

Foreword

While substantial improvements in controlling pollution of the Mediterranean sea from domestic and industrial effluent discharges have been made during the last decade, the situation is still a cause of concern. Places of natural and/or of cultural beauty are threatened by pollution that represents a risk for deterioration and may become pollution hot spots. The risk will decrease and eventually disappear if protective measures are applied. The pollution sensitive areas represent an issue that needs to be taken care of, and their national ranking would provide the countries with certain criteria in order to prioritise their action.

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 was given the responsibility for collecting, analysis 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 to address pollution from land-based activities.

In order to fulfil the needs for identification and, in particular the prioritisation, a ranking system was developed to show the severity of each of the effects on the identified sensitive areas. All countries agreed that a list of pollution sensitive areas should be prepared for each country. Such a list for hot spots and sensitive areas was prepared for every country (see MAP Technical Reports Series No. 124), also including an indication of the costs for rehabilitation activities, but did not take fully into account the specificity of the pollution hot spots and sensitive areas.

Following the decision of the Contracting Parties in their ordinary meeting of 2001 in Monaco, to update the lists of pollution hot spots and sensitive areas, there was a need to finalize the already completed list and to facilitate the preparation of a national prioritisation list by using common criteria for the classification of the pollution hot spots and sensitive areas.

In order to also consider the above specificities, the criteria for pollution sensitive areas have been revised and agreed by the MED POL National Coordinators.

This document includes information on national pollution sensitive areas in the Mediterranean and their prioritization in order to apply adequate measures for their protection. It also includes some data from the 1997 survey, as some of the countries did not succeed to update the national reports, therefore old and new data coexist in order to complete the picture.

In addition, no information has been submitted from France, Israel and Libya. Those countries that have not provided any data for 2002 are kindly invited to send their inputs related to the national pollution sensitive areas as soon as possible.

CRITERIA FOR THE EVALUATION OF POLLUTION SENSITIVE AREAS IN THE MEDITERRANEAN COUNTRIES

1. INTRODUCTION

This part has been prepared in order to establish a series of criteria and to develop a ranking system for the evaluation of the pollution sensitive areas in the Mediterranean Sea. The ranking system should be capable to describe the pollution effects and their severity on the sensitive areas, taking into consideration both the environment and human health. The identification and ranking of sensitive areas is included in the framework of the development of a 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. The evaluation refers to national level and the resulting ranking should provide a picture of prioritization inside each country, although the method will provide general information at regional (Mediterranean) level.

Sensitive areas of the Mediterranean basin are of great importance because of their potential capacity to become, if not protected, future pollution hot spots. If such a development takes place, sensitive areas will require huge investments for their rehabilitation, instead of very moderate ones for their actual protection.

In the document on the "Identification of Priority Pollution Hot Spots and Sensitive Area in the Mediterranean Sea" (UNEP, 1999. MAP technical Report Series No. 124), sensitive areas are defined:

"Estuaries and coastal waters of natural or socioeconomic value are considered sensitive areas if they are at higher risk to suffer negative impacts from human activities. Natural characteristics may determine the vulnerability of a coastal system, for example a bay with low flushing rates is more sensitive to pollution impacts than one, which is well flushed. Human activities determine the level of risk, hence planned development may increase the risk of environmental degradation. Both vulnerability and risk contribute to the sensitivity of a particular area or system in the context of this assessment".

It has to be clarified that sensitive areas are not protected areas of great ecological value. Sensitive areas are aquatic environments already polluted, which will become hot spots if no action is taken. Their "sensitivity" refers to their imminent environmental degradation.

2. CRITERIA FOR SENSITIVE AREAS

An area is sensitive because it has natural characteristics that allow pollutants accumulation (low assimilation capacity) or/and because its environmental quality may be severely degraded due to human activities at its vicinity. Therefore there are two major groups of criteria: (i) the pollution risk of the area and (ii) the natural characteristics of the area.

