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REPORT ON MARINE POLLUTION INDICATORS IN MEDITERRANEAN COUNTRIES

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TABLE OF CONTENTS

1. THE ROLE OF MEDPOL IN ADDRESSING MPIs

The pursuit of the Ecosystem Approach to Environmental Management and the Strategy for Sustainable Development through the integration of environmental and sustainability goals, require monitoring as a key tool for their formulation and implementation and rectification. Furthermore, the management of coastal ecosystems requires the evaluation of their ecological quality through indicator –based investigation and assessment at the biological community level that seems to be appropriate for describing the long term trends in anthropogenic stress impacting on the ecosystem (along with hydrological and chemical parameters of the water column). The establishment of "Sustainable Ecosystem Indicators" and "environmental monitoring" has been projected in the Mediterranean as a SMAP (The Short and Medium-term Priority Environmental Action Programme) objective which also focuses on both trade and environment issues. The proper development of an indicators framework makes the concept of sustainable ecosystem operational in terms of policy decisions and, in the case of detection of unsustainability, generates political pressure.

The European Water Framework Directive (WFD) which came into force in December 2000, emphasises on the assessment and where necessary the improvement of the Ecological Quality Status (EQS) of coastal and estuarine waters, Many other international initiatives and agreements also draw attention to the need for the assessment of the quality of marine environment e.g. the Ecological quality objectives (EcoQO). The required assessment of the ecological status will be based on suitable indicators that focus on the physico-chemical and hydromorphological characteristics as well as the different biological components of the ecosystem (e.g. plankton, benthos)

Halting the current biodiversity loss that threatens to undermine economic and social progress in Europe and worldwide, is a key priority to the EU.

In the Message from Malahide (the output of the stakeholder conference entitled 'Biodiversity and the EU – Sustaining Life, Sustaining Livelihoods' held under the Irish Presidency in Malahide, Ireland from 25th to 27th May 2004) the unprecedented level of consensus on this priority objectives was declared. Priority objectives and detailed targets to be achieved by 2010, have been designed to meet the EU commitment to '*halt the decline of biodiversity by 2010*'[1], and to optimise the EU contribution to the global commitment to '*the achievement by 2010 of a significant reduction in the current [2002] rate of loss of biological diversity*'[2] in a

[1] Presidency Conclusions, Goteborg Council, 15 and 16 June 2001. SN/200/1/01 REV1, page 8. http://ue.eu.int/newsroom/newmain.asp?lang=1
[2] Convention on Biological Diversity Decision VI/26 Annex (Strategic Plan) paragraph 11, http://www.biodiv.org/decisions/default.aspx?m=COP-06&id=7200&lg=0;

manner that ensures that 'resources are used as cost-effectively as possible'. The progress towards the 2010 commitments will be monitored through a first set of headline biodiversity indicators designated to this purpose.

Similarly the EU Thematic Strategy on the Protection and Conservation of the Marine Environment (Marine Strategy, adopted by the European Commission on 24 October 2005[3]) aims to achieve good environmental status of the EU's marine waters by 2021 and to protect the resource base upon which marine-related economic and social activities depend. The Marine Strategy will constitute the environmental pillar of the future maritime policy the European Commission, designed to achieve the full economic potential of oceans and seas in harmony with the marine environment. The regional Marine Strategies will contain a detailed assessment of the state of the environment, a definition of "good environmental status" at regional level and the establishment of clear environmental targets and monitoring programmes in consistency with the WFD. Thus, Member States will be required to develop an assessment of pressures and threats impacting upon the marine environment and regional environmental objectives along with indicators and monitoring measures to evaluate progress towards these objectives.

