfaisant et une élimination qui ne répond pas aux besoins :

**Déchets ménagers :**

- Difficulté dans l'évaluation des tonnages ;
- Concentrations variant entre 0,61 et 0,89 Kg/hab/jour ;
- Tonnage très sous estimé ;
- Données corrigées non disponibles

**Déchets hospitaliers :**

- Données fragmentaires ;
- Données corrigées non disponibles

**Déchets industriels :**

- Données non disponibles

## VI.3. Sources de détritus dans les zones côtières (Méditerranée)

A part les débris provenant de la mer (Offshore) et ceux ramenés par les crues torrentielles d'hiver ou vents (pour les déchets légers notamment les plastiques), rares sont les débris provenant des agglomérations urbaines côtières méditerranéennes vers les plages à proximité. Presque toutes les plages méditerranéennes situées à l'extérieur des périmètres urbains sont à l'état naturel et ne sont soumises à aucune pression humaine.

### VI.3.1. Zones côtières (plages) présentant des détritus non ramassés (cf. Tableau ci-dessous) :

| Nom du site | | Qualité des sables des plages |
|---|---|---|
| **TANGER MOR I** | | La qualité du sable de toutes les plages est bonne malgré la présence de détritus |
| | 1. Plage municipale | |
| | 2. Malabata | |
| **TETOUAN MOR II** | | La qualité du sable de toutes les plages est bonne malgré la présence de détritus |
| | 1. Rifienne | |
| | 2. Tres piedras | |
| | 3. Sania Torres [ Restinga] | |
| | 4. Sabaatou Rijal ‘’M’diq’’ | |
| | 5. M’diq | |
| | 6. Martil | |
| | 7. Oued Laou | |
| **AL HOCEIMA MOR III** | | Pas de détritus rencontrés dans toutes les plages de MOR III. La qualité du sable est bonne |
| **NADOR MOR IV** | | La qualité du sable de toutes les plages est bonne malgré la présence de détritus |
| | 1. Miami | |
| | 2. Kariat Arekmane | |

### VI.3.2. Qualité des Eaux de mer à proximité des plages (Méditerranéennes marocaines où se présentent des détritus (cf. Tableau ci-dessous) :

| | **Nom du site** | **Fortement polluée** | **Polluée** |
|---|---|---|---|
| **TANGER MOR I** | La qualité du sable de toutes les plages est bonne malgré la présence de détritus | | |
| | 1. Plage municipale | Momentanément polluée | |
| | 2. Malabata | Momentanément polluée | |
| **TETOUAN MOR II** | La qualité du sable de toutes les plages est bonne malgré la présence de détritus | | |
| | 1. Rifienne | Bonne | |
| | 2. Tres piedras | Bonne | |
| | 3. Sania Torres [ Restinga] | Bonne | |
| | 4. Sabaatou Rijal ‘’M’diq’’ | Momentanément polluée | |
| | 5. M’diq | Moyenne | |
| | 6. Martil | Moyenne | |
| | 7. Oued Laou | Moyenne | |
| **AL HOCEIMA MOR III** | Les eaux de baignades de toutes les plages de MOR III sont de bonne qualité. | | |

| | | |
|---|---|---|
| **NADOR MOR IV** | La qualité du sable de toutes les plages est bonne malgré la présence de détritus | |
| | 1. Miami | Moyenne |
| | 2. Kariat Arekmane | Bonne |

### VI.4. Ressources en eau et pollution urbaine

Dans la région méditerranéenne marocaine, l'accroissement démographique, le développement des activités industrielles et l'extension de l'agriculture au niveau des bassins versants, exercent de fortes pressions sur les ressources en eau qui sont appelées à être de plus en plus sollicitées pour satisfaire la demande croissante en eau.

Ces activités domestiques et industrielles génèrent des charges polluantes relativement importantes et très diversifiées (micro-organismes, substances organiques et minérales, produits toxiques,…) qui risquent de porter préjudice à la qualité du milieu récepteur.

Par ailleurs, ces activités sont conditionnées par une hydrodynamique très intense (crue, pente des versants, nature géologique des terrains, variation de débit, etc.) et par l'effort de production qui doit satisfaire les besoins croissants de la région Nord du Maroc

#### VI.4.1. Pollution des eaux

Une évaluation quantitative et qualitative des effluents domestiques et industriels générés par les principaux centres urbains de la côte méditerranéenne a été traité dans le chapitre sur les points chauds et zones sensibles de pollution , en utilisant l'analyse multicritère recommandée par le Secrétariat du PAM/MED POL à Athènes.

La pollution engendrée par les eaux usées domestiques est due principalement à trois facteurs :

* Insuffisance voire l'absence dans certains cas de d'entretien des réseaux d'assainissement quand ceux-ci existent;

* Rejet des eaux usées sans aucun traitement préalable dans le milieu naturel;

* Absence de stations d'épuration (exception faite dans les cas des villes de Nador et d'Al Hoceima).

La plupart des villes côtières sont dotées uniquement de réseaux d'égouts unitaires et les eaux usées sont déversées soit dans les cours d'eau (cas de Tétouan ''MOR II'') soit en mer (cas d'Al Hoceima ''MOR III'' et Tanger ''MORI'' et Nador ''MOR IV'').

Trois cas sont néanmoins spécifiques, à signaler :

**(i)** La ville de Nador1 ou le réseau est raccordé à une station d'épuration par boues activées dont la capacité risque d'être dépassée compte tenu de l'urbanisation accélérée de cette ville;

**(ii)** Certains complexes touristiques (Cabo-Negro, Kabila, Club méditerranéen) qui traitent leurs eaux usées avant leur rejet en mer;

**(iii)** La ville de Tanger, qui bien que disposant d'un réseau bien dimensionné dans l'ensemble (pour la population logée dans les zones assainies), souffre d'un manque d'entretien et de

1 La lagune de Nador reçoit quotidiennement 18 173 $M^3$/j d'eaux usées dont 10 000 $m^3$ sont traitées dans la station d'épuration de Nador, les eaux usées non traitées proviennent de l'Oued Lhar et l'Oued Selouane.

surveillance de cet important réseau. Ceci a pour effet de contribuer à la pollution de la baie de Tanger et priver, par conséquent, le réseau de sa fonction essentielle.

Par ailleurs, la prolifération des zones industrielles dans les périmètres urbain a contribué davantage à l'augmentation du risque de détérioration de la qualité des eaux côtières (Oued Moghora, Oued Souani). De plus, la disparition progressive des sables côtiers engraissant la baie de Tanger ont aggravé la situation par l'accès directe des eaux usées vers la côte.

Par ailleurs, dans l'objectif d'analyser les éventuels projets d'investissements relatifs à la réhabilitation du réseau ou mise en place de stations de traitement des eaux usées en Méditerranée marocaine, il a été procédé à la collecte de données concernant chaque site (MOR I à IV) (cf. fiches techniques par site en annexe). Par ailleurs, ces données, en plus de celles recueillies à partir programme de surveillance continue de la qualité des eaux côtières de la méditerranée (MED POL Phase III 1997 à 2000), ont fait l'objet d'analyses multicritères tel qu'il a été recommandé par le Secrétariat du MED POL à Athènes, concernant les points chauds et zones sensibles de pollution de la Méditerranée Marocaine cf. Tableaux ci-dessous.

## ANALYSE MULTICRITERE DES POINTS CHAUDS ET ZONES SENSIBLES DE POLLUTION (MORI, MORII, MORIII et MORIV)

Concentrations moyennes des principaux paramètres indicateurs de pollution dans les principales zones côtières à proximité des agglomérations urbaines de la Méditerranée marocaine

| | | DBO5 mg/l | DCO mg/l | NTK mg/l | PT mg/l | TSS mg/l | Hyd.Tot mg/l | Détg. mg/l | Phénols mg/l | Cd µg/l | Cu mg/l | Cr mg/l | Ni mg/l | Pb µg/l | Zn mg/l | Fe mg/l | Hg µg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Stati-ons** | **Tanger MORI** | 122 | 404 | 47,5 | 8,3 | 200 | 0,43 | 1,25 | 0,007 | 38,8 | 0,035 | 0,057 | 0,021 | 4,93 | 0,14 | 4,113 | <1 |
| | **Tétouan MORII** | 30 | 63 | 19,04 | 3,205 | 100 | 0,035 | 2,3 | 0,007 | 87,5 | 0,038 | 0,015 | 0,06 | 3,547 | 0,27 | 12,49 | <1 |
| | **Al Hoceima MORIII** | 40 | 69 | 48,1 | 7,3 | 32 | 0,04 | 0,9 | <0,002 | 4,8 | 0,025 | 0,0056 | 0,03 | 1,733 | 0,135 | 1,573 | <1 |
| | **Nador MORIV** | 52,5 | 136 | 54,88 | 7,203 | 113 | 0,025 | 1,15 | 1,07 | 4 | 0,0175 | 0,006 | 0,06 | 22,23 | 0,0275 | 0,675 | <1 |

Charges polluantes (t/an) des principaux paramètres indicateurs de pollution, véhiculées vers les eaux côtières.

| | | DBO5 | DCO | NTK | PT | TSS | Hyd.Tot. | Détg. | Phénols | Cd | Cu | Cr | Ni | Pb | Zn | Fe | Hg | Débits moyen $M^3/j$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Stati-ons** | **Tanger MORI** | 1541 | 5102 | 600 | 105 | 2226 | 5,5 | 15,8 | 88 Kg/an | 490 Kg/an | 442 Kg/an | 720 Kg/an | 265 Kg/an | 62,26 Kg/an | 1,8 | 52 | <21,6 Kg/an | 34600 |
| | **Tétouan MORII** | 329 | 690 | 209 | 35 | 1095 | 383 Kg/an | 25,2 | 77 Kg/an | 958 Kg/an | 416 Kg/an | 164 Kg/an | 657 Kg/an | 39 Kg/an | 3 | 137 | <11 Kg/an | 30 000 |
| | **Al Hoceima MORIII** | 63 | 108,3 | 75,5 | 11,5 | 50,3 | 62,8Kg/an | 1,4 | 3,2 Kg/an | 7,5 Kg/an | 4 Kg/an | 9,4 Kg/an | 47 Kg/an | 2,7 Kg/an | 212 Kg/an | 2,5 | <1,8 Kg/an | 4 300 |
| | **Nador MORIV** | 192 | 496,4 | 200,4 | 26,3 | 412,5 | 91,3 Kg/an | 4,2 | 4,0 | 14,6 Kg/an | 64 Kg/an | 22Kg/an | 219 Kg/an | 81,3 Kg/an | 102 Kg/an | 2,5 | <2,6 Kg/an | 10 000 |

### VI.4.1.1 Pollution Industrielle

Bien que le littoral n'ait pas une vocation industrielle affirmée, les quelques industries implantées dans les zones urbaines (Tableaux 3 et 4) ne manquent pas de poser à l'environnement, parfois, certains problèmes relativement graves. Il s'agir notamment des deux agglomérations de Tanger et Tétouan.

Les industries implantées dans cette région Nord Ouest de la Méditerranée sont diversifiées. Cependant, le tissu industriel reste fortement dominé par les petites et moyennnes entreprises notamment le secteur du textile et du cuir avec 212 unités. Le secteur agroalimentaire arrive en deuxième position avec 181 unités, les secteur de chimie et parachimie (174 unités) et enfin le secteur de la mécanique-métallurgique-électrique avec 86 unités.

Il faut souligner cependant, qu'il n'existe pas d'études d'ensemble fondée sur une analyse détaillée des charges polluantes générées par les unités industrielles de chaque secteur ou branche d'industries.

En ce qui concerne Tétouan, la plupart des industries étant situées en milieu urbain et dans la vallée de l'oued Martil, on dénote une concentration de pollution émanant des industries de métallurgie, de textile, de chimie, de papeterie et des abattoirs ainsi que certaines unités agro-alimentaires. D'autre part, il y a lieu de noter que toutes ces unités rejettent leurs effluents liquides soit directement dans les eaux de l'Oued de Martil soit dans le réseau d'égout lui-même se déversant dans le cours d'eau.

Au niveau de la ville de Tanger , la pollution industrielle provient de quatre sources :

(i) La zone industrielle située sur la route de Tétouan dont les effluents liquides (textile, Aluminium, papeterie, agro-alimentaire...) sont évacués par le réseau d'assainissement urbain);

(ii) La zone de Moghogha (Textile, tannerie et agro-alimentaire...) dont les effluents liquides sont rejetés dans l'Oued Moghogha;

(iii) La zone du quartier Moulay Ismael, au sud de la ville, (minoterie et textile) qui est raccordée à l'égout municipal;

(iv) Le groupement d'industries de la route de l'aéroport situé au Sud Ouest de la ville (atelier de teinture) dont les eaux usées sont déversées dans l'Oued Lihoud.

En général les principales industries dans la zone sont essentiellement réparties et concentrées dans les villes de Tanger, Tétouan. Un inventaire des unités industrielles existantes ainsi que le milieu récepteur de leurs rejets a été établie1.

Les valeurs enregistrées pour les charges (MES, DCO, $DBO_5$, NTK et $P_{tot}$,) montrent un apport de la matière organique, azote et phosphore, véhiculé dans les différents cours d'eau, reflétant ainsi une qualité mauvaise et très dégradée des eaux superficielles, elles sont inaptes à la plupart des usages. Ceci est du aux déversement à l'état brut des effluents urbains et industriels des villes de la région sans traitement préalable.

A cette pollution organique s'ajoute une pollution chimique, particulièrement par les métaux lourds toxiques dans les rejets caractérisés, avec des niveaux inférieurs aux PMVLG (Projet marocain de valeurs limites générales). Cette constatation laisse supposer que les rejets

1 Minist. TP, 1992.

étudiés présentent un caractère à dominance domestique avec une dilution d'éventuels rejets industriels sans toute fois ignorer le problème d'une bioaccumulation chronique de ces agents dans certains organismes marins (mollusques).

**Tableau N° 3 : Principales industries implantées dans la côte Méditerranéenne marocaine1**

| LOCALISATION | INDUSTRIE | NATURE DU PRODUIT | MILIEU RECEPTEUR | TRAITEMENT EMPLOYE |
|---|---|---|---|---|
| **TANGER** | Brasserie | brasserie | O. Lihoud | Aucun |
| | Nastotex | textile | O. Lihoud | Aucun |
| | Satfilage | textile | O. Lihoud | Aucun |
| | Coca Cola | brasserie | O. Lihoud | Aucun |
| | Eteinord | brasserie | O. Mghogha | Aucun |
| | Sofocosine | brasserie | O. Mghogha | Aucun |
| | Saviab | brasserie | O. Mghogha | Aucun |
| | Gaton | textile | O. Mghogha | Aucun |
| | Textile | textile | O. Mghogha | Aucun |
| | Abattoir | viande | O. Mghogha | Aucun |
| **TETOUAN** | Papeterie | Papier | O. Martil | Aucun |
| | Caoutchouc | Caoutchouc | O. Martil | Aucun |
| | Coelma | Soude | O. Martil | Décantation |
| | Usine thermique | Production elect. | O. Martil | Aucun |
| | Allumettes | Allumettes | O. Martil | Aucun |
| | Eurafrica | textile | O. Martil | Aucun |
| | Tannerie | cuir | O. Martil | Aucun |
| | Colainord | lait | Nappe de Martil | Aucun |
| | Regie.tabac | cigarette | O. Martil | Aucun |
| | Zone Industrielle | Textile | Nappe de Martil | Aucun |
| | Abattoir | Viande | O. Martil | Aucun |
| | Cimenterie | Ciment | O. Martil | Aucun |
| | Sonivision | Fil de fer | O. Martil | Aucun |
| **AL HOCEIMA** | | | | |
| **NADOR** | SONASID<br>SUCRAFOR<br>POISSON et CONSERVE :ITALIA<br>NADOTEX<br>SETEX | Fer à béton<br>Sucre Granulé,<br>Conserve de poisson<br>Couverture<br>Fibres de textile | | |

1 Minist. Tp. 1992.

**Tableau N°4 : Flux de pollution industrielle**

| Ville | Unités industrielles | | | | | | Pollution industrielle t/an | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | IAA | ITC | IMME | ICP | Total | Débit $M^3/j$ | DBO5 | DCO | MO | MES |
| **Tanger** | 49 | 188 | 41 | 62 | 340 | 4406,4 | 2469 | 5187 | 3375 | 1057 |
| **Tétouan** | 56 | 21 | 21 | 60 | 158 | 5702,4 | 1614 | 2560 | 1929 | 569 |
| **Nador** | 55 | 3 | 24 | 42 | 124 | 4000 | 887 | 1218 | 997 | 268 |
| **Al Hoceima** | 21 | 0 | 0 | 10 | 31 | 32,5 | 210 | 262 | 227 | 60 |

**IAA** : Industrie agroalimentaire; **ITC** : Industrie du textile et du cuir; **IMME** : Industrie mécanique-métallurgique et électrique; **ICP**: Industrie de la chimie et parachimie

A partir des données mentionnées dans les tableaux N°3 et 4, il ressort que la ville de Tanger arrive en tête avec un 340 unités industrielles,suivie de Tétouan (158); Nador (124) et Al Hoceima (31) unités. Par ailleurs, la pollution engendrée par ces 4 villes est proportionnelle au nombre d'unités industrielles. Les villes de tanger et de Tétouan devancent largement Nador et Al Hoceima (cf. Tableaux des analyses multicritères sur les points chauds ci-dessous).

Les plages de la région connaissent une dégradation physique intense causée par les extensions portuaires réalisées entre 1930 et 1950, dont la baie de Tanger est la plus exposé à ce phénomène. Cette dégradation est manifesté par une érosion de la partie Est de la plage entre l'Oued Mghora et Ghandouri, et par une sédimentation dans la partie Ouest entre l'Oued Mghora et le port. De plus, ce phénomène est amplifié par une érosion éolienne qui agit dans le même sens.