(i) Pollution Risk

Pollution risk depends on the vicinity of the sensitive area to land based intensive human pressures, or its geographical relation to drainage basins with important human activities. Intense human pressure includes industrial and urban threats, such as: industry, storage of potentially hazardous products, elevated concentration of human population due

to residential or touristic establishments, ports and marinas. Therefore pollution risk criteria may be:

- Existence of intensive human pressure (industrial or urban) at the vicinity of the sensitive area
- Existence of intensively cultivated land in the drainage basin of the sensitive area

Pollution risk can therefore be assessed using the same rationale used for the prioritization of land based hot spots. In that case the criteria were: (a) public health, (b) marine biodiversity and habitats, (c) fisheries and (d) recreation and tourism. However in the case of sensitive areas priorities are set for the receiving water body and not for the pollution source, as was the case in the prioritization of the land based pollution hot spots. Therefore it is more suitable to combine fisheries and recreation and tourism to a single “socioeconomic value” criterion, referring to the value of the sensitive area for income generation.

(ii) Natural characteristics

Natural characteristics of an area are the natural parameters that affect the pollutant's assimilation capacity of the water body. Such characteristics may be:

- Low flushing capability of the coastal area because of morphology of the coastline (lagoon, semi-enclosed bay, wetland) or the absence of currents
- Shallow water (small water volume)
- Estuary of drainage basin outflow
- Intensity of vertical mixing (stratification)

It has to be underlined that these two groups of criteria aim at different “sensitivities”.

The Pollution Risk group of criteria describes the potential for a serious environmental degradation of an area that is already influenced by anthropogenic activities. That area may be a bay or a coastal zone near important urban or industrial centres, which is already receiving pollutants. Because of the already existing contamination, any further input of pollutants may cause serious environmental degradation (rapid degradation of water quality, loss of ecological diversity or/and fisheries potential, etc.). These areas may not be of great ecological value but, nevertheless, they are of great importance for recreation and economic resources.

The Natural Characteristics group of criteria describes the inherent vulnerability of an area. It measures the stability of the environmental equilibrium in that area and describes the capability of the system to absorb environmental stresses. Estuaries, lagoons, wetlands, but also shallow semi-closed bays are among the marine environments that are not able to deal with pollution stress because of their limited capacity to assimilate pollutants. Most frequently those are areas with great ecological importance for marine or avian communities.

Both groups of criteria are of equal significance for the prioritization of sensitive areas. For methodological reasons two steps are to be considered. First the Pollution Risk criteria could be used to evaluate the severity of the already existing pollution in an area. Then by applying to these results the Natural Characteristics criteria the inherent fragility of the area will be highlighted, enhancing or reducing its potential “sensitivity”. This procedure will help us to identify the most sensitive areas under threat, in order to set priorities for the necessary actions. Also it will allow us to focus on the sensitive areas cases, which are in immediate danger if no action is taken, in order to set priorities for the protective actions to be undertaken.

Also, it has to be mentioned that there is a transboundary aspect to the prioritization of sensitive areas in the Mediterranean Sea. Such cases are mostly determined by the geographical location of the sensitive area, i.e. whether the sensitive area is at the borders between two (or more) countries and if the immediate drainage area of the sensitive area is divided between more countries.

The ranking system to be developed for the prioritization of the sensitive area in the Mediterranean Sea has to be able to give information on the severity of the various effects on the sensitive area using well established parameters. The pollution effects have to consider both the environmental quality and human health. Finally, the ranking system has to be based on easily accessible and already existing data. Although such data may not always be detailed enough to evaluate the sensitivity of an area, they are the best available information for a method that has to be used in different Mediterranean countries.

3. DEVELOPMENT OF CRITERIA

Two kinds of criteria are developed: the Pollution Risk criteria and the Natural Characteristic criteria. The final ranking of the sensitive areas will be made with the combination of both criteria groups.

3.1. Pollution Risk

The pollution risk can be described by evaluating the possible pollution impacts from pollution sources that may affect the sensitive area. Therefore the criteria can be similar to those developed for the hot spots prioritization. Therefore the following criteria are proposed:

- Public health
- Aquatic ecosystems
- Socioeconomic value

Public health: It is considered that public health could be affected through contaminated edible fish and shellfish, which could eventually transfer toxic compounds to the human food chain and affect human health. Also, human health can be affected by pathogens present in the seawater. The major pollutants related to this kind of risk are Persistent Toxic Substances (PTS), toxic heavy metals (HM) and pathogenic microorganisms (MO). Therefore the parameters for the public health criterion are the industrialization, the urbanization and the intensification of agriculture in the coastal zone (or the drainage basin) at the vicinity of the sensitive area.