While indicators can contribute to negative EQS trends being detected and rectified, such environmental quality deterioration can be avoided from the beginning by prospective impact assessments. With regard to the vast impact of the Mediterranean Free Trade Zone (MFTZ) on all sectors of life and the environment in the Mediterranean region, a comprehensive indicator based MFTZ Impact Assessment has rightfully been called for. However, while the SMAP framework programme of action for the protection of the Mediterranean environment provides for an Environmental Impact Assessments, the MEDA Regional Strategy 2002-2006 (the principal financial instrument of the European Union for the implementation of the Euro-Mediterranean Partnership) rightfully refers to a more comprehensive *Sustainability* Impact Assessment (Ecologic, 2002). With view to what has been pointed out above, there is a documented and urgent need in the Mediterranean to enforce both sustainability indicators – including economic, social and environmental indicators – and the MFTZ Sustainability Impact Assessment.

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and World Summit for Sustainable Development, Plan of Implementation, Paragraph 44. http://www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/ POIToc.htm

[3] Communication from the Commission to the Council and the European Parliament "Thematic Strategy on the Protection and Conservation of the Marine Environment" COM(2005)504; Impact Assessment SEC(2005)1290; Proposal for a Directive of the European Parliament and of the Council establishing a Framework for Community Action in the field of Marine Environmental Policy (Marine Strategy Directive) COM(2005)505, 24 October 2005.

The Contracting Parties to the Barcelona Convention in their 12th Meeting in Monaco, November 2001, requested the MED POL Programme “To review and develop a set of marine pollution indicators, in cooperation with Blue Plan, EEA, UNIDO-ICS and other competent bodies and organizations” as a base for the development of MEDPOL reporting system. (UNEP/MAP 2003a). To this aim, MEDPOL first prepared a series of National Diagnostic Analysis (NDAs) as the first step in the preparation of a National Action Plan (NAP) integrated analysis to address the main issues related to LBS in coastal areas, including their environmental impacts. LBS of pollution. It is an (Overview of NDA’s. in EEA, 2006). That was followed by a process towards the development of the indicators that included the following steps:

a) Guidelines for the development of Ecological Status and Stress Reduction Indicators (UNEP/MAP 2003b)

b) Preparation of facts sheets for each of the proposed indicators (UNEP/MAP, 2004) and

c) An experts meeting (Athens 4-5 April 2005) (UNEP/MAP, 2005).

The Contracting parties to the Barcelona Convention at the National Coordinator meeting in Barcelona, 24-27 May 2005, adopted the Strategy for the Development of Mediterranean Marine Pollution Indicators (MPIs) to be considered as the basis for the preparation of marine environmental assessments in a manner which could facilitate the development of policy for the protection and conservation of the Mediterranean Sea and coastal areas. The feasibility to implement the MPIs proposed by UNEP/MAP (2003b and 2004), at a country level has been reported to UNEP/MAP by 14 countries.

2. SCOPE OF THE REPORT

The scope is to draw up a report on UNEP/MAP experience in the development of MPIs at regional revel, based on the capacities and data availability of the Contracting Parties to the Barcelona Convention as reported to UNEP/MAP.

The aim of the report is twofold

a) Critical analysis of the regional status of indicators together with identification of difficulties and barriers

b) Development of a country based action plan to address the identified difficulties and barriers and the role of MEDPOL in addressing these issues.

Bearing in mind that the ecosystem approach is integrating environmental concerns into all sectors and policies in the region in order to promote sustainable development, it is expected that the present report can serve as a base for:

- exchanges of views with the European Commission with a view to improving complementarity and synergies in the light of the European Marine Strategy
- the development of the MEDPOL reporting system.

3. METHODOLOGY /SOURCES

The current Synopsis Report is based primarily on the country tests on the feasibility of MPIS (Table 1). In the case where such reports were not available (e.g. Albania, Cyprus, Libya and Turkey) information was derived from National Diagnostic Analysis Reports (Table 1). Additional sources consulted in drawing the present report include: a) country reports on pollution host spots (e.g. Italy, UNEP/WHO, 2003]; b) The EEA /UNEP MAP report on priority issues in the Mediterranean (EEA, 2006); c) information gathered in the fact sheets (UNEP/MAP, 2004); and d) scattered literature. At a later stage, to supplement the information from the country tests, information was derived from 1) country questionnaires for eutrophication assessment [hereafter reported as "***Questionnaire***"**(**UNEP/MAP, 2007a.)**;** 2) results from UNEP/MAP, Eutrophication workshop Athens 5-6 February, 2007 (Pagou, 2007); 3) results of the MED GIG workshop Athens February 7-9, 2007 (MED-GIG, 2007). Finally personal contacts were used to ascertain the measurement of parameters in some cases (e.g. TRIX in Egypt, monitoring of bacterial loads in Greece etc).