Des études sédimentologiques et océanographiques récentes ont estimé l'érosion à environ 50000 $m^3$/an dont 70% par l'action de la houle et 30% par l'action éolienne.
Le littoral méditerranéen marocain souffre du problème de la pollution des rejets liquides. Les rejets de la ville de Tanger, Al Hoceima et Nador, en plus les embouchures des Oueds Souani, Mghora et Martil déversent les eaux usées domestiques et industrielles directement dans la côte sans aucun traitement préalable.

Le tableau N°5 montre les niveaux moyens des concentrations des matières organiques, azotées et phosphorées véhiculées par les différents rejets et cours d'eau des Régions méditerranéennes marocaines.

**TABLEAU N° 5 : Niveaux moyens des concentrations des polluants des émissaires1**

| 1999 | MES (mg/l) | DCO (mg/l) | DBO5 (mg/l) | NTK (mg/l) | Ptot (mg/l) |
|---|---|---|---|---|---|
| **Oued Lihoud** | 198 | 520 | 252 | 66 | 9 |
| **S. bouknadel** | 476 | 674 | 323 | 63 | 9 |
| **Oued Souani** | 337 | 602 | 293 | 97 | 10 |
| **Oued Mghora** | 175 | 589 | 180 | 50 | 6 |
| **R. Fnideq** | 435 | 700 | 352 | 50 | 10,5 |
| **Sorite de STEP El Hoceima** | 34 | 69 | 39 | 51 | 7,3 |
| **O. El Har** | 55 | 20 | 11 | 3 | 0,7 |
| **PMVLG**[1] | 50 | 150 | 30 | 10 | 2 |
| **Av. O. Martil** | 96 | 75 | 35 | 11 | 2 |
| **Classe de** | Bonne | Mauvaise | Très | Très | Mauvaise |

1 PMVLG : Projet marocain valeurs limites générales (CNE, 1996)

| | | | | | |
|---|---|---|---|---|---|
| **qualité** | | | mauvaise | mauvaise | |
| **O. Selouane** | 45 | 12 | 1,4 | 1 | 0,1 |
| **Classe de qualité** | Bonne | Très bonne | Très bonne | Bonne | Bonne |
| **Sortie de STEP Nador** | 113 | 136 | 52,5 | 55 | 8,3 |
| **Oued Lhar** | 44 | 22,4 | 9,3 | 6,6 | 0,78 |

La comparaison des résultats des dernières, années, montre que la qualité des eaux des Oueds Souani et M'ghora est très mauvaise, inapte à la plupart des usages et nécessite un traitement préalable des rejets des effluents domestiques et industriels de la ville de Tanger avant d'être rejetés dans ces cours d'eau qui débouchent directement dans les eaux côtières la mer méditerranéenne. Ces deux Oueds sont considérés comme des émissaires à ciel ouvert à cause de leur rareté en eau et la quantité des eaux usées qu'ils reçoivent.

## VII. CONFORMITE RELATIVE A LA QUALITE HYGIENIQUE DES EAUX DE BAIGNADE

Durant la période estivale, les plages constituent un pôle d'attraction important pour une population hétérogène. Ces dernières années, elles ont fait l'objet de surveillance et de contrôle de leur qualité hygiénique. Les différentes études menées à cet effet, en particulier celles du Ministère de la Santé, du ministère de l'Equipement et du Département de l'Environnement ont montré que les plages les plus polluées sont celles qui reçoivent une forte masse d'estivants et parmi les plages les plus fréquentées, certaines ne disposent pas d'infrastructure minimale nécessaire et d'autres sont polluées par l'évacuation, sans traitement préalable, des eaux usées.

**Tableau N° 6 : Niveaux de concentrations des principaux métaux lourds pour l'année 1999**

| Stations | Pb (µg/l) | Cr (µg/l) | Cd (µg/l) |
|---|---|---|---|
| **Oued Lihoud** | 5 | 1,4 | <1 |
| **S. bouknadel** | 12 | 2,9 | 1 |
| **Oued Souani** | 8,3 | 11 | 2 |
| **Oued Mghora** | 3 | 2,2 | 1,2 |
| **R. Fnideq** | 41 | 25 | 0,33 |
| **Av. O. Martil** | <1 | <1 | 14 |
| **O. Smir** | <1 | <1 | 18 |
| **R. M'dique** | <1 | <1 | 18 |
| **Sortie de STEP Al Hoceima** | 24,8 | <1 | <1 |
| **O. El Har[2]** | <1 | <1 | <1 |
| **O. Selouane2** | <1 | 13,75 | <1 |
| **Sortie STEP Nador** | 22,23 | 6 | 4 |
| **Oued Lhar** | 31,13 | 5 | 0,4 |

Débit. O. Selouane = 6590 $m^3$/j
Débit O. Lhar = 1583 $m^3$/j

### VII.1. Résultats globaux relatifs à la conformité:

La classification de la qualité hygiénique des principales plages autorisées pour la baignade a été effectuée conformément à la norme marocaine (NM 03.7.200 relative à la

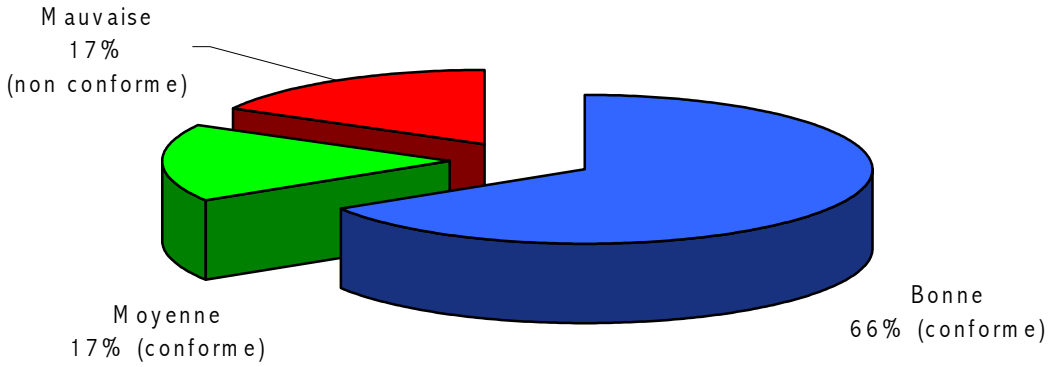
2 Reçoit les eaux usées des quartiers périphériques, non reliés au réseau d'assainissement de Nador.

surveillance de la qualité des eaux de baignade). Cette Norme est conforme aux directives de l'Union Européennes et l'OMS.

Classification des plages selon la qualité hygiènique des eaux de baigandes1

| Plages | Qualité | Classes | Conformité |
|---|---|---|---|
| Saïdia | Bonne qualité pour la baignade | A | Conforme |
| Quemado | Qualité moyenne pour la baignade | B | Conforme |
| Calabonita | Qualité moyenne pour la baignade | B | Conforme |
| Nador | Qualité moyenne pour la baignade | B | Conforme |
| Martil | Qualité moyenne pour la baignade | B | Conforme |
| Tanger | Mauvaise qualité | D | Non conforme |

**Présentation de la qualité hygiènique des principales plages Méditerranéennes (2000-2001)**




Tendance de la qualité micro biologique des principales plages de la Méditerranée marocaine autorisées pour la baignade1

| | *93-94* | *94-95* | *95-96* | *96-97* | *97-98* | *98-99* | *99-00* |
|---|---|---|---|---|---|---|---|
| Tg.Municipale* | C | C | C | D | C | D | C |
| TTRifienne** | D | B | B | B | B | B | A |
| Sania Torres | B | A | A | A | B | A | A |
| SR MDiq | D | C | C | D | D | C | C |
| MDiq | C | B | B | B | B | B | B |
| Martil | B | B | C | C | C | C | B |
| Oued Laou | A | A | A | B | A | A | B |
| Quemado | A | B | B | B | B | B | B |
| Calabonita | A | B | B | B | B | B | A |

La tendance de la qualité microbiologique des principales plages montre que :

- Certaines plages subissent une dégradation continue de leur qualité notamment : Tanger, Sania Torres ;
- Une catégorie de plages accusent maintien de leur qualité : M'diq, Quemado ;
- D'autres plages montrent une amélioration de leur qualité : TTRifienne, SR M'diq, Martil,

1 Département de l'Environnement/MATUHE (2001)

1 Ministère de l'Equipement /ODEP 2000. **Tg: Tanger (MOR I); **TT: Tetouan (MOR II).*

## VII.2. Actions menées pour la préservation et l'amélioration de la qualité hygiènique des plages

Depuis 1999, sous la présidence effective de Son Altesse Royale La Princesse Lalla Hasna, des campagnes nationales consacrées à l'hygiène des plages ont été réalisées. Ces opérations qui entrent dans le cadre de la mise en œuvre du programme *Maroc Propre*. Ces campagnes de communication et de sensibilisation des usagers de la plage ont pour objectif :

- l'arrêt de la spirale de détérioration de l'environnement côtier au Maroc et la prévention de l'apparition de maladies pouvant porter atteinte à la santé du citoyen
- la mise à la disposition des estivants d'un produit balnéaire touristique répondant à des normes nationales et internationales, compétitives tant sur le plan environnemental et esthétique que sur le plan des équipements en infrastructures de base
- La promotion d'un esprit de partenariat efficient entre tous les partenaires aussi bien privés que publics pour une action concrète et durable sur le terrain
- La mobilisation générale, aussi bien des administrateurs et des administrés en vue d'une responsabilisation partagée.
- La conciliation entre la nécessité d'améliorer l'état des plages et celle de coordonner les différentes actions menées sectoriellement et épisodiquement par les différents acteurs concernés ;
- L'instauration un système permanent d'évaluation de l'état des plages et
- La promulgation d'une législation appropriée (Loi sur le littoral et loi sur les Etudes d'Impact sur l'Environnement).

Parallèlement à la réglementation existante, une Circulaire conjointe (N° 84 du 08 juin 1998) relative à la gestion et la protection des plages a été élaborée par les Ministères de l'Intérieur et de l'Equipement. L'objectif général de cette circulaire est conforme aux visions du *Département de l'Environnement* en matière de gestion et de protection de la qualité hygiénique des plages. Il matérialise aussi le renforcement de la politique de décentralisation administrative en :

**(i)** Mettant les plages à la disposition des collectivités locales ce qui va leur permettre de gérer ou soumettre ces plages au privé, conformément au droit d'occupation de ces plages suivant les dispositions telles qu'elles sont spécifiées dans ladite circulaire ;

**(ii)** Instituant une Commission provinciale, présidée par le Wali ou Gouverneur, chargée de l'examen de la conformité de l'usage des plages publics.

A cet effet, l'Etat a invité les Collectivités Locales urbaines ou rurales ou d'autres secteurs publics ou privés et le citoyen à prendre en charge la gestion des plages du domaine public maritime, ouvertes pour la baignade.

Les secteurs bénéficiaires seront chargés de gérer lesdites plages et mettre en place les installations nécessaires pour leur gestion et veiller sur leur propreté ainsi que la santé des estivants.

## VIII. CONCLUSION

La pollution du littoral méditerranéen a quatre causes principales: les eaux usées municipales et industrielles, les eaux de ruissellement agricole et lessivage, les hydrocarbures et les déchets chimiques déversés par les navires et l'évacuation inadéquate des déchets solides, (les matières plastiques, en particulier).

Les eaux usées et celles de ruissellement agricole contiennent des éléments nutritifs, source d'eutrophisation et de problèmes connexes.

Une grande partie d'eaux usées municipales non traitées ou mal traitées sont rejetées dans les zones littorales, souvent par des déversoirs marins très courts. Les taux de pollution marine n'ont pas été contrôlés scientifiquement durant de longues périodes, mais il ressort des résultats du Réseau de surveillance du MED POL que la pollution d'origine domestique et industrielle est en augmentation en maints endroits. Il est courant de voir des signes de la pollution par les eaux d'égouts sur les côtes. Lorsque les réseaux d'assainissement et de drainage des eaux de pluie se combinent, les déversoirs pluviaux peuvent contenir des concentrations particulièrement élevées de déchets liquides et solides.

Par ailleurs, en se basant sur une étude réalisée dans le cadre du schéma directeur national d'assainissement liquide, l'estimation des coûts d'aménagement de stations d'épuration des eaux usées domestiques pourrait être établie en fonction du nombre d'habitants. Tenant compte du calendrier actuel (2001), par exemple, pour une ville de 100.000 habitants, le budget nécessaire pour construire une station d'épuration est de 500 dirhams/habitant (HT) ; les coûts de construction de stations d'épuration seraient donc de 263.107.500 DH pour la ville de Tanger ; 202 000 000 DH pour Tetouan ; 6 000 000 DH) pour la ville d'Al Hoceima et 134 500 000 DH pour la ville de Nador.

Bien que les niveaux de concentrations des contaminants industriels soient relativement dans la région méditerranéenne, la pollution marine du large par contre, atteint des niveaux élevés a tel point qu'elles affectent certaines zones côtières marines proches du continent. Elle présente à cet effet un risque sur la santé, les loisirs, le tourisme, les zones littorales humides, les zones de pêche et les écosystèmes côtiers. On enregistre les taux les plus élevé dans les points de déversements des effluents.

Par ailleurs, les villes côtières méditerranéennes marocaines et surtout celle de Tanger au détroit de Gibraltar, sont constamment confrontées à la pollution marine off shore qui est due aux impacts du transport maritime. Le passage quotidien d'un ensemble important de navires, dont les pétroliers et tankers trasportant les produits toxiques et dangereux dans ce détroit, entraîne des rejets illicites dans la mer. A ce niveau on peut signaler les fuites normales des hydrocarbures, des rejets non réglementaires directement dans la mer (vidange et nettoyage des bateaux...). Par ailleurs, le risque de pollution accidentelle de cette zone est très élevé, du fait du flux important des bateaux et des effets de la pollution industrielle des pays du Nord en raison de la proximité. Toute cette pollution échoue sur le rivage et entraîne la dégradation du littoral et augmente l'insalubrité des plages.

## IX. PERSPECTIVES

1°- Les provinces côtières doivent être dotées de stratégies basées sur des plans d'actions spécifiques (plans d'aménagements) qui traitent des schémas antipollution : réseaux rénovation des réseaux d'assainissement, mise en place de stations d'épuration (Par manque d'informations spécifiques, il est difficile de fournir des estimations précises des coûts de cette épuration). Pour le cas de Naor, une station d'épuration nouvelle collectant les rejets en provenance des centres rejetant les eaux usées dans l'oued Saloune et l'oued Lhar est requise.

2°- Les provinces des zones côtières doivent être dotées par secteur dans l'avenir, de leur propre systèmes d'interception, de ponçage, de traitement des eaux usées d'émissaires (marin ou autre) ;

3°- Dans le cas de difficulté de réalisation du point précédant, une possibilité de transfert des effluents d'un secteur à un autre, en vue de l'acheminer vers un émissaire sous marin est à envisager.

4°- Renforcer les capacités des stations d'épuration existantes en vue d'assurer leur gestion durable.

5°- Les rejets industriels, requièrent un prétraitement préalable avant tou rejet dans le milieu récepteur ;

6°- Mettre en place un mécanisme technico-financier de mise à niveau des industries (FODEP…) pour l'introduction de la dimension Environnementale dans tout processus de gestion des entreprises polluantes ;

7°- Renforcer les capacités du réseau de surveillance continue de la mer Méditerranée (MED POL) pour étendre ses actions aux nouvelles composantes de la surveillance (Surveillance de l'eutrophisation, des effets biologiques…)

## CARACTERISATION DES "POINTS CHAUDS" LIES A LA POLLUTION DE LA MEDITERRANEE MAROCAINE

| Nom | Type | **Santé publique** | **Qualité de l'eau de boisson** | **Flore et faune aquatiques** | **Loisirs** | **Autres avantages bénéfiques** | **Conditions socio-économiques** | **Catégorie** | **Nature de l'investissement** | **Estimation préliminaire du coût financier (en dollars E.U.)** |
|---|---|---|---|---|---|---|---|---|---|---|
| | | (1) | (0.9) | (0.7) | (0.8) | (0.8) | (0.7) | | | |
| Tanger (MORI° | Domestique & industrielle | 3 | 1 | 2 | 2 | 3 | 6 | D | 1- Réhabilitation du réseau d'égouts ;<br>2- Construction d'une SEEU;<br>3- Confluence de tous les émissaires existants vers un émissaire sous marin,<br>4- Mise en place de systèmes de PTEUI. | (1+2+3)- 30 millions<br>(4)- Renforcement des capacités par des mécanismes technico-financiers de mise à niveau et conformité environnemental des industries polluantes à l'image du FODEP/GTZ .<br>(L'estimation des coûts à déterminer) |
| Tetouan (MOR II) | Domestique & industrielle | 4 | 3 | 4 | 3 | 3 | 6 | D | 1- SEEU + réhabilitation du réseau d'égouts existant;<br>2- Mise en place de systèmes de PTEUI. | (1+2)- 48 millions<br>(2)- Renforcement des capacités par des mécanismes technico-financiers de mise à niveau et conformité environnemental des industries polluantes à l'image du FODEP/GTZ.<br>(L'estimation des coûts à déterminer) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Al Hoceima (MOR III) | Domestique & industrielle | 2 | 1 | 2 | 2 | 1 | 3 | D | - Réhabilitation du réseau d'assainissement | - 7 millions |
| Nador (MOR IV) | Domestique & Industrielle | 3 | 2 | 3 | 4 | 3 | 2 | D | 1- Construction d'une SEEU (Axe Nador-Zeghenghene);<br>2- Mise en place de systèmes de PTEUI. | (1)- 12 millions<br>(2)- Renforcement des capacités par des mécanismes technico-financiers de mise à niveau et conformité environnemental des industries polluantes à l'image du FODEP/GTZ.<br>(L'estimation des coûts à déterminer) |

SEEU : Station d'épuration des eaux usées domestiques
PTEUI : Prétraitement des eaux usées industrielles
1 dollar E.U = 10 DH (dirhams)

# REVISION OF POLLUTION HOT SPOTS IN THE MEDITERRANEAN

Country report for

***S L O V E N I A***

## ***Acknowledgements***

- *Ms. Lidija Globevnik, SAP Focal Point, who collected the necessary data and filled out the relevant questionnaires.*
- *Ms. Helena Senekovic-Marchisetti, Assistant to the Director of the Nature Protection Authority, Ministry of the Environment and Physical Planning, for providing useful information on the economic activities in the coastal strip, the situation regarding the urban infrastructure, and infrastructure development plans.*
- *Mr. Viktor Simoncic, Consultant to the Government of Slovenia, for acting as an intermediary with various Government offices in order to obtain all the necessary information.*

## 1. Introduction

This report has been prepared in the framework of MED POL Phase III and the Strategic Action Programme (SAP) for the Mediterranean Sea as a follow-up to the signing of the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-based Sources and Activities.