Aquatic ecosystems: Aquatic ecosystems in the coastal areas are threatened by eutrophication, changes in the physicochemical characteristics of the water body (i.e. water transparency, dissolved oxygen concentration, etc.) and the introduction of persistent toxic compounds and metals. However, since the persistent toxic compounds impact has already been assessed in the previous criterion, the estimation includes the presence of nutrients (N and P) released from industrial and urban sources, as well as from the drainage of agricultural land. Also the organic load, which is entering the sensitive area, will be estimated taking into consideration the presence of urban population and relevant industrial or livestock sectors in the coastal zone.

Impact on fisheries is included in this criterion, since the degradation of the marine habitats will affect negatively the catches.

Socioeconomic value: This criterion includes all aspects of the socioeconomic identity of the sensitive area. It includes mainly tourism, recreation and cultural value, which are mostly affected by the degradation of the marine coastal environment appearance (solid

wastes, oil and tar). Therefore the parameters under consideration should be the presence of industrial, urban or harbor activities. Furthermore, the aesthetic degradation of the coastline, due to human uncontrolled activities (industrial or urban), should also be considered.

Criteria development

Semi-qualitative criteria will be used based on the presence or absence of specific activities in the coastal zone or the drainage basin. The degree of environmental impact will be measured on a scale of 0 – 3, where 0 is minimal impact 1 is intermediate impact and 3 is maximal impact. That scaling will give emphasis on the most degraded areas.

3.1.1. Public Health

For public health two groups of pollutants are used: Priority Pollutants (persistent toxic substances and heavy metals) and Pathogenic Microorganisms (MO).

a) Priority pollutants

Priority pollutants include organic and inorganic compounds and elements, which are persistent, toxic and liable to bioaccumulation in aquatic organisms. They include pesticides, industrial organic chemicals, toxic metals and metalloids, organometallic compounds and unwanted contaminants, which are mainly present in the waste streams and the runoff from industrial activities and intensively cultivated agricultural land.

Score 3: Existing and/or planned within the drainage basin at a distance that **may affect** the sensitive area of: industrial activities with effluents not conforming to the national emission standards for the Priority Pollutants; and/or intensive agricultural activities.

Score 1: Existing and/or planned within the drainage basin at a distance that **may affect** the sensitive area of: industrial activities with effluents conforming to the national emission standards for the Priority Pollutants; and/or no intensive agricultural activities.

Score 0: Minor industrial and agricultural activities.

b) Pathogens

Pathogens are mainly present in the urban effluents. Therefore urban areas are the main source that has to be assessed in order to estimate the potential threat for public health.

Score 3: Existing and/or planned within the drainage basin at a distance that **may affect** the sensitive area, of urban centers with total population ≥1,000,000, which do not operate Municipal Wastewater Treatment Plants.

Score 1: Existing and/or planned within the drainage basin at a distance that **may affect** the sensitive area, of urban centers with total population between 100,000 and 1,000,000, which do not operate Municipal Wastewater Treatment Plants.

Score 0: Existing and/or planned within the drainage basin, of human settlements with total population ≤ 100,000.

3.1.2. Aquatic ecosystem

For the effect on the aquatic ecosystem two groups of pollutants are used: Nutrients (nitrogen and phosphorus which are related to eutrophication) and organic matter (BOD). Both pollutants affect the characteristics of the marine ecosystem leading to serious degradation of the aquatic environment. Priority pollutants are also influencing the aquatic ecosystem. However these parameters have already been assessed when dealing with the Public Health criterion, and therefore will not be taken into consideration.

a) Nutrients

Nutrients (nitrogen and phosphorus) are mainly transferred to the marine coastal environment through surface runoff from intensively cultivated land. Also, urban effluents are rich in N and P, as well as the waste streams from specific industrial activities (i.e. fertilizer production, phosphoric acid production, food processing).

Score 3: Existing and/or planned within the drainage basin at a distance that **may affect** the sensitive area of: areas of intensive agricultural activities, and/or cities with a total population > 1,000,000, and/or industrial activities generating wastes not conforming to the national emission standards for N or P, and/or significant livestock activities (i.e. animal breeding, farming, aquaculture).