Table 1: Sources of information on MPIs. For countries noted with asterisk, data were gathered from other sources. Scientific publications are included in the countries text (Chapter 5) Questionnaire is quoted only when used as a primary source of data and not as supplementary

Country	**Source of information**
Albania❖	NDA-Albania, 2003
Algeria	MPI-Algeria, 2006; UNEP/MAP, 2005 fact sheets; Questionnaire
Bosnia Herzegovina	MPI- Bosnia and Herzegovina, 2006
Croatia	MPI –Croatia, 2006; MED-GIG, 2007
Cyprus❖	NDA-Cyprus, 2003; fax to UNEP/MAP, MED-GIG, 2007; Questionnaire
Egypt	MPI – Egypt, 2006
France	MPI –France, 2006 MPI; MED-GIG, 2007
Greece	MPI – Greece, 2006; MED-GIG, 2007
Israel	MPI – Israel, 2006
Italy❖	UNEP/WHO, 2003; UNESCO/IOC, IMC, 2005; UNEP/MAP, 2007c; MED-GIG, 2007; Questionnaire
Lebanon	MPI – Lebanon, 2006
Libya❖	NDA-Libya, 2003
Malta	MPI – Malta, 2006; MED-GIG, 2007
Morocco	MPI-Morocco, 2006
Slovenia	MPI, Slovenia, 2006; MED-GIG, 2007
Spain	MPI – Spain, 2006; MED-GIG, 2007
Syria	MPI – Syria, 2006; UNESCO/IOC, IMC, 2005
Tunisia	MPI –Tunisia, 2006
Turkey MPI❖	NDA –Turkey, 2003; EEA, 2006; UNESCO/IOC, IMC, 2005; Questionnaire

The development or feasibility to develop indicators on a country basis was arbitrarily categorized in a scale ranging from 0(for data Non Existing and /or Non Available) to 3 fully developed indicators. In the third a further distinction was made. Thus

- 3^- was used when the indicator was almost fully developed (neither temporal scale nor trends were presented in the national report, but apparently exist)

- 3 for Indicator fully developed (data series exist according to national report and sometimes actually presented in the report)
- 3^+ in cases the Indicator is fully developed and used for EQS assessment.

From the approach followed, it is obvious that the assessment is biased on information the countries provided (MPI reports between 5 pages MPI- Bosnia and Herzegovina, 2006 and 104 pages - MPI- Spain, 2006), with no independent evaluation particularly in the cases where no data was provided on the development of some indicators. No information has been treated as no development of the indicator unless other sources of information could be traced. In any case zero development might have been the result of negligence, or lack of knowledge. As it was pointed out in the case of questionnaires [UNEP/MAP, 2007c] the subjectivity in country reporting can introduce an error in the whole evaluation process.

4. STATE OF ART PER INDICATOR

Based on the best available information, the following conclusions can be drawn (with a caution of bias) on the feasibility of development MPIs (in respect to the UNEP/MAP criteria [Box 1]

BOX 1: UNEP/MAP criteria for developing MPI's
Relevance to coastal zone,
Relevance to Barcelona Convention,
Relevance to LBS, Dumping and Hazardous Waste protocol,
Comparability of the data
Availability of QA/QC programmes /reference (background value)
Availability of adequate time series and reasonable spatial coverage