Review of the existing list of hot spots and sensitive areas for Slovenia determined in MAP Technical Reports Series No. 124 were prepared according to recent data on discharges from coastal cities or urban coastal agglomerates and from main industries discharging directly into the sea. The report summarizes evaluation of the impacts of priority hot spots within criteria on transboundary effects.

## 2. Characteristics of Slovenian coastal water

Northern Adriatic, as many coastal ecosystems, has been subject to increases in nutrient inputs that reflect changes in land-use patterns because of the increase in human population densities in coastal watersheds. Phenomena such as algal blooms and accumulation of gelatinous masses have been frequent over the last few years, reducing tourism and affecting the benthic community. In addition to those anoxic events, harmful algal bloom, habitat loss, the exploitation of living resources and translocation of non-indigenious species are obvious examples of alterations caused by men.

Slovenian transitional and coastal waters are considered as an ecological unit of the Gulf of Trieste, the northernmost part of the Adriatic Sea with an approx. surface area of 600 $km^2$ and volume of about 9.5 $km^3$. The Gulf is a shallow (max depths 20-25 m) marine basin, influenced by freshwater inflow, bottom sediment resuspension and increasing pollution. Despite its shallowness, the Gulf has a pronounced effect on the general anticlockwise circulation pattern of the Adriatic Sea with the inflow of oligotrophic South Adriatic water. The seasonal variation of water circulation is moreover controlled by fluctuations of the freshwater inflow. Average inflow from the north-western part is about 120 $m^3/s$ with peaks higher than 1000 $m^3/s$. The general anti-clockwise circulation pattern in the Gulf of Trieste is modulated by local winds, tidal currents, density currents and inertial effects. Large temperature amplitudes (6-26$^oC$) and salinity (32 - 38.5 PSU in the surface layer, 36 – 39 PSU in the bottom water) cause great temporal variability. The density stratification in the water column starts in spring and intensifies until the late summer, which is often associated with hypoxia in bottom waters. The physical properties of the Gulf of Trieste affect the chemistry and dynamics of the biology of the system.

Slovenia is a country with a total surface area of 20.255$km^2$. Its coastline along the Adriatic sea is 46.6 km in length. Along most of the length a very narrow belt with flysch cliffs and solitary lime rocks prevails between the flat-bottomed valleys
Dragonja rivers. The coastal area can be subdivided into two parts: the deeper part of the Gulf of Trieste which is widely open to the rest of the northern Adriatic, and the second part comprising small shallow bays (the Bay of Koper - max depth about 16 m, the Bay of Strunjan, and the Bay of Piran) which have similar origins and fairly high sedimentation rates (1mm/year), but different pollution loading.

## 3. Human pressure and pollution sources

The coastal area has been exposed to strong development pressure shown in the rapid growth of population, town planning and development of business sectors (traffic, trade, tourism, processing activities, agriculture).

### 3.1 Population and tourism

The coastal region extends over the territory of three municipalities Koper, Izola and Piran with an area of 384 $km^2$ (about 1,7% of the total national territory) and with a population of under 80.000 people (about 4% of the total population) (Tab.1). The population density of the area is more than twice the national average (232 inhabitants/$km^2$, the national average is 98 inh/$km^2$). Most of the population (more than 80%) lives within the 1,5 km wide strip along the coast.

**Table 1: Population and tourist numbers in the coastal region in the year 2000***

| | Area ($km^2$) | Population | Population (%) served by municipal sewer system | Number of total overnight stays | Average seasonal increase (3months) |
|---|---|---|---|---|---|
| Koper | 311.2 | 48251 | 57 | 239 000 | 5.4% |
| Izola | 28.6 | 14590 | 80 | 222 818 | 16.6% |
| Piran | 44.4 | 17440 | 86 | 1306 455 | 81.4% |

*Statistical yearbook of the Statistical Office of the R Slovenia, 2000.

In the coastal region of Slovenia population growth is slightly higher than on Slovenian national level, but in the last decade (in the 90's) population growth stagnated around zero (0.1%).

### 3.2 Industry and port

The principal industries include metal manufacturing, production of chemicals and the food industry. Economic development caused regression in agriculture activities that now mainly include wine, fruit and olive growing and vegetable cultivation.

Because of good inland transport connections the port of Koper has become the most important export-import port of central Europe increasing its activities every year. The Port of Koper handles about 10 million tons of cargo per year (over 1 500,000 tone of oil and oil products and over 100,000 tons of chemicals and inflammable liquids). A the port of Koper yhere is a general cargo terminal (coffee, metal, paper, fruits and vegetables, cotton, textiles), a RO-RO and car terminal, a timber terminal, a terminal for iron and coal, a liquid cargo terminal (chemicals, phosphoric acid, vegetable oil, Latex), a terminal for fertilizers and other bulk cargoes, and a silos for cereals and oilseeds, aluminum). The oil terminal is operated by OMV-ISTRABENZ – Instalacije d.o.o. The main sources of pollution are tank cleaning, inadequate drains, volatile emissions and general spillage during the emptying of hoses.

Preliminary estimation of organic loads from industries represents 22550 PE (population equivalent) (Tab.2) (individual loads have been calculated where data were available).

**Table 2. Organic load from industries along Slovenian coastline**

| Industry | Load in PE |
|---|---|
| Delamaris | 7000 |
| Ladjedelnica - shipyard | 100 |
| Mehano | 200 |
| Argo | 100 |
| Droga | 1800 |
| Frigomar | 800 |
| Cimos – Koper | 500 |
| Tomos | 800 |
| Intereuropa | 250 |
| Kemiplas & Polisinteza | 2500 |
| Luka Koper | 2000 |
| Vina Koper | 6500 |
| **Industry total** | **22550** |

### 3.3 Other important activities

The sea is also used for bathing and recreation (including sports like sailing, wind surfing, rowing.), fishing and mariculture:

- along the Slovenian coastline are located 29 registered beaches;
- fishing (about 2500 t/y) and mariculture (shellfish: annual production about 80 tons; fish: annual production about 50 t);
- transportation - in addition to Port of Koper there are three marinas (in Portorož, Izola and Koper). A two-fold increase in moorings and yachting harbors in the last 10 years (from 898 to 1618) indicates the growth of "yachting" tourism.

## 4. Main loads and hot spots

### 4.1

The river Rižana receives mainly untreated urban and industrial waste water from the town of Koper and inland agglomerations along the river. The combined sewer system (which also collects a storm waters) is connected to a mechanical wastewater treatment plant, with total yearly effluent about $4.7 \times 10^6$ $m^3$/year. About 34 % of the waste water is from industry/enterprises/public sector; 66 % is household waste water. The sewage effluent is discharged into the estuary of the Rižana river. The system also collects effluents from the following industries: VINA KOPER, wine production (combined sanitary and technological effluents, pretreatment); CIMOS, car industry (combined sanitary and technological effluents, pretreatment); I&I bus service (combined sanitary and technological effluents, pretreatment); INTEREUROPA, AVTOPLUS, CESTNO podjetje, SGP, TOMOS, car washing, lacquering, electroplating (combined sanitary and technological effluents, pretreatment); Port of Koper, washing containers, trucks, cars, store-house, (combined sanitary and technological effluents, pretreatment).

There are also some industries with direct discharge into the Rižana river: KEMIPLAS, chemical industry (combined sanitary and technological effluents, pretreatment); INSTALACIJE (combined sanitary and technological effluents, biological treatment); and LAMA- metal manufacturing (combined sanitary and technological effluents, biological

treatment). The expected organic load from industries in the municipality of Koper is around 12550 PE (Tab. 3).

### 4.2 Izola domestic wastewater outlets

The sewage of the community of Izola is collected in a treatment basin and discharged without treatment into the sea about 300 m from the shore, with a flow rate of about 3.5 x $10^3$ $m^3$/day. In addition there are several small outlets discharging directly into the sea and discharge from the DELAMARIS fish-cannery pre-treatment plant (discharge rate 82.000 $m^3$/year).

The system collects effluents from the following industries:

LADJEDELNICA, shipyard, pretreatment, some activities in the dock – wastes directly in the sea; City HOSPITAL, DROGA – food processing, MEHANO – toy factory, other small enterprises. Expected organic load from industries in Izola is app. 10000PE (Tab. 3).

### 4.3 Piran submarine outfall

The sewage system in the community of Piran has a central sewage treatment plant with a capacity of 30.000 PE and total yearly effluent about 2.7 x $10^6$ $m^3$/year. After mechanical treatment (screening, sand and grease removal, sedimentation) the sewage water is discharged into the sea, through two submarine pipes, 3450 m and 3600m from the shore, with diffusers at the end. No industry is connected to the WWTP.

Some preliminary individual loads on waste water treatment plants and the Izola outlets have been calculated separately for summer and winter, since summer loads are higher due to the increase of tourist population during summer (Tab.3).

**Table 3. Loads on WWTP's and Izola's pumping station**

| | Winter load present | Summer load present | Winter load future | Summer load future | Existing treatment capacity |
|---|---|---|---|---|---|
| WWTP Koper | 31.569 | 34.686 | 52.490 | 58.605 | WWTP for 50.000 PE |
| WWTP Piran | 14.953 | 27.101 | 17.780 | 32.980 | WWTP for 30.000 PE |
| Izola outlet | 19.575 | 23.195 | 22.330 | 29.530 | none |

## 5. Assessment of the level of pollution

About 23% of the sewage load around the Gulf of Trieste arrives in the gulf from the southern Slovenian coast. Yearly water input to the entire bay from rivers is estimated at 7300x$10^6$$m^3$, while on the Slovenian site fresh water input is 2.6 x $10^8$$m^3$. The total quantity of urban and industrial wastewaters is 1.1 x $10^7$ $m^3$/year. The existing flow measurements contain rain water as well as intrusion seawater.

The gross fluxes of some pollutants have been estimated for the entire region (Tab. 4a and 4b). With regard to individual pollutants the larger sources of pollution are the river Rižana and the river Badaševica in the inner part of the Bay of Koper. The rivers receive untreated urban and industrial waters and thus represent a significant source of pollution from suspended and dissolved matter that affects chemical and biological processes in the

coastal sea. The estimated yearly inputs of some pollutants according to available data of flow rates and mean annual concentration for identified hot spots are shown in table 4a,b and 5a,b.

**Table 4a. The gross flux of some pollutants estimated from the effluent inflows and data for the year 2000**

| **LOADS** | | Pollutants | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Flow rate | COD | $BOD_5$ | TotN | TotP | TSS | FC | Oil |
| | [$m^3$/y] | [t/y] | [t/y] | [t/y] | [t/y] | [t/y] | [No./100 ml] | [t/y] |
| WWTP Koper | $4.7 \times 10^6$ | 2054 | 583 | 126 | 14.6 | 662 | $6.3 \times 10^5$ | 0.011 |
| WWTP Piran | $2.7 \times 10^6$ | 594 | 270 | 92 | 8.1 | 270 | $1.4 \times 10^7$ | 0.014 |
| IZOLA | $3.1 \times 10^6$ | 1976 | 641 | 88 | 16.2 | 641 | $2.4 \times 10^7$ | 0.017 |
| DELAMARIS | $8.2 \times 10^4$ | 399 | 16 | 15 | 2.0 | 91 | | |
| **Total** | $1.1 \times 10^7$ | 5023 | 1658 | 321 | 40.9 | 1664 | | 0.042 |

**Table 4b. The gross flux of selected heavy metals estimated from the effluent flow rates and mean concentration of seasonal measurements**

| **LOADS** | Heavy metals | | | | | |
|---|---|---|---|---|---|---|
| | Hg [kg/y] | Cd [kg/y] | Pb [kg/y] | Zn [kg/y] | Cu [kg/y] | Ni [kg/y] |
| WWTP Koper | 0.804 | 47.3 | 236.0 | 520.5 | 236.0 | 47.3 |
| WWTP Piran | 0.440 | 13.5 | 21.6 | 602.3 | 280.9 | 27.0 |
| IZOLA | 1.257 | 46.0 | 61.3 | 953.5 | 371.0 | 24.5 |
| DELAMARIS | 0.000 | 0.000 | 0.001 | 0.018 | 0.006 | 0.001 |
| **Total** | 2.5 | 106.8 | 318.9 | 2076.3 | 887.9 | 98.8 |

**Table 5a. The gross flux of some pollutants estimated from the riverine inflow data for the year 2000**

| **HOT SPOTS** | Flow rate | COD | $BOD_5$ | TotN | TotP | TSS | Oil | FC |
|---|---|---|---|---|---|---|---|---|
| | [$m^3$/y] | [t/y] | [t/y] | [t/y] | [t/y] | [t/y] | [t/y] | [No./100 ml] |
| Rižana | $1.5 \times 10^8$ | 2138 | 689 | 548 | 7.5 | 507 | 0.06 | 18200 |
| Badaševica | $6.3 \times 10^7$ | 5563 | 329 | 445 | 6.3 | 688 | 0.038 | 19575 |
| Dragonja | $3.0 \times 10^7$ | 1109 | 114 | 117 | 1.8 | 127 | 0.004 | 544 |
| Drnica | $1.6 \times 10^7$ | 1582 | 66 | 124 | 2.6 | 96.5 | 0.004 | 725 |
| **Total** | $2.6 \times 10^8$ | 10392 | 1198 | 1234 | 18.2 | 1419 | 0.106 | |

**Table 5b. The gross flux of selected heavy metals estimated from the riverine inflow data for the year 2000**

| HOT SPOTS | Heavy metals | | | | | |
|---|---|---|---|---|---|---|
| | Hg [kg/y] | Ni [kg/y] | Cr [kg/y] | Cu [kg/y] | Zn [kg/y] | Pb [kg/y] |
| Rižana | 0.419 | 2468 | 120 | 638 | 1010 | 390 |
| Badaševica | 0.402 | 180 | 63 | 156 | 718 | 69 |
| Dragonja | 0.019 | 38 | 24 | 33 | u.d.l.* | 16 |
| Drnica | 0.025 | 75 | 24 | 64 | u.d.l. | 96 |
| **Total** | **0.865** | **2761** | **231** | **891** | **1728** | **571** |

*u.d.l. Under detection limit

## 6. Sites of biological and ecological value

Various economic activities have developed over roughly 80 % of Slovenia's coastline, leaving only 8 km (20 %) of the coast in its natural state. It is obvious that even on these few kilometers we can not talk about true naturalness since there are numerous indirect and direct impacts from various human activities. Among the indirect impacts are those due to sewage and industrial outlets, traffic and other activities on the urbanized part of the coastal area. Direct impacts on the remaining parts of the natural coastline are derived mainly from tourism (leisure boat traffic, anchoring), fishing and collecting mussels. Salt-pans, flysch cliffs and solitary lime rocks are important littoral ecosystems in terms of biodiversity. The list of landscape parks (LP), natural reserves (NR), and natural monuments (NM) of great importance needing protection for their natural assets and biological diversity is presented in table 6.

**Table 6: Sites of conservation interest on the Slovenian coast**

| Protected area | Type | Main characteristics | Continent | Protected since |
|---|---|---|---|---|
| Cape Debeli rtiè | NM | geomorphology, great diversity of the underwater life | 24.3 ha (sea 21.8 ha coastal 2.5 ha) | 1991 |
| Škocjanski zatok | NR | brackish lagoon, ornithological site | 120 ha (lagoon 80 ha coastal 40 ha) | 1998 |
| Molet | | Posidonia meadow | | |
| Cape Korbat | | only calcareous part of the coast | | |
| Strunjan | NR | unique geomorph. features, submediterranean vegetation, diverse marine plant and animal life | 160 ha (coastal 45 ha sea 115 ha) | 1990 |
| Strunjan | LP | important natural and cultural heritage | appr. 471.8 ha | 1990 |
| Stjuža lagoon | NM | marine lagoon, spawning area | | 1990 |

| | | | | |
|---|---|---|---|---|
| Fiesa lakes | NM | freshwater and brackish habitat | 2.1 ha | 1990 |
| Cape Madona | NM | underwater ridge, diversity of marine life | 12.8 ha | 1990 |
| | LP | outstanding natural and cultural assets; more than 200 bird species | 864.2 ha | 1990<br>2001*<br>Ramsar site since 1993 |

*Governmental decree replaced previous municipal one

## 7. Priority hot spots

Priority hot spots have been graded according to the relative importance of their impacts on public health, drinking water quality, recreation, aquatic life & biodiversity, economy and welfare. Main hot spots are identified according to the monitoring data regarding the pressure on and sensitivity of the area.

**Hot spots:**

Badaševica (Industrial, Domestic)
Izola (Industrial, Domestic)
Piran (WWTP Piran with submarine outfall) (Domestic)
Dragonja (Domestic, Agricultural)

The priority hot spots are shown in the attached table. The table contains the assessment of effects using the ranking system agreed on which includes the nature of investment required, transboundary aspects, and a preliminary estimated financial requirement.

## 8. Conclusions and recommendations

The report attempts to review pollution hot spots and sensitive areas involving the state of the marine environment in Slovenia. The uneven distribution of human activities and the number of inhabitants along the Slovenian coastal area result in a number of factors that in consequence generate some of the conflicts in the area (growth of the everyday car traffic to the coast and back, designation of large areas for car parking, environmental pollution, increasing pressure on the remaining parts of the natural coastline, etc.).