Score 1: Existing and/or planned within the drainage basin at a distance that **may affect** the sensitive area of: areas of semi-intensive agricultural activities, and/or cities with a total population between 100,000 and 1,000,000, and/or industrial activities generating wastes conforming to the national emission standards for N or P, and/or medium livestock activities (i.e. animal breeding, farming, aquaculture).

Score 0: No intensive agriculture in the drainage basin of the sensitive area, human settlements with a population < 100,000, cities of any size operating a tertiary treatment system (N and P removal), **no significant** industrial or livestock activity.

b) Organic matter

Organic matter is mainly present in the city effluents and the waste streams from specific industries. Therefore these are the main sources that have to be assessed in order to estimate the potential organic matter threat to the water receiving body.

Score 3: Existing and/or planned within the drainage basin at a distance that **may affect** the sensitive area of: cities with a total corresponding population* > 100,000, cities which don't possess a wastewater treatment plant and don't comply with the national standards for urban effluents and/or industrial or livestock activities generating wastes not complying with the national emission standards for organic matter (BOD, COD).

Score 1: Existing and/or planned within the drainage basin at a distance that **may affect** the sensitive area of: cities with a total corresponding population* between 10,000 and 100,000, cities which possess a wastewater treatment plant and comply with the national standards for urban effluents and/or industrial or livestock activities generating wastes complying with the national emission standards for organic matter.

Score 0: Human settlements with corresponding population* < 10,000, **no significant** industrial or livestock activities

* **Corresponding Population** takes into consideration the presence or not of Municipal Wastewater Treatment Plant (MWTP), supposing that the applied biological treatment removes 90% of the pollution load. Therefore, the corresponding population of a city with a population of 1,000,000 operating a MWRP is $1,000,000 \times 10\% = 100,000$, which is identical to a city of 100,000 population without a MWTP.

3.1.3. Socioeconomic value

Tourism is a major parameter in this criterion, along with other income generation activities in the sensitive area (fisheries). Cultural value is also another parameter that contributes to the socioeconomic values of the area. Since most pollutants have already been taken into consideration in the previous criteria, mainly the impact on the aesthetic value will be included in this criterion: presence of solid wastes, oil and tar in the coastal waters and the beach, and/or uncontrolled development.

a) Solid wastes, oil and tar

Score 3: Presence in the coastal zone of uncontrolled dumping sites serving a total permanent and/or seasonal population $\geq 100,000$, and/or important economic activities (i.e. harbors, hydrocarbon transfer facilities, services).

Score 1: Presence in the coastal zone of uncontrolled dumping sites serving a total permanent and/or seasonal population between 10,000 and 100,000, and/or moderate economic activities (i.e. harbors, hydrocarbon transfer facilities, services).

Score 0: Absence of uncontrolled dumping sites; minor economic activities.

b) Landscape degradation

Score 3: Presence in the coastal zone of uncontrolled and/or illegal urban /recreational /industrial development.

Score 1: Presence in the coastal zone of controlled and legal urban /recreational /industrial development.

Score 0: No important development in the coastal zone.

3.1.4. Weighting factors

The criteria developed so far are not equally important, therefore weighting factors are necessary to compensate for the differences in their importance.

Criteria	Weighting factor
Public Health	1.0
Aquatic ecosystem	0.8
Socioeconomic value	0.7

It was assumed that public health is always the first priority of any assessment. Then follows the protection of the aquatic ecosystem and finally the socioeconomic value. However, it has to be remembered that several aspects of the impact of pollutants on the aquatic ecosystems have already been included in the public health criteria (such

as the impact of heavy metals and persistent toxic substances). Similarly, the impact on fisheries (a socioeconomic criterion per se) has been included in the aquatic ecosystem criterion. Therefore, the weighting of the criteria seems to be well balanced.

3.2. Natural characteristics

A sensitive area is already an area with inherent problems to assimilate the incoming pollution load. It has probably a reduced water mass regeneration because of low flushing rate. However, not all of the sensitive areas have the same inherent “vulnerability”. Therefore, a weighting factor, the **vulnerability general weighting factor (VGWF)**, will be used for that purpose.