4.1. Chemical Indicators

Indicators related to the MEDPOL strategy for monitoring eutrophication (T, S, pH, DO, Transparency, Orthophospate, Silicate, Chlorophyll-a, Total N, Total P, Nitrate, Nitrite, Ammonium and chlorophyll-a appear to be in the best stage since they are the most 'measured' parameters in most monitoring programmes of Mediterranean countries. Their development has even reached a level where they are used in the countries Ecological Quality Assessment. Monitoring of heavy metals in biota and bacterial levels in bathing waters are also very well developed whereas the monitoring of organochlorines and even more so the monitoring of Petroleum hydrocarbons in water, are lagging. The limited monitoring on these parameters can be attributed to the fact that are not considered as primary threats to the marine environment of many countries (as in the case of hydrocarbons) and that there are inherent difficulties in their quantification (as in the case of

organochlorines). Finally more information was received on 'eutrophication indicators' as more sources were available [UNEP/MAP, 2007a and UNEP/MAP, 2007c).

Looking into Chemical MPIs in detail

A simple ranking exercise was carried out by adding the data availability scores (0,1, 2 and 3) we have assigned to each indicator based on the best information available. Bearing in mind that there are 19 countries the maximum score an indicator can get is 57 (= 19*3). The ranking of chemical MPIs is presented in Figure 1 - their 'scoring' in Table 2.

Hydrological parameters such as Temperature/Salinity and pH are the best-monitored parameters through out the Mediterranean. Almost all countries examined (73%, 63%) have programmes that fully cover data collection and analysis (a simple procedure) and posses data series adequate for implementing the indicator. The exception is 16% of the countries where no trends nor data series appear to exist (Albania, B&H and Libya) and 11% of the countries where they are partially developed (Syria and Spain) in the case of T/S. The respective percentages for pH are 16% (Albania, B&H and Libya) and 21% (Lebanon, Slovenia, Syria and Spain). However, the data availability is counterbalanced by the fact that these parameters are not regarded as primary ones for the determination of the environmental quality status (e.g. eutrophication), and have small affinity to the 'relevance' criteria (relevance to coastal zone Barcelona Convention and Protocols). Nevertheless in Egypt they are used in a matrix (with nutrients – see below) for the assessment of the Ecological Quality Status (EQS) of the marine environment. Salinity and temperature and pH per se is of little concern as far as protection of the coastal environment is concerned. No policy or management principles have been included in the Barcelona Convention and Protocols regarding discharges of high temperature or high salinity waters and are only relevant for monitoring effluent discharges.