Being aware of the severe pressure of conflict activities, an integrated coastal management program has been developed (in 1997) and Slovenia participates actively in the implementation of the Protocols under the Barcelona Convention.

In order to resolve the problem of municipal and industrial wastewater, an appropriate management project has to be implemented for long-term solution of sewage pollution in the region. The project should provide a determination of the most cost – effective integrated investment solution for sewage collection and wastewater treatment facilities for the municipalities of Koper, Izola and Piran. The project should cover the preparation of detailed technical specifications for the most cost-effective investment projects and the completion of all the necessary project documentation.

The specific objectives of the project should be:

– to identify the " most cost-effective" solution for sewage collection and treatment of wastewater in Koper, Izola and Piran including the rural hinterland,

- to identify the optimal locations for the new WWTP`s,
- to evaluate the environmental impacts of the proposed facilities and to elaborate the Environmental Impact Assessment,
- to develop a financial plan for the investments,
- to prepare the necessary project documentation including Tender Dossier to enable the investment projects.

The intrusion of seawater to the sewers is of major concern. Several culprits of intrusion of seawater have been identified. The identification and subsequent elimination of these points is a task of paramount importance for the successful operation of future WWTP`s.

***Pollution Hot Spots in <u>SLOVENIA</u>***

| Name | Type | Public Health | Drinking Water Quality | Aquatic Life | Recreation | Other Beneficial use | Welfare and economy | Category | Nature of investment | Preliminary estimated financial requirement (in US$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | (1) | (0.9) | (0.7) | (0.8) | (0.8) | (0.7) | | | |
| Rižana river | Domestic, Industrial | 3 | 1 | 3 | 5 | 4 | 5 | C | WWTP extension + sewage system reconstruction | 11.000.000,00 |
| Izola | Domestic, Industrial | 3 | 1 | 3 | 5 | 4 | 4 | C | WWTP construction + sewage system reconstruction | 8.000.000,00. |
| Piran | Domestic | 3 | 1 | 3 | 4 | 3 | 1 | D | WWTP extension + sewage system reconstruction | 6.000.000,00 |
| Badaševica | Domestic, Industrial | 3 | 1 | 3 | 4 | 4 | 3 | D | See river Rižana and WWTP Koper | WWTP Koper |
| Dragonja | Domestic, Agricultural | 2 | 1 | 2 | 2 | 2 | 2 | E | | |

# REVISION OF POLLUTION HOT SPOTS IN THE MEDITERRANEAN

Country report for

***S Y R I A***

***Acknowledgements***

- *The Syrian environmental authorities and in particular the General Commission for Environmental Affairs (G.C.E.A.).*
- *Mr Yahya Awaidah, Head of the Engineering Group of G.C.E.A. and SAP-coordinator, whose dedicated commitment, coordination and critical remarks ensured the efficient collection and evaluation of data within the given tight time limits.*
- *Mrs Abir Zeno, environmental engineer and member of the same Group, is also warmly thanked for her intensive efforts and assistance in the preparation of the report.*
- *Mr Sadek Abou Watfeh, Director of the Directorate of Wastewater and Sewerage (Ministry of Housing), for his immediate response regarding investment plans - remedial action.*
- *Ms Reem Abed Rabboh, Head, Water Department, Ministry of State for Environmental Affairs*

**Prepared in 1997 by:** **Mr Dimitrios Tsotsos**
**Revised in 2001 by:** **Mr Mohamad K. Kayyal**

## 1. SUMMARY

The purpose of this study is to develop an updated list of priority pollution hot spots and sensitive areas on the Syrian coastline that reflects changes in pollution loads from the previous list included in the MAP 124 Report, and to produce a separate list accounting for transboundary aspects.

The categories of transboundary effects consist of: public health; marine biodiversity and habitats; fisheries; and recreation and tourism.

Field and laboratory investigations were conducted to obtain wastewater samples from Lattakia, Banias and Tartous for use in updating the priority pollution hot spots in Syria.

The list of priority pollution hot spots and sensitive areas on the Syrian coastline was updated by computing pollution effluents loads from domestic and industrial sources at specific locations in each of the four hot spots and for specific parameters.

The pollution hot spots ranking on the Syrian coastline is as follows:

- Banias
- Lattakia
- Tartous
- Jableh
-

An identical list was obtained for the hot spot areas that account for transboundary aspects.

## 2. INTRODUCTION

### 2.1 Background

Within the framework of the MED-POL Programme and the activities related to the implementation of the Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities, the WHO Office of the Coordinating Unit of Mediterranean Action Plan (MAP) was given the responsibility for collecting, analyzing and processing of data and information related to the ***identification of priority pollution hot spots and sensitive areas in the Mediterranean***. This task was funded by a Project Development Facility (PDF) Block B grant of the Global Environment Facility (GEF) through UNEP/MAP, as one of a number of reports prepared to support the preparation of a Strategic Action Programme (SAP) to address pollution from land-based activities in the coastal areas of the Mediterranean Sea.

In order to fulfill the needs for identification and, in particular the prioritization of hot spots, a ranking system was developed to show the severity of each of the effects on the identified hot spots. The list was prepared for every country (see MAP Technical Reports Series No. 119) also including an indication of the costs for rehabilitation activities. However, this list did not take into account the transboundary effects of the hot spots on the environment and on human health. Therefore, a revised ranking system was developed (see Report EUR/ICP/HEV-MED 5052112), which accounts for specific parameters to describe the transboundary effects of the identified hot spots.

### 2.2 Purpose and Objectives of Study

The purpose of this study is to develop an updated list of priority pollution hot spots and sensitive areas on the Syrian coastline that reflects changes in pollution loads from the previous list included in the MAP 124 Report due to the presence of new point sources; the implementation of measures for the progressive elimination of loads polluting the sea; or the creation of a new hot spots.

This is accomplished by compiling new data on pollutants loads, collection, treatment and disposal of the coastal cities' wastewater, and from data on industrial pollution for every major industrial facility, discharging directly into the sea, while taking into consideration transboundary effects. This list will be used to select pollution hot spots in the Mediterranean for the preparation of the pre-investment studies for rehabilitation.

The objectives of this study can be summarized as follows:

1. Review the existing national list of pollution hot spots in Syria;
2. Conduct field and laboratory investigations to update existing figures and data used in the ranking of pollution hot spots in the prioritization list initially prepared four years ago;
3. Modify the list of identified pollution hot spots based on the integration of new information and data; and,
4. Prepare a revised country report and an updated prioritization list of hot spots in Syria taking into consideration transboundary aspects.

## 3. EXISTING NATIONAL LIST OF HOT SPOTS

### 3.1 General

According to the MAP No. 124 report, hot spots are defined as:

- **Point sources** on the coast of the Mediterranean Sea which potentially affect human health, ecosystems, biodiversity, sustainability or economy in a significant manner. They are the main points where high levels of pollution loads originating from domestic or industrial sources are being discharges

- Defined **coastal areas** where the coastal marine environment is subject to pollution from one or more point of diffused sources on the coast of the Mediterranean which potentially affect human health in a significant manner, ecosystems, biodiversity, sustainability or economy.

### 3.2 Preliminary Identification of Potential Hot Spots in Syria

Hot spots were identified and tabulated in the MAP No. 124 report based on existing data, surveys, etc. As an indication, the number of hot spots proposed was related to:

a) the coastal cities and urban coastal agglomerates with considerable population; and,
b) the main industrial facilities discharging directly into the Mediterranean.

In order to confirm that an area is a potential hot spot, information was assembled on:

a) load, collection, treatment and disposal of the coastal cities domestic wastewater
b) industrial pollution for every major industrial facility discharging directly into the sea.

However, due to the fact that data included in the MAP No. 124 report, which were used in determining whether an area was a hot spot, were obtained about five years ago (February 1997), and due to the population growth in this period and the development of new industries, it was decided to conduct a new field survey at the location of the Syrian hot spots, and to collect water samples for laboratory analyses from the points of discharge of municipal and industrial wastewater effluents and from river estuaries. The results of these analyses were subsequently utilized to confirm or update the data included in the MAP Report Series No. 124, and to compute pollutants loads discharged to the Syrian coast.

### 3.3 Identified Priority Pollution Hot Spots in Syria

Evaluation of priority hot spots was based on a ranking system from 1 to 6. This ranking was followed to show the severity of each of the effects on the identified hot spots. A ranking of "1" indicated no effect, while a ranking of "6" pointed to extreme effects. The MAP Technical Reports Series 124 of the Mediterranean pollution hot spots includes a table that explains the criteria for ranking the effects.

The criteria used for evaluation consisted of determining the risk exerted by the point sources with effects on:

a) Public health;
b) Drinking water quality;
c) Recreation;
d) Other beneficial uses;
e) Aquatic life (including biodiversity); and,
f) Economy and welfare (including marine resources of economic value).

The risk is weighed based on a multiplier depending on the importance of the effects. The multipliers are as follows::

- 1.0 for public health
- 0.9 for drinking water quality
- 0.8 for recreation
- 0.8 other beneficial uses
- 0.7 for aquatic life including biodiversity
- 0.7 economy and welfare including marine resources of economic value

The priority pollution hot spots in Syria, which are listed in the MAP Report Series No. 124, are reproduced in Table 3.1.

**Table 3.1: Evaluation of Priority Hot Spots in Syria**

| Name | Type | Public Health | Drinking water quality | Aquatic Life | Recreation | Other Beneficial Use | Welfare and Economy | Weighted total | Relative importance index |
|---|---|---|---|---|---|---|---|---|---|
| Tartous | Municipal/Industrial | 5 | 4 | 5 | 5 | 5 | 5 | 23.6 | 100 |
| Lattakia | Municipal/Industrial | 6 | 4 | 5 | 5 | 4 | 3 | 22.5 | 95 |
| Banias | Municipal/Industrial | 3 | 4 | 4 | 4 | 4 | 6 | 20 | 85 |
| Jableh | Municipal/Industrial | 4 | 4 | 3 | 4 | 3 | 5 | 18.8 | 80 |

The nature of investment, transboundary aspects and preliminary estimated financial requirements, as indicated in the MAP 124 Report are tabulated in Table 3.2.

**Table 3.2: Evaluation of Transboundary Aspects and Type and Nature of Financial Requirement for the Priority Hot Spots in Syria**

| Name | Nature of Investment | Transboundary Aspects | Preliminary Estimated Financial Requirement (in USD) |
|---|---|---|---|
| Tartous | WWTP – construction: secondary (planned) | - Reduction in value of tourism<br>- Fisheries<br>- Biodiversity | 41 million |
| Lattakia | WWTP – construction: secondary (planned) | Reduction in value of tourism | 73 million |

**Table 3.2: Continued**

| Name | Nature of Investment | Transboundary Aspects | Preliminary Estimated Financial Requirement (in USD) |
|---|---|---|---|
| Banias | WWTP – construction: secondary (suggested) | Reduction in value of tourism | 35.6 million |
| Jableh | WWTP – construction: secondary (planned) | Reduction in value of tourism | 41.7 million |
| | | Capacity building and industrial waste management plan | 1.5 million |

## 4. CRITERIA ON TRANSBOUNDARY EFFECTS

### 4.1 General

In the expert meeting conducted on the 5th and 6th of April 2001 in Athens, Greece, the definition of the term 'transboundary effects' was broadened to indicate the possible effects of specific hot spots transferred to other areas. This would also refer to other areas, such as international waters, so that the possible impacts of transboundary significance would be those affecting areas beyond the jurisdiction of local pollution hot spot restrictions (including those in international waters and neighbouring countries). The view was that any pollution transported beyond local areas should be considered as having potential transboundary effect.

### 4.2 Transboundary Effects

The categories of transboundary effect consist of: (i) public health; (ii) marine biodiversity and habitats; (iii) fisheries; and (iv) recreation and tourism. These categories include factors and/or indicators to be considered in the classification of hot spots as detailed below:

*4.2.1 Public health:*

It is considered that the main transboundary risk to public health is the potential pollution and contamination of edible fish and shellfish, which would eventually enter the human food chain and have an impact on human health. The risk of transboundary effects on human health due to pollutants containing persistent chemicals and heavy metals would be significant should the release of the pollutant be greater than 1/10 of the upper level specified in data supplied in the past related to national pollution hot spots (MAP Technical Reports Series No. 124, Table III-3). The following data are adopted as the principal indicators1 to signify there is a significant risk of adverse transboundary effects on human health, when the loads related to the specific pollutants listed below are greater than the referred levels:

| | | |
|---|---|---|
| a. | Hg > 128 kg/year | rounding 130 kg/year |
| b. | Cd > 260 kg/year | rounding 260 kg/year |
| c. | Pb > 427 kg/year | rounding 430 kg/year |
| d. | Cr > 1140 kg/year | rounding 1140 kg/year |
| e. | Cu > 2540 kg/year | rounding 2540 kg/year |
| f. | Zu > 31,317 kg/year | rounding 31000 kg/year |
| g. | Oil > 3483 kg/year | rounding 3500 kg/year |

Another factor with a transboundary risk to public health is the population pressure, which through the discharge of wastewater may have an adverse effect on human health. Discharges would carry a significant risk should the population exceed 1,000,000 inhabitants. If a wastewater treatment facility exists, then a correction factor of 1/10 is introduced. When multiplied by the actual population, this correction factor provides the actual figure to be considered (e.g. if the population equivalent is 2,000,000 inhabitants and the city is equipped with a wastewater treatment facility, then the population to be considered in order to arrive at the potential risk of adverse effects, is: 2,000,000 x 1/10 = 200,000 inhabitants). If the final figure is less than 1,000,000, then it is considered that there is no significant risk of transboundary effects as a result of the discharge.<

1 The specific pollutants selected as indicators were addressed because relevant data were available in the MAP Technical Reports Series No. 124.

*4.2.2 Marine Biodiversity and Habitats*

The factors with a transboundary risk to marine biodiversity and habitats that are examined include pressure of human population (which is considered on the same basis as for human health), and releases of phosphorus and nitrogen into the marine environment. These discharges pose an elevated risk to marine biodiversity and habitats due to the formation of algal blooms as a result of releases of phosphorus (P) and nitrogen (N) and also to chemical pollutants (persistent organic pollutants, heavy metals, etc.) that usually accompany these discharges, and which have a significant impact, according to the total pollution load discharged. Data provided on releases of P and N into the marine environment is compared to the figures published in MAP Technical Reports Series No. 109 (table 2.3). These figures are an estimate of the total P and N pollution loads discharged into the Mediterranean. Considering there are about 100 pollution hot spots2, which constitute a significant release of pollution into the sea, a considerable transboundary effect would result should the above loads exceed 1/100. To be precise, the total P release resulting in a potential risk of transboundary effects on marine biodiversity and habitats is 570 tons per year. The corresponding total release of N is 2,000 tons per year.

*4.2.3 Fisheries*

The significant factors that would lead to a risk of adverse transboundary effects on fisheries include BOD, COD and TSS. Based on the same formula used for the calculation of phosphorus and nitrogen, 1/100 of the total value of pollution loads related to BOD, COD and TSS (MAP Technical Reports Series No. 109, table 2.3) are 1500, 4500 and 300 tons per year, respectively. In specifying these figures, the relationship and interaction between these parameters was taken into consideration. In addition, if national or local authorities consider the marine hot spot area as a nursery ground, then the pollutant loads are multiplied by a factor of 10. For example, if the actual load related to BOD is 1200 tons per year and the area is a nursery ground, then the load to be considered is 12,000 tons per year, which exceeds the value of 1500 tons per year and results in a significant risk of transboundary effect on fisheries.

*4.2.4 Recreation and Tourism*

The factors that would lead to a risk of adverse transboundary effects are recreation, tourism and cultural heritage. The risks of adverse effects of transboundary significance are translated as depriving the public of a common shared good. The significance of risk due to recreation can be evaluated based on the location and the use of the recreational facilities with respect to the marine hot spot area. Finally, the significance of risk to cultural heritage is based on the existence of sites of value. The UNESCO and the Mediterranean Centre of One Hundred Historic Sites Inventories available from internationally and regionally recognized organizations such as the 'World Heritage List' (http://www.unesco.org/whc/heritage.htm) and a list of 'Mediterranean Hundred Historic Sites' are used for that purpose.

## 5. METHODOLOGY FOR CONDUCTING FIELD AND LABORATORY INVESTIGATIONS

### 5.1 General

Field and laboratory investigations were conducted to obtain wastewater samples for use in updating the priority pollution hot spots in Syria. These were conducted according to the following plan:

1. The locations of wastewater effluents along the Syrian coastline were determined and classified as (i) industrial effluents, (ii) domestic effluents, or (iii) river water effluent. River discharges are typically contaminated by effluents discharging into their body of water prior to reaching the sea.

2 The exact number reported in MAP Technical Reports Series No. 124 is 103 hot spots

2. From each water/wastewater effluent and/or river estuary, homogeneous representative samples were obtained and placed in a suitable container for transport to wastewater analysis laboratories.
3. Laboratory experiments were performed to determine the water/wastewater characteristics and properties in accordance with international standards.
4. Test results were computed and utilized in updating the figures used for prioritizing the hot spots in Syria.

## 5.2 Field Investigation

The field investigation was conducted in September 2001. It consisted of obtaining 27 wastewater samples along the coastal shore of Syria as shown on Figure 1. The sampling locations consisted of domestic and industrial wastewater effluents and river estuaries in Lattakia, Banias and Tartous areas.

Samples required for heavy metal analyses were placed in polyethylene containers after washing with nitric acid. Samples for mercury analyses were placed in clean glass containers, and diluted with sulfuric acid and potassium dichromate. BOD samples were placed in sterilized glass containers, and placed in a field cooler, and transferred directly to the laboratory for analysis. COD samples were placed in polyethylene containers and placed in a field cooler and transferred to the laboratory for analysis within 24 hours. Total phosphorus and nitrogen samples were place in glass containers cleaned with sulfuric acid.

### *5.2.1 Lattakia*

The field investigation consisted of investigating 9 locations. These were eight mixed (domestic and industrial) wastewater effluents and the one river estuary (Al Kabir Al Shamali River) as shown on Figure 2.