Vulnerability includes the following parameters: the flushing rate, how much enclosed is the water body, the mean depth, the mean slope of the sea floor. Also the aquatic ecosystem’s quality has to be assessed, as well as, the sensitive area’s proximity to protected areas because of their high biodiversity. It is understandable that this information may be qualitatively estimated, since more often it is not supported by specific quantitative data.

Table 1

Natural characteristics of the sensitive area and weighting factors

Natural characteristics	Vulnerability General Weighting Factor (VGWF)
Low flushing capability, and/or shallow water (mean depth < 10 m), and/or semi-enclosed bay, and/or lagoon, and/or wetland, and/or estuary, and/or mean slope < 1% for 2 miles from shore. Low intensity of vertical mixing (stratification)	3
High flushing capability, and/or deep water (mean depth >10 m), and/or open bay, and/or mean slope > 1 % for 2 miles from shore. High intensity of vertical mixing (stratification)	1

4. CONCLUSIONS

The formula, which is used for the ranking system for the Mediterranean sensitive areas, is the following:

$$[\text{Priority Pollutants} + \text{Pathogens}] \times 1.0 = \text{Public Health Score (PHS)}$$

$$[\text{Nutrients} + \text{Organic Matter}] \times 0.8 = \text{Aquatic Ecosystem Score (AES)}$$

$$[\text{Solid waste, oil and tar} + \text{Landscape degradation}] \times 0.7 = \text{Socioeconomic Value Score (SVS)}$$

In the sensitive areas evaluated, for every criterion (ex. Pathogens) a score is given from 0 to 3.

Then, the sum of the scores, is multiplied by the Vulnerability General Weighting Factor (VGWF) described in Chapter 3.2.

$$[\text{PHS} + \text{AES} + \text{SVS}] \times \text{VGWF} = \text{Overall Score of the sensitive area}$$

After the completion of the scoring, the scores are used to create a ranking for the sensitive areas of the Mediterranean Sea. According to their overall score, sensitive areas are classified in different categories based on the following rationale: If all criteria were given maximum values, then the absolute maximum Pollution Risk score would be 15. If the area has the highest Vulnerability General Weighting Factor (3) the Overall Score of the sensitive area will be $15 \times 3 = 45$, which is named **Maximum Overall Score**. On the other hand, if all criteria were given the minimum values the absolute minimum score would be 0 (zero). Therefore the possible scores will vary between 0 and 45. The sensitive areas with score above 75% of the maximum score (> 33.5) are classified as Category A; the sensitive areas with scores between 25% and 75% of the maximum score ($11.5 - 33.5$) are considered as Category B; and the sensitive areas with score below 25% of the maximum score (< 11.5) are considered as Category C. Apparently Category A sensitive areas are the more threatened by pollution and therefore immediate action is needed to avoid their transformation into hot spots. Category B sensitive areas are in a better situation than Category A, but need action to improve their environmental status. Category C sensitive areas are not under imminent threat but monitoring is needed to follow the trend of their environmental status. If a sensitive area has a score $< 10\%$ of the Maximum Overall Score (< 4.5), it is closer to a clean area than to a polluted one and National authorities could consider to remove it from the sensitive areas list.

Table 2

Scoring and categories of sensitive areas

Score	Categories	Recommendations
> 33.5	A	Needs immediate action in order not to become a hot spot
11.5 – 33.5	B	Needs action to improve the environmental status
< 11.5	C	Require regular monitoring

It has to be underlined that the sensitive areas prioritization, based on the scoring system above described, is made on a national level in order to provide the national authorities a tool to evaluate the urgency of the necessary actions in the different sensitive areas in the country. Scoring could also provide information on a regional basis, although a direct comparison of different sensitive areas between countries cannot be implemented.

Therefore the applied ranking system provides not only a prioritization of the threatened sensitive areas in the marine environment of the Mediterranean Sea, but also a tool to pinpoint the priorities for action. The areas with higher priority (Category A) are not only the more threatened because of existing pollution but also the more fragile for serious degradation in the near future. Furthermore, the scoring system can be used on other coastal environments (not included in the sensitive areas list) in order to identify new sensitive areas.

Finally, based on the sensitive areas scoring, the rehabilitation factors have to be considered, in order to prioritize the necessary action to be undertaken by countries in the Mediterranean region. These factors include (i) the funds needed for the implementation of activities for the protection of the area, and (ii) the application of better management.