### *5.2.2 Tartous*

Ten samples were obtained along the coast of the City of Tartous. All samples were from mixed wastewater effluents as shown on Figure 3.

### *5.2.3 Banias*

Eight samples were obtained in the vicinity of Banias, four mixed wastewater effluents, three river water estuaries and a single sample from the wastewater effluent of the Banias refinery as shown on Figure 4.

### *5.2.4 Jableh*

No wastewater samples were collected from the city of Jableh and vicinity because in the past five years, no major changes occurred in relation to population growth or new industrial activities, which would impact results of laboratory analyses used previously for classifying this hot spot. Accordingly, data provided in MAP 124 report were used for updating the classification of this hot spot.

## 5.3 Laboratory Investigation

Laboratory analyses were conducted in three government approved laboratories. These are:

1. The laboratory for wastewater analyses in the Department of Water Pollution Control, Ministry of Irrigation - Damascus.
2. The laboratory for wastewater analyses in the Department of Water Pollution Control, Ministry of Irrigation – The directorate of the coastal basin - Lattakia.

3. The laboratory for environmental research at the higher institute for applied sciences and technology in Damascus.

The laboratory investigation consisted of performing tests in accordance with the standards methods for the examination of water and wastewater (APHA) to determine the following parameters:

- Suspended Solids, SS, standard test method 209
- Biological Oxygen Demand, $BOD_5$, standard test method 507
- Chemical Oxygen Demand, COD, standard test method 508
- Total phosphorus, standard test method 424
- Total nitrogen, standard test method 416
- Heavy Metals including Cu, Ni, Pb, Zn, Cd, Hg, in accordance with standard test methods 204, 321, 316, 328 310, and 320, respectively.

## 6. DETERMINATION OF POLLUTANTS LOADS FROM SYRIAN HOT SPOTS

### 6.1 General

In developing an updated list of priority pollution hot spots and sensitive areas on the Syrian coastline, consideration was given to computing pollution effluents loads from domestic and industrial sources. Results of laboratory test analyses and computation of pollutants loads are provided in this section.

### 6.2 Estimating Pollutants Loads

The basis for estimating pollutants loads from mixed (domestic and industrial) sources was population size and average consumption of water. In principle, it is assumed that 85 percent of consumed water is discharged to the sewers. Accordingly, It would be possible to estimate the pollutants effluent loads based on the laboratory analyses results.
Population sizes and average water consumption and discharge in the four hot spot areas are tabulated in Table 6.1.

**Table 6.1: Population sizes, average consumption of water and discharge of wastewater**

| Location of hot spot | Population Equivalents | Average water consumption3 ($m^3$) | Estimated average wastewater discharge4 ($m^3$/day) |
|---|---|---|---|
| Lattakia | 746,851 | 128,000 | 108,800 |
| Tartous | 319,152 | 56,000 | 47,600 |
| Banias | 168,900 | 40,000 | 34,000 |
| Jableh | 166,779 | 48,000 | 40,800 |

Pollutants loads from industrial sources, which are discharged to river estuaries (indirect discharge to sea), were computed by multiplying the concentration of pollutants by the flow rate of the river.

Pollutants loads for heavy metals, and for total nitrogen and phosphorus were calculated based on average measured concentrations from the various effluent points. Average values were used due to the fact that differences in measurements between the various points at the time of sampling were minimal. BOD and COD loads were calculated based on average concentrations taken for all wastewater effluents points, in addition to the actual concentration in the river waters at the time of sampling. Average concentration values are multiplied by the respective river flow rates.

Pollutants loads from each of the four hot spot are tabulated in Tables 6.2 to 6.5, for the Lattakia, Tartous, Banias and Jableh hot spots, respectively.

3 Data published in a study conducted by the Japanese International Cooperation Agency (JICA), titled "Water Resources Study of the Western and Northern Coastal Areas in Syria", 1998.
4 Discharge estimated at 85 percent of consumed water

**Table 6.2: Pollutants Concentrations and Loads in the Lattakia Hot Spot**

| Sample Location and Designation | | Average Discharge *($m^3$/day)* | Suspended Solids *(mg/l)* | $BOD_5$ *(mg/l)* | COD *(mg/l)* | Total Nitrogen *(mg/l)* | Total Phosphorus *(mg/l)* | Oil *(mg/l)* | Hg ( g/l) | Cd ( g/l) | Pb ( g/l) | Cr ( g/l) | Cu ( g/l) | Zn ( g/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Itihad | LM-1 | 108,800 | 270 | 195 | 352 | 54.6 | 10.33 | - | 0.55 | 0.45 | 0.6 | 4.6 | 15.5 | 63.8 |
| Shaab | LM-2 | | 238 | 215 | 264 | 67.9 | 22.45 | - | 5.57 | 0.30 | 1.1 | 3.6 | 12.0 | 57.5 |
| Janoubi 1 | LM-3 | | 258 | 197 | 368 | 31.6 | 10.08 | - | - | 0.60 | 1.2 | 3.8 | 27.0 | 64.9 |
| Janoubi 2 | LM-4 | | 255 | 230 | 408 | 22.3 | 8.65 | - | 1.40 | 0.90 | 1.6 | 2.8 | 17.0 | 62.1 |
| Port 1 | LM-5 | | 152 | 100 | 160 | 33.3 | 6.84 | - | - | 0.45 | 2.1 | 2.4 | 10.5 | 59.4 |
| Port 25 | LM-6 | | 250 | 185 | 333 | 37.5 | 9.95 | - | 0.28 | 0.60 | 1.1 | 2.2 | 25.0 | 62.0 |
| Port 36 | LM-7 | | 230 | 25 | - | 18.8 | 0.35 | - | 8.79 | 0.45 | 1.5 | - | - | - |
| Azhari | LM-8 | | 259 | 170 | 256 | 67.2 | 7.40 | - | - | 0.30 | 1.0 | 2.8 | 6.0 | 60.6 |
| Kabir Al Shamali | LR-9 | 1590 | 20 | 35 | 120 | 16.8 | 0.39 | - | - | 0.75 | 3.1 | 9.4 | 1.7 | 57.7 |
| Ave concentration from sewers | | $M_i / n_i$ | 239 | 185 | 306 | 41.6 | 9.50 | - | 3.30 | 0.50 | 1.3 | 3.2 | 16.1 | 61.5 |
| Pollutants loads Sewers *(kg/year)* | | LOM | $9.5x10^6$ | $7.3x10^6$ | $12.1x10^6$ | $1.6x10^6$ | 377,264 | - | 131 | 20 | 51 | 126 | 641 | 2441 |
| Pollutants loads Kabir Al Shamali River *(kg/year)* | | LOR | $11.6x10^3$ | $20.3x10^3$ | $69.6x10^3$ | $9.7x10^3$ | 226 | - | - | 0.4 | 1.8 | 5.5 | 1.0 | 33.5 |
| Total pollutants load discharged to sea *(LO)* | | LOM + LOR | 9503 *ton/year* | 7367 *ton/year* | 12,222 *ton/year* | 1664 *ton/year* | 377 *ton/year* | 91407 *kg/year* | 131 *kg/year* | 20 *kg/year* | 52 *kg/year* | 132 *kg/year* | 642 *kg/year* | 2475 *kg/year* |

5 The sample is mixed with seawater at the port area

6 Seawater next to the domestic wastewater effluent

7 Based on data available at the Water Pollution Control Department – Ministry of Irrigation

**Table 6.3: Pollutants Concentrations and Loads in the Tartous Hot Spot**

| Sample Location and Designation | | Average Discharge *($m^3$/day)* | Suspended Solids *(mg/l)* | $BOD_5$ *(mg/l)* | COD *(mg/l)* | Total Nitrogen *(mg/l)* | Total Phosphorus *(mg/l)* | Oil *(mg/l)* | Hg ( g/l) | Cd ( g/l) | Pb ( g/l) | Cr ( g/l) | Cu ( g/l) | Zn ( g/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Near port fence | TM-1 | 47,600 | 168 | 205 | 352 | 25.5 | 7.44 | - | 9.0 | 0.26 | 0.77 | 1.86 | 34.2 | 40 |
| Port fence | TM-2 | | 245 | 285 | 552 | 33.6 | 5.56 | - | <0.5 | 0.24 | 1.20 | 2.81 | 20.4 | 30 |
| Opposite to citadel | TM-3 | | 186 | 168 | 432 | 30.0 | 3.50 | - | 7.2 | 0.20 | 0.39 | 1.14 | 5.5 | 15 |
| Opposite to mosque | TM-4 | | 198 | 208 | 488 | 30.8 | 13.20 | - | 3.4 | 0.20 | 0.72 | 7.99 | 20.0 | 19 |
| Arwad island port | TM-5 | | 102 | 108 | 312 | 41.2 | 6.42 | - | 11.5 | 0.16 | 0.43 | 2.02 | 4.9 | 22 |
| Shahine hotel | TM-6 | | 148 | 152 | 408 | 21.6 | 8.28 | - | 11.4 | 0.15 | 0.49 | 1.59 | 27.7 | 33 |
| Workers union | TM-7 | | 230 | 178 | 492 | 27.2 | 6.94 | - | 10.8 | 0.16 | 0.45 | 3.00 | 9.2 | 40 |
| Near Sea hotel | TM-8 | | 123 | 143 | 348 | 25.2 | 5.58 | - | 18.2 | 0.12 | 0.37 | 1.07 | 4.4 | 21 |
| agriculture directorate | TM-9 | | 302 | 213 | 604 | 43.9 | 12.16 | - | 5.1 | 0.18 | 0.72 | 4.51 | 29.1 | 53 |
| Ghamka River | TM-10 | | 228 | 205 | 528 | 38.4 | 9.28 | - | 5.8 | 0.15 | 0.49 | 3.65 | 24.3 | 37 |
| Ave. concentration from sewers | | $M_i / n_i$ | 193 | 186 | 452 | 31.7 | 7.80 | - | 8.3 | 0.18 | 0.60 | 2.97 | 18.0 | 31.0 |
| Pollutants loads sewers *(kg/year)* | | LOM | $3.4x10^6$ | $3.2x10^6$ | $7.8x10^6$ | $0.55x10^6$ | 135,517 | - | 144 | 3.1 | 10.4 | 51.6 | 312.7 | 539 |
| Pollutants discharged to sea | | LO | 3353 *ton/year* | 3240 *ton/year* | 7846 *ton/year* | 552 *ton/year* | 136 *ton/year* | 200008 *kg/year* | 144 *kg/year* | 3.1 *kg/year* | 10.4 *kg/year* | 51.6 *kg/year* | 312.7 *kg/year* | 539 *kg/year* |

8 Based on available data at the Water Pollution Control Department – Ministry of Irrigation

**Table 6.4: Pollutants Concentrations and Loads in the Banias Hot Spot**

| Sample Location and Designation | | Average Discharge *($m^3$/day)* | Suspended Solids *(mg/l)* | $BOD_5$ *(mg/l)* | COD *(mg/l)* | Total Nitrogen *(mg/l)* | Total Phosphorus *(mg/l)* | Oil *(mg/l)* | Hg ( g/l) | Cd ( g/l) | Pb ( g/l) | Cr ( g/l) | Cu ( g/l) | Zn ( g/l) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Banias 1 | BM-1 | 34,000 | 151 | 100 | 330 | 15.1 | 8.59 | - | 155 | 0.14 | 0.43 | 1.03 | 16.8 | 14.0 |
| Banias 2 | BM-2 | | 322 | 312 | 480 | 11.8 | 7.42 | - | 68.7 | 0.13 | 0.33 | 1.37 | 8.7 | 19.0 |
| Banias 3 | BM-3 | | 183 | 135 | 250 | 12.6 | 3.69 | - | 28.7 | 0.11 | 0.32 | 1.17 | 5.8 | 1.0 |
| Banias 4 | BM-4 | | 160 | 135 | 300 | 9.1 | 3.29 | - | 357 | 0.11 | 0.35 | 1.43 | 9.9 | 3.0 |
| Hussein River | BR-5 | 3800 | 6 | 5 | 56 | - | - | - | <0.5 | 0.08 | 0.16 | 0.33 | 2.4 | <0.5 |
| Markia River | BR-6 | 88,128 | 6 | 5 | 64 | - | - | - | <0.5 | 0.08 | 0.25 | 0.62 | 1.7 | <0.5 |
| Banias River | BR-7 | 16,675 | 4 | -2 | 56 | 1.9 | 1.71 | - | 16.4 | 0.07 | 0.16 | 0.56 | 1.1 | <0.5 |
| Banias Refinery | BI-8 | 7550 | 100 | 70 | 250 | 4.9 | 0.24 | - | - | 0.07 | 0.17 | - | - | - |
| Ave. concentration from sewers | | $M_i / n_i$ | 204 | 170 | 340 | 12.2 | 5.75 | - | 152 | 0.12 | 0.36 | 1.25 | 10.3 | 9.3 |
| Pollutants loads sewers *(kg/year)* | | LOM | 2,531,640 | 2,109,700 | 4,219,400 | 150,781 | 71,357 | - | 1886 | 1.49 | 4.47 | 15.5 | 127.8 | 114.8 |
| Pollutants loads Hussein River *(kg/yr)* | | $LOR_5$ | 8322 | 6935 | 77,672 | - | - | - | 0.694 | 0.111 | 0.22 | 0.46 | 3.38 | 0.7 |
| Pollutants loads Markia River *(kg/yr)* | | $LOR_6$ | 193,000 | 160,833 | 2,058,670 | - | - | - | 16 | 2.57 | 8 | 20 | 56 | 16 |
| Pollutants loads Banias River *(kg/yr)* | | $LOR_7$ | 24,346 | 12,173 | 340,837 | 11,564 | 10,408 | - | 99.9 | 0.43 | 0.974 | 3.4 | 6.88 | 3 |
| Pollutants loads from Banias refinery (k*g/yr)* | | LOI | 275,575 | 192,903 | 689,000 | - | - | - | - | - | - | - | - | - |
| Pollutants discharged to sea | | LO | *2862 ton/year* | 2342 *ton/year* | 6893 *ton/year* | 162 *ton/year* | 82 *ton/year* | 4389*ton/year* | 2002 *kg/year* | 4.6 *kg/year* | 13.7 *kg/year* | 45.3 *kg/year* | 191 *kg/year* | 135 *kg/year* |

9 Based on available data from the Water Pollution Control Department – Ministry of Irrigation

# 7. EVALUATION OF SIGNIFICANCE AND PRIORITIZATION LIST OF HOT SPOTS IN SYRIA

## 7.1 Evaluation of Significance and Ranking of Hot Spots

Based on existing data and surveys and available information, an update of the pollution hot spots lists for Syria are produced. These include an update for the existing list included in the MAP Report No. 124 (tabulated in Table 7.1), and a second list, which accounts for transboundary significance (tabulated in Table 7.2). The methodology used for producing the first list is similar to that adopted in producing the previous list with the exception being that when the weighted total is calculated, a category is written expressed with letters (A, B, C, D, E), where the calculated number falls, according to the following table:

| Category | Weighted Total |
|---|---|
| A | 29.4 - 24.5 |
| B | 24.5 - 19.6 |
| C | 19.6 - 14.7 |
| D | 14.7 - 9.8 |
| E | 9.8 - 4.9 |

The methodology for producing the second list (Table 7.2) is explained as part of the individual tables, which present the potential risk for each of the four hot spot areas, and included in the Annex. The ranking of the four hot spots, which require investments for improving the environmental conditions, is as follows:

- Banias
- Lattakia
- Tartous
- Jableh

For the first list, the nature and required economic investments are also noted.

**Table 7.1: Pollution Hot Spots in Syria**

| Name | Type | Public Health | Drinking Water Quality | Aquatic Life | Recreation | Other beneficial use | Welfare and economy | Category | Nature of investment | Preliminary estimated financial requirement (in US$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | (1) | (0.9) | (0.7) | (0.8) | (0.8) | (0.7) | | | |
| Banias | Municipal and industrial | 5 | 4 | 5 | 3 | 2 | 6 | B | - DWWTP (construction)<br>- Refinery WWTP (rehabilitation)<br>- Adoption of clean technology<br>- Improving monitoring system<br>- Industrial feasibility study<br>- Rehabilitation of oil terminal | 36 million |
| Lattakia | Municipal and industrial | 5 | 4 | 3 | 5 | 3 | 4 | B | - DWWTP (construction)<br>- IWWTP (planned & construction)<br>- Improving industrial inspection and monitoring systems<br>-Industrial feasibility study<br>- Capacity building | 73 million |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Tartous | Municipal and industrial | 3 | 5 | 3 | 5 | 3 | 3 | C | - DWWTP (construction)<br>- IWWTP (planned & construction)<br>- Cement factory rehabilitation<br>- Port and oil terminal rehabilitation<br>-Industrial feasibility study | 40 million |
| Jableh | Municipal and industrial | 2 | 3 | 3 | 2 | 2 | 2 | D | - DWWTP (construction)<br>- Improving monitoring system | 20 million |

# REVISION OF POLLUTION HOT SPOTS IN THE MEDITERRANEAN

Country report for

***T U N I S I A***

**Prepared in 1997 by:** **Mr Béchir Benmansour**
**Revised in 2001 by:** **Mr Nouredine Ben Aissa**

## 1. Contexte général

Il est bien connu aujourd'hui que les grandes civilisations du passé se sont établies ou épanouies sur les franges littorales des mers et des océans. Il en va de même pour les civilisations méditerranéennes, bien qu'elles sont si diverses, elles ont puisé l'essentiel de leur développement et leur prospérité « d'une seule mer ».

Au fil des temps, l'activité des hommes à modifié l'environnement de ce milieu en utilisant des moyens et des pratiques de plus en plus sophistiqués voire agressifs .

Les tendances déclinantes de l'environnement côtier en Tunisie s'expliquent en fait des atouts de la morphologie du littoral qui recèle une grande variété des paysages naturels riches en espaces insulaires, forêts, zones humides, accès facile par voie maritime que par voie terrestre ; un relief encadrant à peine accidenté sauf sur la façade Nord-Nord Est ou on trouve des terres limitrophes fertiles ; des richesses halieutiques abondantes et variées.

Toutes ces caractéristiques et bien entendu d'autres ont favorisé le développement des villes ; la concentration des activités économiques et des populations et par conséquent la rupture des équilibres environnementaux de cet écosystème avec l'apparition de certains phénomènes préoccupants tels que :

L'érosion et la pollution des plages, la pollution des eaux côtières, la perte des terres agricoles et des ressources naturelles la dégradation tant qualitative que quantitative des richesses halieutiques et de la bio diversité etc.…

Pour faire face à cette perte de valeur écologique et freiner la pression des différentes tendances et activités socio économiques sur cette frange du territoire, la Tunisie a mis en place une politique de gestion rationnelle du littoral axée sur la préservation des zones sensibles, l'exploitation judicieuse des zones à potentialité notable et l'éradication de la pollution sous toutes ses formes.

Une approche basée sur la cohérence entre les différentes stratégies et politiques sectorielles a été adoptée en se basant sur les orientations des plans de développement socio-économiques et considérant l'évolution profonde de l'espace économique mondial régional et local, ainsi que la valorisation des ressources naturelles et humaines.

L'Agenda 21 Méditerranéen servant de guide dans la voie des développements durables a permis de consolider nos orientations sur le mode de développement et notamment dans les zones côtières afin de minimiser l'épuisement des ressources naturelles et éviter la dégradation irréversible de l'environnement sans ralentir pour autant la croissance économique et compromettre le développement des générations futures.

La mise en œuvre des mesures, en faveur de ce développement équilibré nécessite toujours une meilleure compréhension pratique du concept et des exigences du développement durable, une cohérence des mécanismes à activer avec les objectifs fixées, l'adhésion de tous les acteurs, une meilleure connaissance d'état des lieux à différents niveaux pour pouvoir mieux baliser les pistes à prendre et approfondir la réflexion, et aider ainsi la prise de décision.

La contribution menée à travers ce rapport cherche à focaliser l'analyse sur la situation des milieux les plus dégradés et plus touchés essentiellement par la pollution (points chauds ).

## 2. Données de base :

### 2.1 Cadre physique :

Le développement socio-economique du littoral en matière d'urbanisation, industrie, tourisme, agriculture, a contribué fortement à « l'artificialisation » accéléré du paysage côtier et au processus de dégradation malgré une prise de conscience certaine et relativement ancienne, jalonnée par de nombreuses initiatives engageant aussi bien le secteur public que les collectivités locales les opérateurs économiques et d'autres acteurs de la société civile dans les différentes régions du littoral.

La bande côtière est caractérisée par une grande variété de paysages environnementaux hétérogènes et diversement dynamiques qui s'étendent sur plus de 1300km subdivisés en quatre grandes zones :

- **La côte nord :** (côte du corail ), elle s'étend depuis les frontières Algérienne jusqu'à Bizerte, elle présente une structure éscapée, étroite et encadrée par un relief montagneux et plusieurs forêts. La mer est relativement profonde, et abrite une panoplie et une grande diversité de mollusques, poissons, récifs coralliens… En plus ; la réserve de la biosphère d'Echkeul est, considérée comme station et refuge des oiseaux migrateurs.

Dans l'ensemble, cette zone est caractérisée par une faible pression humaine, néanmoins durant la dernière décennie, elle a connu un essor remarquable en matière du tourisme (Tabarka) et d'industrie (Bizerte)

- **La côte Nord Est** : ( Golfe de Tunis) ; située entre Bizerte et le cap de Houaria, cette zone est marquée par une structure hétérogène (milieux Lacustres, baies et estuaires des réseaux hydro graphiques importants ; Madjerda et Miliane…). Elle constitue en outre un territoire faunistique important riche et diversifié.

Cependant les pressions démographiques et urbaines et le développement industriel touristique, ,portuaire, agricole et autres constituent les caractéristiques principales de la dynamique de cette zone.

- **Le Golfe de Hammamet :** cette frange bornée de Houaria au nord et Chebba au sud, couvre la région de Nabeul /Hammamet et la région du sahel. Elle présente un plateau continental étroit et accidenté entre Haouria et Klebia, et en revanche une morphologie étendue et plus espacée au sud de Sousse en outre il faut noter l'existence de quelques étendues de milieux sensibles (Sebkhas / marécages) à korba- et Mahdia). Le tourisme, et l'expansion des villes constituent les principales pressions sur cette partie du littoral.

- **Le Golfe de Gabès :** cette zone limitée par chebba au nord et les frontières libyennes au sud est caractérise par un plateau continental très étendu et peu profond, riche en herbier de posidonias océanicas servant de vivier et de niche pour une faune marine variée et abondante. Certains secteurs constituent des escales d'importance au transit des oiseaux migrateurs (Thina /Sfax et lac bougrara /Zarzis ).

Ce pendant l'industrie de transformation des phosphates (Gabes, Sfax Sud et Skira ) constitue la principale pression anthropique sur le littoral de cette zone en raison de la pollution engendrée. Le tourisme est considéré parmi les secteurs économiques les plus développés au sud (Djerba/Zarzis) néanmoins ce développement a tendance d'aggraver la situation à cause des impacts, d'occupation parfois anarchique des terrains limitrophes, et des pressions sur les ressources en eau (aridité/ salinisation ) et difficulté de gestion des

déchets
( manque d'espaces / foncier …)

## 2.2 Cadre socio-économique

Le littoral joue un rôle important dans l'économie du pays, toutefois l'équilibre ou les exigences du développement socio -économique doit constituer une ligne médiane sans laquelle les coûts des impacts d'un tel développement risquent de dépasser ses bénéfices.
Pour donner une idée sur la place qu'occupe la bande côtière dans l'économie du pays et cadrer par conséquent l'empreinte et le déficit écologique engendré il y a lieu de préciser que cette zone abrite :

- 71 % de la population (population : 9,800 millions. ) avec une forte concentration urbaine dans les principales ville (densité : 2100hab/km² à Tunis, 1300hab /km² à Sousse, 1100hab/km² à Sfax) alors que la moyenne nationale est de l'ordre de 60hab/km² .
- 75% du parc national du logement
- 90 % de l'activité touristique
- 89 % du Tissu industriel
- 88 % de l'Emploi ( secteur industriel )
- 55 ports ( commerciaux, pêches, loisirs )

## 2.3 Maîtrise du développement durable du littoral

L'interaction des différents facteurs a généré une pression considérable sur le milieu côtier et notamment sur la qualité des eaux dans quelques points que nous considérions fragiles malgré les efforts considérables engagés par la Tunisie depuis les trois dernières décennies pour préserver l'environnement et le milieu hydrique spécialement ; le coût de remise en état des sites concernés est considéré comme une question majeure dans le cadre de la coopération internationale en matière de lutte contre la pollution des eaux côtières.

La croissance et la solidarité doivent bénéficier à toutes les régions du littoral national et en particulier à ces zones sensibles ou profondément touchées qu'il faut aider à surmonter leurs handicaps et leur assurer un développement durable et équilibré.

En fait la dégradation des écosystèmes marins et littoraux correspond en quelques sorte à autant de bénéfices perdus, l'évaluation de cette perte passe nécessairement par l'évaluation des dommages et des atteintes sur le plan environnemental et socio-économique des régions du littoral.

Les niveaux d'investissement nécessaires pour réparer cette dégradation considérable et largement hors de portée des autorités nationales et des opérateurs économiques et des privés.

Il est donc stratégique de les chiffrer afin qu'ils rentrent dans le champ des actions prioritaires des bailleurs de fonds internationaux et des mécanismes régionaux.

Cet inventaire national préliminaire des points chauds avec une estimation sommaire des coûts correspondants à leur réhabilitation permettrait de fixer les ordres des grandeurs des moyens financiers nécessaires.

## 3. Les points chauds de pollution sur les côtes Tunisiennes :

Le choix des points critiques ou points chauds sur le littoral Tunisien a été basé entre autre sur les éléments et les informations des inventaires précédents, de l'importance des agglomérations littorales ayant plus de 100.000 habitants de la qualité des rejets et des contaminant et l'importance et la taille des installations déversant directement leurs rejets dans la mer.

L'examen des listes existantes réalisées dans les exercices passés, montre en fait les efforts de réduction des charges polluantes notamment à Bizerte et à Tunis sud en raison des actions d'assainissement urbains engagées et des opérations de dépollution industrielle et des réhabilitation des zones industrielles dégradées.

Cependant ces efforts méritent une consolidation et un soutien afin d'éradiquer les poches de pollution dans ces deux zones.

Les zones de Gabès et de Sfax sud demeurent parmi les points chauds les plus critiques, en raison de la dominance de l'activité de transformation des phosphates et les problèmes engendrés par les rejets du phosphogypse en plus d'autres sources diffuses d'industries diverses .

### 3.1 Site de Gabès :

La ville de Gabès est située au sud Est de la Tunisie, elle domine le « golfe de Gabès » et constitue un point triple de rencontre d'espaces maritimes, montagneux et sahariens avec l'existence d'oasis côtière. La ville est considérée la capitale nationale en matière des transformations des phosphates et de production d'engrais.

L'activité portuaire, production d'électricité et d'autres industries diverses viennent renforcer son rôle économique, en plus d'autres activités agricoles et touristiques. Les impacts de l'activité phosphatière sont à l'origine de la pollution des eaux de la mer et la régression de l'activité de production halieutique et même agricole.

Il faut rappeler que des efforts considérables ont été déployés à Gabès pour atténuer la pollution atmosphérique, ainsi que des actions notables d'assainissement urbain et d' amélioration du cadre de vie.

#### a) Données socioéconomiques :

- *situation : Sud Est de la Tunisie :*

| | |
|---|---|
| **Population** | - 180.000hab ( accroissement estival : 30-35%)<br>- Gabès Nord :( lieu du point chaud ) 70.000hab |
| **Industrie ( Gabès nord)** | 300ha<br>transformation des phosphates<br>ciment<br>production d'électricité<br>Autres industries (détergents mécaniques agroalimentaire |

| | |
|---|---|
| **Agriculture** | culture maraîchère<br>arboriculture<br>palmeraie<br>activités halieutiques (>4000t/an : 50 % production nationale) |
| **Tourisme**<br>**( Gabès sud)** | - > 1350lits<br>-projet d'extension ( 200 ha) rive sud |
| **Transport maritime** | -port commercial /port de pêche |

**b) Sources de pollution :**

| | |
|---|---|
| Pollution d'origine urbaine | eaux usées produites 21000$m^3$ /jour (13000m3/jour sont épurés) : taux d'épuration 96%)<br>– capacité d'épuration existante:17000$m^3$/jour- taux de branchement 70 %<br>caractéristiques des eaux usées brutes :<br>*DBO5 : 450_700mg/l<br>*DCO : 800- 950mg/l<br>* MES(TSS) : 320-600mg/l<br>* Nt :120-140mg/l |
| **Pollution d'origine industrielle**<br>( activité de transformation des phosphates ) | Pollution atmosphérique : / SOx/NOx / Fluor/ mercaptans (odeurs) / Poussières et suies des phosphates.<br>Pollution hydrique : / rejet de 14000 T/jour de phosphogypse dans la mer / traces de métaux lourds : Cd / PH acide / fluor / phosphore / rejet de 350000$m^3$/jour environ : eau de refroidissement. |

**c) Actions réalisées ou proposée**

- **Actions réalisées** :

- construction d'une station d'épuration des eaux usées domestiques(capacité 17500$m^3$/jour) plus un réseau de collecte.
- Réutilisation de 30% des eaux épurées dans l'agriculture.
- Atténuation des émissions Sox / Nox (65 à 80% : 28 millions US$)
- Installation embryonnaire d'un réseau de contrôle de la qualité de l'air (deux stations).
- Etude technique d'une décharge contrôlée de phosphogypse (en cour d'approfondissement)

- **Actions proposées :**

- extension des réseaux d'assainissement plus la station d'épuration ainsi que l'ajout d'un étage de traitement tertiaire pour valoriser d'avantage les eaux épurées dans cette région aride < 200mm / an (50millions US $).
- Atténuation des émanations du fluor/ mercaptans…(problème de fluorose et d'odeur)
- Mise en terril du phosphogypse ( 120milllions US $)

### 3.2 Site de Sfax Sud :

A l'inverse de sa façade Nord qui a bénéficié d'un projet important concernant l'arrêt de l'usine NPK et l'aménagement des zones dégradées avoisinant à cause du phosphogypse rejeté sur la côte et dans la mer , la ville de Sfax contenue toujours à chercher à rétablir l'équilibre dans sa rive sud qui constitue un amalgame d'activité industrielle, commerciale, urbaine en plus d'autres infrastructures concernant la décharge des déchets solides, stockage des margines, épuration des eaux… cette situation critique reflète un contraste remarquable entre la situation environnementale préoccupante existante, et les atouts d'une zones naturelle limitrophe et d'importance écologique ; « Parc de Thyna » ; bien entendu en plus des risques sur la santé humaine, la pollution des eaux côtières et des nappes et la dévaluation du cadre de vie d'une façon générale.

Bien que cette analyse vise essentiellement le listing des points chauds et la caractérisation sommaire des sources de pollution dans un esprit d'évaluation et d'hiérarchisation, pour le cas de Sfax Sud, il est opportun de considère qu'un développement durable doit passer obligatoirement par un ensemble d'actions et de mesures, dans une vision de gestion intégrée et multi-sectorièlle.
Les contraintes financières constituent évidement un facteur limitant. Une présentation des activités urgentes semble nécessaire et qui fera un premier lot d'un grand plan de gestion intégré.

**a / Données socio-économiques**

- *situation : sud est ( nord du golfe de Gabès) :*

| | |
|---|---|
| population | - grand Sfax : 700000 hab<br>- Sfax sud : 300000 hab |
| Industrie( Sfax Sud) | - Industries chimiques (transformation des phosphates(SIAPE)/détergents/peinture…<br>- autres industries : agroalimentaire/mécanique /électrique/céramique…<br>- superficie>400ha et plus de 400 entreprises (98%PME)<br>- SIAPE :600 emplois |
| Agriculture(Sfax Sud) | - oliveraie/amandier /<br>- Activité halieutique très développée. |
| tourisme | - Activité moins développée. |
| Transport (maritime) | - Port de pêche.<br>- Port de commerce |

**b/ sources de pollution**

| | |
|---|---|
| Pollution d'origine urbaine (Sfax Sud) | • Eaux usées produites≈36000m3/jour dont 26000m3/jour sont épurés (rendement épuratoire 80 %).<br>• Capacité d'épuration existante : 24000m3/jour (dépassée).<br>• Taux de branchement 70%.<br>• Caractéristiques des eaux usées (brutes) : DBO : 550- 620mg/l<br>DCO : 1000-1050mg/l<br>MES : 400- 450mg/l |
| Pollution d'origine industrielle (Sfax sud) | • Pollution atmosphérique :<br>- SIAPE ; Sox / Nox / Fluor/ mercaptans suie et poussières.<br>-Autres entreprises ;fumées (combustion ,fuel…)<br>• pollution hydrique :<br>- phosphogypse ( en terril)<br>-rejets industriels divers dans les canaux et les fossés allant vers la mer ( métaux lourds HC ) |

**c/ actions réalisées ou proposées**

- **<u>actions réalisées :</u>**

- étude d'aménagement et d'assainissement de la zone industrielle Surélévation de deux cheminées de la SIAPE pour améliorer la dispersion des gaz dégagés.

- **<u>actions proposées</u> :**

- étude d 'élaboration d'un plan de gestion intégrée de Sfax sud.
- Etude environnementale du complexe SIAPE et analyse des possibilités de délocalisation ou adoption de procèdes plus écologiques ( production plus propre ).
- Traitement et aménagement du terril du phosphogypse.
- Réhabilitation et décontamination des terrains et des espaces pollués.
- Transfert de la décharge des déchets urbains ainsi que les bassins des margines.
- Réhabilitation et extension de l'infrastructure d'assainissement (réseaux plus station d'épuration).

### 3.3 Site du lac Sud de Tunis :

Il est important de signaler que le bassin versant du lac sud de Tunis constitue une bonne partie de la banlieue sud de la capitale. Ce bassin est caractérisé par une importante activité industrielle et portuaire. Durant la période écoulée, des actions d'envergure en matière de protection de l'environnement et de lutte contre la pollution industrielle notamment, ont été réalisées. Les investissements consacrés à cette zone bien qu'ils sont insuffisants, ont contribué à la réhabilitation des infrastructures (réseaux divers), installation des systèmes de pré traitement des rejets polluants, dragage et élimination des dépôts contaminés dans le lac sud etc. et par conséquent à l'amélioration du cadre de vie et de protection de la zone côtière.

Cependant pour compléter les efforts déployés et essayer de rentabiliser les dépenses engagées d'un coté et assurer un développement durable de la zone et préserver les équilibres des écosystèmes et spécialement les franges côtières du lac d'un autre coté ; il est primordial de considérer dans les étapes prochaines des actions concernant la réhabilitation des zones industrielles restantes, l'aménagement de la zone portuaire et de stockage des hydrocarbures.

**a/ données socio-économiques :**

*-Situation :sud de Tunis*

| | |
|---|---|
| **Population** | **-**Banlieue sud de Tunis :480000habitans<br>-Bassin versant du lac sud de Tunis :250000habitans |
| Industrie | -Superficie >500ha plus de 600unités industrielles<br>-Activités industrielles diversifiées, chimiques, mécaniques céramiques, textiles agroalimentaires ciment….<br>-Stockage des hydrocarbures |
| Agriculture | **-**Activité halieutique |
| Transport maritime | -Port de commerce |

**b/ Sources de pollution**

| | |
|---|---|
| Pollution d'origine urbaine | -Eaux usées produites :60000$m^3$/jour dont 40000sontépurés (rendement épuratoire 90%)<br>-Capacité d'épuration existante :37000$m^3$/j ( dépassée)<br>-Taux de branchement 70%<br>-caractéristiques des eaux usés brutes :DBO5 400-500mg/l /DCO800-1000 mg/l /MES350-450mg/l /présence du P et N |
| Pollution d'origine industrielle | -Pollution atmosphérique :poussières/fumées/SOx/NOx/Pb (activités : ciment ,centrales électriques)<br>-Pollution hydrique :<br>-Rejet de 5000$m^3$/j dans le lac<br>-Présence de métaux lourds (cd-cr-Hg-Zn…) HC et micro-organismes |

**c/ Actions réalisées ou proposées**

- **Actions réalisées**

**-** Réhabilitation de 70% des infrastructures d'assainissement des zones industrielles (15millions US $)
- Dragage et décontamination du lac sud de Tunis ( travaux à80%d'exécution :coût du projet 70millions US$)
- Pré traitement des rejets des unités industrielles polluantes (80%)
- Réalisation d'une station égrappée de traitements des rejets industriels les plus polluants :capacité 5000$m^3$/j, coût 4 millions US $.

- **Actions proposées**

- Réhabilitation des zones industrielles restantes
- Aménagement et assainissement de la zone portuaire et de stockage des hydrocarbures.
- Interceptions des rejets venant des poches non assainis .
- Extension de la capacité d'épuration
- Aménagement de l'estuaire de Oued Miliane servant de déversoir des eaux épurées .

### 3.4 Site de Bizerte / Menzel Bourguiba :

La zone de Bizerte / Menzel Bourguiba constitue un pôle industriel important, elle abrite des monopoles tels que l'usine de sidérurgie, raffinerie de pétrole, unité de raffinage des huiles usagers …

En outre, de par sa proximité de la capitale ( 60 km) et de ses atouts naturels : plages / forêts / parc Echkeul etc) elle connaît une extension urbaine galopante et un développement touristique remarquable.

Les caractéristiques physiques et morphologiques du lac de Bizerte ainsi que l'importance des activités halieutiques nous invitent à approfondir la réflexion sur les impacts et les retombés de telles activités.

Consciente de cette situation la Tunisie à engagé depuis longtemps un programme d'assainissement visant à doter la zone d'une infrastructure de collecte et d'épuration performante.

Cependant des efforts supplémentaires restent à déployer en terme de dépollution industrielle ( atmosphérique, hydrique, déchets solides) ainsi que l'extension des réseaux d'assainissement et des systèmes d'épurations existants . Les investissements nécessaires sont de loin hors de la portée des industries même et de la communauté nationale.

#### a) Données socio – économiques :

- *Situation Nord de la Tunisie*

| | |
|---|---|
| Population | Population du grand Bizerte :<br>300.000hab ( accroissement de 50 % environ :pendant l'été ) |
| Industrie | - Industrie :métallurgique, raffinage d'hydrocarbure, textile, agroalimentaire , ciment/ céramique et verre, construction navale….)<br>- Tissu en industriel d'environ 300 unités<br>- One industrielle ( libre échange)<br>- Emplois > 5000 |
| Agriculture | - culture maraîchère céréalière, halieutique et élevage …<br>- zone protégée de Ichhkeul ( réserve naturelle )<br>- forêts de chêne - liége ( façade Nord) |
| Tourisme | - capacité de 1200 lits ( projection de 5000 lits :2015 ) |
| Transport maritime | - port de commerce : 4 millions de t /an<br>- terminal pétrolier |

***b) Sources de pollution :***

| | |
|---|---|
| Pollution d'origine urbaine | - eaux usées produites : 40.000m $^3$ /j dont 7000 m $^3$ /j sont épurés ( rendement épuratoire 97%)<br>- capacité d'épuration existante :27000m$^3$ /j<br>- taux de branchement 70 %<br>caractéristiques des eaux usés ( brutes) : DBO5 : 350-600mg/l / DCO :850-1000mg /l / MES : 400mg- 450ml/l / traces métaux lourds/ HC / Eléments fertilisants : P/ N |
| Pollution d'origine industrielle | - Pollution atmosphérique : poussières / Nox /Sox / Pb / Zn ( activité sidérurgique , raffinage de pétrole..)<br>- Pollution hydrique :<br>• déversement plus de 5000m$^3$ /j ( rejets industriels ) dans le lac<br>• rejets des métaux lourds ( Fe/ Pb/ Cr/ Hg/ Zn…)<br>• pré traitement des rejets polluants très insuffisants |
| Pollution d'origine Agricole | - Pollution diffuse générée par les agrochimiques (Engrais, pesticides…) ( zone relativement humide : pluviométrie> 500 mm/an |

***c) Actions réalisées ou proposées :***

- **Actions réalisées**

- assainissement des villes de Bizerte et de Menzel Bourguiba (réseaux de collecte + stations d'épuration).
- pré traitement de quelques rejets pollués dans des petites unités industrielles.
- Traitement partiel des eaux polluées de la raffinerie

- **Actions proposées :**

- élaboration d'une étude globale sur l'aménagement intégré des rives du lac de Bizerte
- extensions des réseaux de collecte d'eaux usées municipales et renforcement de la capacité d'épuration existante.
- Dépollution des rejets et des émissions des grandes unités industrielles (sidérurgie, raffinerie, cimenterie, unité de raffinage des huiles usagers)
- Réalisation/réhabilitation des infrastructures d'assainissement des zones industrielles.
- Dépollution, décontamination et protection du lac de Bizerte.

**Conclusion**

Cet exercice nous a permis de dégager à travers les informations disponibles et les données nouvelles par rapport à l'ancienne liste établie , l'importance des 4 sites ou points chauds de pollution ainsi que les 3 sites sensibles .

Il est important de signaler que ces points chauds constituent des poches de pollution avancée, la non-action, pourrait aggraver la situation et par conséquent affecter d'une façon profonde le développement durable des zones concernées.

Certes les efforts déployés dans le passé et notamment en matière d'assainissement dans les villes proposées sont d'une importance capitale pour la sauvegarde de l'environnement et surtout de la santé publique, moins nous considérons que des investissements supplémentaires pourront renverser les vapeurs et contribuer à établir les équilibres de ces zones côtières afin d'assurer leur rôle socio-économique en tant que pôle industriel et urbain .

Les estimations préliminaires proposées pourront être justifiées et approfondies à travers des études spécifiques et bien ciblées : néanmoins pour le projet de mise en Terril de Gabès les études techniques d'exécution ont atteint des phases avancées .

Quant aux effets transfrontières et compte tenu du degré d'im précision des informations disponibles en matière de contaminant et de polluants spécifiques et persistants qui pourront affecter les richesses halieutiques et la santé humaine, on ne peut pas juger de tels effets ou impacts . la pression démographique dans les villes proposées, ne semble pas être en mesure d'entraîner un risque significatif, en raison de l'infrastructure d'assainissement déjà opérationnelle, (collecte et épuration).

Les charges polluantes de phosphore et d'azote dans les eaux épurées déversées dans la mer ou les poches restantes d'eaux usées brutes, sont au-dessous des références adoptées.

Des efforts supplémentaires en matière d'assainissement et surtout de traitement tertiaire et d'optimisation des stations dépurations pourront réduire considérablement ces charges.

Pour les sites sensibles proposés nous considérons que le embouchures des cours d'eau (Medjerda) au niveau Ghar El Melh, (Miliane) au niveau de Radès et le canal des rejets des eaux épurées de la station d'épuration de Choutrana au niveau de Raoued nécessitent une attention particulière afin de mener des actions concrètes et efficaces pour alléger ainsi les pressions que peuvent entraîner les polluants industriels et domestiques pour le premier site et les micro-organismes et charges résiduaires en P et N pour les deux autres sites.

## Site points chauds

| Pays | Nom | type | Santé publique | Qualité de l'eau de boisson | Faune et flore aquatique | Loisirs | Autres avantages bénéfiques | Conditions socio – économiques | catégorie | Nature de l'investissement | Estimation préliminaire du coût financier ( en Dollars EU) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Tunisie | Gabès | Domestique<br>Industriel engrais / Phosphates | 6 | 2 | 6 | 5 | 4 | 5 | B | -Extension : réseau+ STEP<br>-Traitement tertiaire<br>- Mise en terril du phosphosgypse | 35<br>120 |
| | Sfax Sud | Domestique<br>Industriel (engrais/ Phosphates | 6 | 1 | 5 | 4 | 4 | 5 | B | Extension et réhabilitation : réseau STEP<br>-Traitement tertiaire<br>Dépollution / aménagement de la zone industrielle / pré traitement | 40<br>50<br>( estimation sans étude) |
| | Lac sud Tunis | Domestique<br>Industriel (HC,Textile) | 5 | 1 | 6 | 5 | 4 | 5 | B | Extension et réhabilitation de réseaux d'assainissement<br>Réhabilitation des zone industrielles et portuaires / pré traitement | 20<br>20 |
| | Lac de Bizerte | Domestique<br>Industriel (siderurgie, Hydro C. Ciment) | 6 | 2 | 6 | 4 | 4 | 5 | B | Extension des réseaux d'assainissement et traitement tertiaires<br>Dépollution / aménagement des zones industrielles / pré traitement | 40<br>40<br>( estimation sans étude) |

# REVISION OF POLLUTION HOT SPOTS IN THE MEDITERRANEAN

Country report for

***T U R K E Y***

***Acknowledgements***

- *Mr Suleyman Baydar, Head of the Department of International Relations in the Ministry of Environment, for his cooperation throughout.*
- *Ms Kumru Adanali, Chief of Division, and Ms Guzin Arat Environmental Engineer, who organized the survey, and were a source of constant assistance during the period of the visit, carried out the necessary liaison with other departments in order to collect the necessary information, and contributed significantly to the final identification and assessment of hot spots.*
- *Mr Hakan Baykal, who was also involved in the survey, and provided valuable assistance.*

**Prepared in 1997 by:** **Mr Louis J. Saliba**
**Revised in 2001 by :** **Mr Asim Acikel**

## 1. INTRODUCTION

The survey was coordinated by the Foreign Relations Department of the Ministry of Environment. The relative questionnaires were distributed to the following:

- State Institute of Statistics
- Bank of Provinces
- Technical Institute of Marine Sciences
- Ministry of Tourism
- Provincial Departments of the Ministry of Environment.

During the visit to Turkey from 24 February to 3 March 1997, comprehensive discussions took place with Officials of the Foreign Relations Department of the Ministry of Environment. The completed questionnaires were gone through, and, where necessary, other information was sought and obtained from the sources mentioned above during the period of the visit.

Turkey has a long Mediterranean coastline, on which settlements of different sizes, varying from large cities to small villages, abound. Unlike the situation on the Black Sea coast of Turkey, where populations have remained relatively constant, and also diminished in some cases, the population in Mediterranean coastal settlements is continually on the increase, the figures varying from one locality to another.

Taken generally, a large proportion of municipal waste is discharged into the sea without treatment. Also, in several of the cities and towns, a sewerage network is either absent or incomplete. This situation is being slowly improved, but a lot of work needs to be done.

Turkey is highly industrialized, but a large percentage of industries are located inland. Relatively few industries (as compared to the country total) discharge their wastes directly into the sea. Hot spot areas are coastal cities and towns where the marine environment receives waste from several industries, as opposed to individual industries. The situation regarding treatment of industrial waste is improving at a faster rate than is the case with municipal effluents, and several industries now treat their waste at source, treatment being mainly secondary, but primary in some cases. A number of industries discharge their wastes into rivers, the effluent again varying from untreated to treated up to the secondary stage. Information on individual industries was difficult to obtain, and work had to be done on global figures for the various localities identified as hot spots of industrial pollution.

Six main rivers discharge into the Mediterranean Sea, two of which discharge at two separate points. River pollution is a serious problem in Turkey, and there is a pressing need for a project on river management. It is strongly recommended that ways and means be found by the appropriate International Agency to finance such a project, the first phase of which could be a comprehensive survey of river pollution.

## 2. APPROACH

A total of forty questionnaires relating to municipal discharges, compiled by the Technical Institute of Marine Sciences, were made available. Many of these were recognized as sources of pollution, and would have normally been included in comprehensive surveys of land-based pollution, but definitely did not rank as priority hot spots. It was therefore decided to draw the line at cities with a permanent population of 100,000 or more inhabitants. Twelve cities fitted into this category. The population figures is drawn from the 1997 population census, and did not reflect the present day situation.

In all the questionnaires, estimations of the loads of the various pollutant parameters were made on the basis of populations, using the following formulae:

| | |
|---|---|
| $BOD_5$ | 60 g / person / day |
| COD | 100 g / person / day |
| Total N | 15 g / person / day |
| Total P | 6 g / person / day |
| TSS | 90 g / person / day |

These formulae were applied to the revised population figures made available by the State Institute of Statistics for the calculation of the new pollution loads. These were made on the basis of permanent populations. Figures for summer populations were not provided, therefore actual pollution load is much more higher than the calculated one on the basis of permanent population in summer seasons in which there is a high mass of tourist.

In all cases, pollution data was limited to $BOD_5$, COD, Total-N, Total-P and TSS. No data regarding the other parameters listed in the questionnaire were available. Similarly, data on receiving water quality were not available.

In the case of industries discharging directly into the sea, only four completed questionnaires were received, all relating to industries whose effluent was receiving the full range of treatment prior to discharge. These questionnaires could not therefore be utilized, as their discharges were not creating, and did not contribute to, pollution hot spots. During the course of visit, data was received from the State Institute of Statistics. This data was global in nature, the total number of industries discharging their wastes directly into the sea being provided for a number of industrial areas, giving a break-up of the total volume of wastewater discharged as follows:

- Direct industrial discharge without treatment
- Direct industrial discharge with secondary or further treatment
- Direct industrial discharge with primary treatment only
- Direct domestic discharge without treatment
- Direct domestic discharge with treatment

It was not possible to obtain either information on individual industries, or data on pollution loads.

Two industrial hot spots were identified from the list supplied. Adana and Icel were linked to cities, and each hot spot relates to a group of industries. In the case of Adana, where only one industry discharging directly into the sea was listed, the locality was retained as a hot spot on the basis of supplementary information regarding other existing industries, which were not listed.

The assessment of effects of all municipal and industrial hot spots listed was done not only on the basis of pollution load, but also taking into account the localities of the discharge

sites and effected areas in question in relation to sensitive areas such as bathing areas, etc., and the contribution of dispersal in the sea to the final effects.

Estimates of the cost required for construction of treatment plants for polluting industries could not be obtained. This would require a comprehensive study of the requirements of each individual industry, and would take considerable time. Costs for the four industrial hot spots, therefore, remain unavailable at the present time, and have been so defined in the assessment table.

For some of the hot spots, the cost is taken directly from the feasibility studies, but sometimes costs for new sewage treatment plants for the coastal cities listed, together with costs for construction or extension of sewerage networks, presented a problem. Information was obtained from the Bank of Provinces in Ankara regarding current costs, which are based on populations served, and which were quoted as follows:

- Primary treatment plus Activated sludge: US$ 32 *per capita*
- The above, with extended aeration US$ 42 *per capita*
- Primary treatment plus trickling filter US$ 34 *per capita*
- Primary treatment plus Stabilization Pond US$ 35 *per capita*
- Construction or extension of sewerage network US$ 170 *per capita*

These costs are high as compared with those obtaining for the Black Sea project. These were also made on the basis of population figures, and application of population figures for the towns listed in the Black Sea document to the costs of wastewater treatment plants and sewerage construction and extension gave figures of US$ 18 *per capita* for the former and 23 US$ *per capita* for the latter. It is understood that the Black Sea figures were obtained by taking an average of the costs quoted by national banks and those quoted by the World Bank.

One further problem in arriving at reasonable cost estimates was the fact that the populations of Mediterranean coastal cities and towns in Turkey are continuously increasing. As the increase varies greatly from one locality to another, it is not possible to apply an overall percentage figure.

In order to be able to provide a cost estimate for some of the hot spots, the 1997 population census figures were used in conjunction with the third option (Primary treatment plus trickling filter) at US$ 34 *per capita*, to reach an indicative figure.

## 3. CONTRIBUTION OF DIFFERENT SOURCES TO THE DEFINED HOT SPOTS

A list of the seventeen identified hot spots, along with the various sources contributing to the discharge, and the principal supporting data expressed as tons of $BOD_5$ per day in the case of municipal sites and wastewater volume in the case of industrial sites, is given in Table 1. A resume of the data contained in the questionnaires on municipal discharges, including total loads of $BOD_5$, COD, Total-N, Total-P and TSS in tons per year, together with $BOD_5$ in tons per day, is given in Table 2. The estimated increases in population in the twelve cities identified as hot spots is given in Table 3.1. The result of 1990 and 1997 population census and annual population increase rate for 1990-1997 is given in Table.3.2.

Industrial discharges from the four industrial sites identified, expressed as volumes of treated, partially treated or untreated wastewater flows, are given in Table 4.

The pollution load from the six main Mediterranean rivers at their point of entry into the sea is given in Table 5.

## 4. ASSESSMENT OF PRIORITY HOT SPOTS

The assessment of the five priority hot spots, using the ranking system provided, is given in Table 5.

## 5. IDENTIFICATION OF MAIN GAPS AND CONSTRAINTS

There are a number of gaps. The main ones are the following:

- the lack of information on (a) concentrations of Petroleum hydrocarbons, heavy metals and organochlorines in municipal effluents, (b) the quality of receiving waters;

- the lack of information on individual industries. This has resulted in estimates of the costs involved in remedial action being impossible insofar as this component is concerned.

It is true that the present exercise was limited to hot spots, and was in no way a comprehensive survey of all pollution sources in the Mediterranean.

## 6. PROPOSED OPTIONS FOR REMEDIAL ACTION

The main option available for remedial action at all sites is the construction of wastewater treatment plants, and in the case of a number of cities, extension of existing sewerage networks or constructions of new ones. In the case of industries, the provision of treatment facilities at source must be accelerated. Feasibility studies are completed for most of the host spots, therefore these host spots with completed feasibility studies needs ,particularly, financial support for investments for construction of WWTP or solid waste landfill.

The costs involved in the construction of treatment plants and sewerage networks for some of the cities listed will have to be re-calculated, taking into account not only *per capita* estimates, but also properly designed population projections for each city. In the case of industries, information currently available could not even lead to an indicative estimate, and calculations will have to be worked out for each individual industry. As already stated, one important need is for a project on river management, as a large amount of waste, both industrial and municipal, finds its way into the Mediterranean through rivers.

Table 1

Identified Mediterranean Hot Spots in Turkey

| Hot-Spots | Pollution Sources | Principal Supporting Data |
|---|---|---|
| ICEL | Domestic | Untreated sewage from **653,662** Pop. BOD load: **39** tons per day |
| Erdemli | Domestic | Untreated sewage from **118,528** Pop. BOD load: **7** tons per day |
| Silifke | Domestic | Untreated sewage from **168,360** Pop. BOD load: **10** tons per day |
| Tarsus | Domestic | Untreated sewage from **306,433** Pop. BOD load: **18** tons per day |
| ANTALYA | Domestic | Untreated sewage from **606,896** Pop. BOD load: **36.5** tons per day |
| Alanya | Domestic | Untreated sewage from **235,884** Pop. BOD load: **14** tons per day |
| **Side** | **Domestic** | **Untreated sewage from 87,067 Pop. BOD load: 5 tons per day** |
| ADANA | Domestic | Untreated sewage from **1,185,049** Pop. BOD load: **71** tons per day |
| | Industrial | Industry discharge 158,400 $m^3$/year untreated industrial water |
| Ceyhan | Domestic | Untreated sewage from **157,050** Pop. BOD load: **9.5** tons per day |
| ANTAKYA | | |
| Iskenderun | Domestic | Untreated sewage from **276,238** Pop. BOD load: **16.5** tons per day |
| Dortyol | Domestic | Untreated sewage from **121,098** Pop. BOD load: **7** tons per day |
| Kirikhan | Domestic | Untreated sewage from **118,524** Pop. BOD load: **7** tons per day |
| BODRUM | Domestic | Untreated sewage from **75,994** Pop. BOD load: **4.5** tons per day |
| Marmaris | Domestic | Untreated sewage from **58,925** Pop. BOD load: **3.5** tons per day |
| Datca | Domestic | Untreated sewage from **11,802** Pop. BOD load: **0.7** tons per day |
| IZMIR | | |
| FOCA | Domestic | Untreated sewage from 33,061 Pop. BOD load. 1.98 tons per day |
| CESME-ALACATI | Domestic | Untreated sewage from 32,709 Pop. BOD load. 1.96 tons per day |

Table 2

Municipal discharges from main Mediterranean cities in Turkey

| CITY | Population | Population served by Sewerage | BOD (Tons/year) | COD (Tons/year) | TOTAL N (Tons/year) | TOTAL P (Tons/year) | TSS (Tons/year) | BOD (Tons/day) |
|---|---|---|---|---|---|---|---|---|
| ICEL | **653,662** | 510,530 | **14,315** | **23,858** | **3,579** | **1,432** | **21,473** | **39.22** |
| ERDEMLI | **118,528** | -- | **2,595** | **4,326** | **649** | **260** | **3,894** | **7.10** |
| SILIFKE | **168,360** | 37,517 | **3,687** | **6,145** | **922** | **368** | **5,531** | **10.10** |
| TARSUS | **306,433** | 118,622 | **6,701** | **11,184** | **1,678** | **671** | **10,066** | **18.36** |
| ANTALYA | **606,896** | -- | **13,291** | **22,151** | **3,323** | **1,329** | **19,937** | **36.41** |
| ALANYA | **235,884** | 50,461 | **5,165** | **8,609** | **1,291** | **517** | **7,749** | **14.15** |
| SIDE | **87,067** | 30,087 | **1,906** | **3,177** | **477** | **191** | **2,860** | **5.22** |
| MANAVGAT | **174,354** | 29,960 | **3,818** | **6,364** | **955** | **382** | **5,726** | **10.46** |
| ADANA | **1,185,049** | 878,736 | **25,952** | **43,254** | **6,488** | **2,595** | **38,929** | **71.10** |
| CEYHAN | **157,050** | 89,877 | **3,439** | **5,732** | **860** | **344** | **5,151** | **9.42** |
| ANTAKYA | **313,371** | 134,056 | **6,862** | **11,438** | **1,716** | **686** | **10,294** | **18.8** |
| ISKENDERUN | **276,238** | 92,189 | **6,049** | **10,082** | **1,512** | **605** | **9,074** | **16.57** |
| DORTYOL | **121,098** | -- | **2,652** | **4,420** | **663** | **265** | **3,978** | **7.27** |
| KIRIKHAN | **118,524** | -- | **2,595** | **4,326** | **649** | **260** | **3,894** | **7.11** |
| BODRUM | **75,994** | 20,449 | **1,664** | **2,773** | **416** | **166** | **2,496** | **4.55** |
| MARMARIS | **58,925** | 23,041 | **1,290** | **2,150** | **323** | **129** | **1,936** | **3.53** |
| DATCA | **11,802** | -- | **258** | **430** | **65** | **26** | **388** | **0.71** |
| IZMIR | | | | | | | | |
| FOCA | **33,061** | -- | **724** | **1,206** | **181** | **72,4** | **1,086** | **1.98** |
| CESME-ALACATI | **32,709** | -- | **716** | **1,193** | **179** | **71,6** | **1,074** | **1.96** |

Table 3.1

Estimated population increases in main Mediterranean cities in Turkey

| CITY | Population 1995 | Percent Increase 1994-1995 | TOTAL Increase 1990-1995 | Average Annual Increase 1990-1995 | Estimated Annual Increase 1995-2000 | TOTAL Percent Increase 1995-2000 |
|---|---|---|---|---|---|---|
| ADANA | 1,066,005 | 3.1% | 16.4% | 3,28% | 3.19% | 15.95% |
| ICEL (City) | 694,867 | 4.9% | 64,5% | 12.90% | 8.90% | 44.50% |
| ANTALYA | 505,862 | 5,96% | 33.8% | 6.76% | 6.36% | 31.80% |
| TARSUS | 333,302 | 2,7% | 77.8% | 15.56% | 9.15% | 45.65% |
| ANTAKYA | 317,725 | 2.24% | 156.0% | 31.2% | 16.72% | 83.60% |
| ISKENDERUN | 276,163 | 1.2% | 78.4% | 15.68% | 8.44% | 42.20% |
| OSMANIYE | 139,116 | 2.6% | 13.7% | 2.74% | 2.67% | 13.55% |
| SILIFKE | 128,509 | 3.6% | 174,0% | 34.90% | 19.20% | 96.00% |
| KIRIKHAN | 120,472 | 3.3% | 75.6% | 15.12% | 9.21% | 46.05% |
| DORTYOL | 116,380 | 0.8% | 147% | 29.48% | 15.14% | 75.70% |

Table.3.2.

Result of 1990 and 1997 census, and annual population increase rates for 1990-1997 in main Mediterranean cities in Turkey

| Name | Main Cities | Population 1990 | Population 1997 | Annual Population Increase rate 1990-1997 (%) |
|---|---|---|---|---|
| ICEL | Total (Including all main cities, towns and villages) | 1,267,253 | 1,508,232 | 24.49 |
| | Mersin | | 653,662 | |
| | Erdemli | | 118,528 | |
| | Silifke | | 168,360 | |
| | Tarsus | | 306,433 | |
| ANTALYA | Total (Including all main cities, towns and villages) | 1,132,211 | 1,509,616 | 40.46 |
| | Antalya | | 606,898 | |
| | Alanya | | 235,884 | |
| | Manavgat | | 174,354 | |
| ADANA | Total (Including all main cities, towns and villages) | 1,549,233 | 1,682,483 | 11.61 |
| | Adana | | 1,185,043 | |
| | Ceyhan | | 157,050 | |
| ANTAKYA | Total (Including all main cities, towns and villages) | 1,109,754 | 1,197,139 | 10.66 |
| | Antakya | | 313,371 | |
| | Iskenderun | | 276,238 | |
| | Dortyol | | 121,098 | |
| | Kirikhan | | 118,524 | |
| MUGLA | Total (Including all main cities, towns and villages) | 562,809 | 640,011 | 18.08 |
| | Bodrum | | 75,994 | |
| | Marmaris | | 58,925 | |
| | Datca | | 11,802 | |

| | | | | |
|---|---|---|---|---|
| IZMIR | Total (Including all main cities, towns and villages) | 2,117,811 | | 20.38 |
| | Foca | | 33,061 | |
| | Cesme-Alacatı | | 32,709 | |

Table 4

Industrial discharges directly into the sea from main Mediterranean cities in Turkey

| **City/Province** | **Number of Industries** | **Industrial wastewater** | | | **Domestic wastewater** | |
|---|---|---|---|---|---|---|
| | | **Untreated $m^3$/year** | **Primary treatment $m^3$/year** | **Secondary treatment $m^3$/year** | **Untreated $m^3$/year** | **Treated $m^3$/year** |
| ADANA | 1 | --- | --- | --- | --- | 158,400 |
| ICEL | 13 | 2,164,350 | 3,150,000 | 7,093,330 | 139,732 | 411,090 |

Table 5

Pollution load from main Mediterranean rivers in Turkey

| River | Number of Measurements | Q $Km^3/y$ | $BOD_5$ mg/l | COD mg/l | NH3-N mg/l | NO2-N mg/l | NO3-N mg/l | PO4-P mg/l | T.coli No./100 ml | FSTREP. No./100 ml | Cr mg/l | Cn mg/l | Pb mg/l | Zn mg/l | TSS mg/l | Cd mg/l |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SEHYAN RIVER<br>KARAYUSUFLU VILLAGE | 4 | 5018 | 2.4 | <20 | 0.7 | 0.049 | 0.43 | 0.14 | NA | NA | NA | NA | NA | NA | 113 | - |
| OOKSU RIVER<br>DOWNSTREAM OF SILIFKE | 6 | 2.949 | 1.1 | <20 | 0.18 | 0.002 | 0.59 | 0.06 | NA | NA | NA | NA | NA | NA | 159 | NA |
| CEYHAN RIVER<br>BEBELI VILLAGE | 4<br>1 | 5.931 | 1.3 | <20 | 0.13 | 0.009 | 1.03 | 0.04 | NA | NA | <.005 | <.005 | 0.014 | 0.111 | | 0.005 |
| MANAVGAT CREEK<br>LAST BRIDGE | 4<br>1 | 3.806 | 1.2 | NA | 0.22 | 0 | 0.20 | 0 | 70 | 23 | 0.005 | 0.005 | 0.008 | 0.005 | 8 | <.005 |
| BUYUK MENDERES<br>SOKE MILAS BRIDGE | 3<br>1 | 0.777 | 10.5 | 37.3 | 0.33 | 0.005 | 0.75 | 0.07 | 1500 | 200 | NA | NA | 0.015 | 0.024 | 46 | 0.005 |
| GEDIZ RIVER<br>MENEMEN BRIDGE | 6<br>2 | 0.338 | NA | <20 | 0.005 | 0.013 | 1.18 | 0.14 | NA | NA | 0.05 | 0.007 | 0.019 | 0.025 | 26 | <.005 |
| MERIC RIVER<br>ENEZII | 6<br>2 | 2.093 | 4.8 | NA | 0.62 | 0.009 | 2.3 | 0.52 | 0 | NA | 0 | 0 | NA | NA | - | - |

1996 Values of parameters measured.

Table 6

Assessment of Mediterranean priority Hot Spots in Turkey

| Name | Main Cities | Type | Public Health | Drinking Water Quality | Aquatic Life | Recreation | Other beneficial use | Welfare and economy | | Category | Nature of investment | | Preliminary estimated financial requirement (in US$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ICEL | Mersin | Mixed | 6 | 3 | 6 | 6 | 4 | 5 | | B | SW (including medical wastes) +WWTP | | Feasibilities have been completed for both SW and WWTP, SW 40 million+ WWTP 50 million |
| | Erdemli (coastal area strip which includes 12 municipalities and Erdemli) | Mixed | 6 | 3 | 6 | 6 | 4 | 5 | | B | SW+WWTP | | SW 10 million+ WWTP 122 million. Feasibility studies have been completed for both solid waste and Waste water |
| | Silifke | Domestic | 3 | 4 | 4 | 3 | 3 | 4 | | C | SW+WWTP | | SW 2 million : WWTP is under construction |
| | Tarsus | Domestic | 5 | 4 | 5 | 3 | 4 | 5 | | B | SW | | SW 14 million |
| ANTALYA | Antalya | domestic | 5 | 5 | 6 | 4 | 3 | 6 | | B | SW +WWTP | | * Submitted to World Bank for financing |
| | Alanya | Domestic | 3 | 1 | 3 | 6 | 5 | 3 | | C | SW | | SW 12 million |
| | Side | Domestic | 3 | 1 | 3 | 6 | 4 | 2 | | C | SW+WWTP | | SW 1.8 million+ network is completed, WWTP is near completion. |
| | Manavgat | Domestic | 3 | 1 | 3 | 6 | 5 | 3 | | C | SW | | SW 3.6 million |
| ADANA | Adana | Mixed | 5 | 4 | 4 | 5 | 4 | 5 | | B | SW (including medical waste) | | Feasibility is completed SW 48 million |
| | Ceyhan | Domestic | 3 | 4 | 3 | 2 | 4 | 5 | | C | SW+WWTP | | SW 6 million : WWTP 25 million |
| ANTAKYA | Antakya | Domestic | 5 | 4 | 5 | 4 | 3 | 4 | | B | SW | | SW 8.5 million |
| | Iskenderun | Domestic | 5 | 2 | 5 | 5 | 3 | 4 | | C | SW | | SW 9.2 million |
| | Dortyol | Domestic | 5 | 4 | 5 | 4 | 3 | 4 | | B | SW+WWTP | | SW 9.2 million : WWTP 13 million |
| | Kirikhan | Domestic | 5 | 4 | 5 | 4 | 3 | 4 | | B | SW+WWTP | | SW 5.4 million : WWTP 25 million |
| MUGLA | Bodrum | Domestic | 3 | 2 | 3 | 6 | 5 | 3 | | C | SW | | SW 1.9 million |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Marmaris | Domestic | 3 | 2 | 3 | 6 | 5 | 3 | | C | SW (landfill side is completed) +WWTP | | Network is completed. Finance has been obtained from WB |
| | Datca | | 2 | 2 | 3 | 6 | 5 | 2 | | C | SW+WWTP | | SW 0.5 million : WWTP 13 million is under construction |
| IZMIR | Foca | Domestic | 3 | 2 | 3 | 6 | 5 | 3 | | C | WWTP | | WWTP 18.8 million. Feasibility is completed |
| | Cesme-Alacatı | Domestic | 5 | 4 | 5 | 4 | 3 | 4 | | B | SW+WWTP | | SW 5 million, WWTP 8 million, |

* No estimation was provided
* SW : Solid Wastes

Table 7

Preliminary estimated financial requirement

| NAME | MAIN CITIES | POPULATION | SOLID WASTE | WASTEWATER |
|---|---|---|---|---|
| ICEL | Mersin | 653,662 | 40 million US$ (feasibility is completed), solid waste including medical wastes | 50 million WWTP, Feasibility study is completed. For financial support, application has been made to EIB. |
| | Erdemli (Coastal Area Strip which includes 12 municipalities and Erdemli) | 118,528 | 10 million US$, (feasibility is completed) | 122 million US$, feasibility study is completed. |
| | Silifke | 168,528 | 4 million US$ | WWTP is under construction by Iller Bank |
| | Tarsus | 306,433 | 14 million US$ (feasibility study has been prepared. Financing is needed) | Financial support provided by German Government |
| ANTALYA | Antalya | 606,896 | Submitted to World Bank for financing | Submitted to World Bank for financing. Network is under construction by İller Bank |
| | Alanya | 235,884 | 12 million US$ (feasibility study is completed) | First Network and treatment plant are completed in the city centre. Second network and sea discharges are under construction by İller Bank. |
| | Side | 30,087 | 1.8 million US$ | network and treatment plant are completed |
| | Manavgat | 174,354 | 3.6 million US$ | Treatment system is completed |
| ADANA | Adana | 1,185,043 | 48 million USD, the feasibility studies is completed by JICA | Network is completed. for foreign credit financing is obtained from EIB |
| | Ceyhan | 157,050 | 6 million US$ | Network and treatment plant are under construction by İller Bank, 15 million US$ |
| ANTAKYA | Antakya | 313,371 | 8.5 million US$ | Treatment plants is completed by Iller Bank |
| | Iskenderun | 276,238 | 9.2 million US$ . A common solid waste landfill area is envisaged for İskenderun and Dörtyol) | Foreign credit has been obtained from a commercial bank |
| | Dortyol | 121,098 | 9.2 million US$ . A common solid waste landfill area is envisaged for İskenderun and Dörtyol) | Feasibility is completed. Network and treatment plant are in the investment programme-2001 of İller Bank. 13 million US$ |

| | | | | |
|---|---|---|---|---|
| | Kirikhan | 118,524 | 5.4 million US$ | Feasibility is being prepared by İller Bank. 25 million US$ |
| MUGLA | Bodrum | 75,994 | 1.9 million US$ (pre-feasibility is completed) | First network is completed. Second network is under construction. Treatment plant for the city centre has been done by the Ministry of Tourism. Network+ treatment+ Sea disposal system are in the investment programme-2001 of İller Bank. 10 million USD |
| | Marmaris | 58,925 | Solid waste disposal site is constructed | Network is completed. Treatment plant is under construction by finance from WB |
| | Datca | 11,802 | 0.5 million US$ | 3 million US$. Network and WWTP are under construction. it is in the investment Programme-2001 of Iller Bank) |
| IZMIR | Foca | 33,061 | -- | 18.8 million USD. Feasibility is completed |
| | Cesme-Alacatı | 32,709 | 5 million US$. | 8 million US$. |