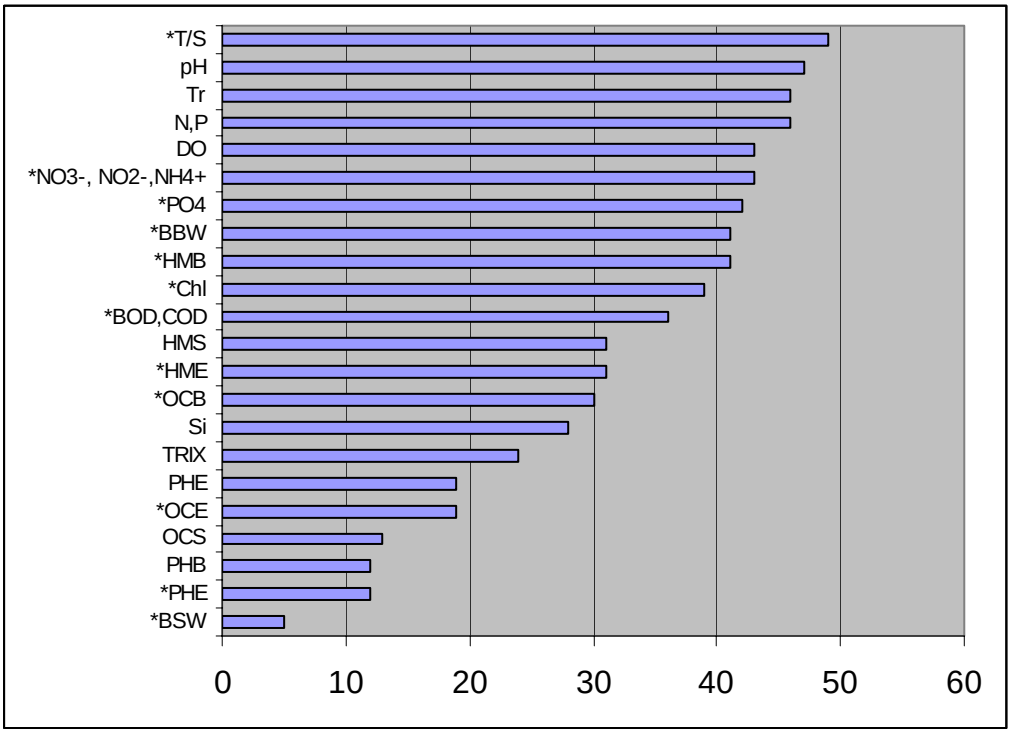

Figure 1. Ranking of indicators according to their level of development in Mediterranean

Note:
T/S = Temperature and Salinity
Tr = Transparency
N, P = Total N and Total P
NO3, NO2, NH4 = Nitrates, Nitrites and Ammonium
DO = Dissolved oxygen
PO4 = Orthophosphates
HMB = heavy metals in Biota
BBW = Bacteria in bathing waters
Chl = Chlorophyll a
BOD = Biological Oxygen Demand
HME: Heavy Metals in Effluent
HMS = Heavy metals in sediment
OCB = Organichlorines in Biota
Si = Orthosilicic acid
PHS = Petroleum Hydrocarbons in Sediment
OCE = Organochlorines in Effluent
OCS = Organochlorines in Sediment
PHB = Petroleum hydrocarbons in Biota
PHE = Petroleum hydrocarbons in Effluent
BSW = Bacteria in shellfish growing waters
* = parameters stipulated under the UNEP/MAP MPI Strategy

Table 2. Level of development per indicator expressed as number of countries

MPI		Number of counties developing MPI level of development			
		Well developed	**Partially developed**	**Poorly developed**	**No data available**
Nutrients	Total N, P	12	3	4	0
	NO_2,NO_3,NH4	12	2	3	2
	P -PO_4	12	2	2	3
	Si –SiO_4	8	2	0	9
	Chl –a	10	4	1	4
	BOD/COD	9	2	5	3
Hydrological	DO	11	4	2	2
	T & S	14	2	3	0
	pH	12	4	3	0
	Transparency	11	5	3	0
	TRIX	8	0	0	11
Heavy metals	Effluent	7	2	6	4
	Sediment	7	2	6	4
	Biota	12	1	3	3
Organochlorines	Effluent	3	3	4	9
	Sediment	3	1	2	13
	Biota	9	0	3	7
Petroleum hydrocarbons	Effluent	2	1	4	12
	Sediment	4	2	3	10
	Biota	3	1	1	14
Bacterial levels	Bathing water	12	1	3	3
	Shelfish growing area	1	1	0	17

The same significance with respect to data coverage applies for Transparency with 58% of the countries having fully developed that parameter within their monitoring programmes. 26% of the countries are partially developing the indicator (Lebanon, Slovenia, Spain, Syria and Tunisia) and 16% (Albania, B&H and Libya) has very poor data. However their importance as MPIs in terms of significance and affinity to the 'relevance' criteria is rather small for the same reasons as in the case of the rest of hydrological parameters described above.

Nutrients (primarily total Nitrogen and total Phosphorus), dissolved oxygen (DO) and the rest of nutrients: Nitrates/Nitrite/Ammonium, and Orthophosphate (in decreasing order) are 'scoring' a little lower values against the data availability criteria, with 63% the countries fully monitoring the parameters.

Some countries appear to have a somewhat lesser coverage. In the case of total N and P 16% of the countries (Greece, Lebanon and Spain) are partially monitoring and the rest 21 % poorly (Albania, B&H, Libya and Syria). In the case of DO the respective percentages are 21% (Lebanon, Spain, Syria and Turkey) and 11% (Albania and B&H) with an extra 11% (Cyprus and Libya) where no data exist/or have not been available. In the case of Nitrates/Nitrite/Ammonium the respective percentages are 11% (Spain and Turkey), 15%

(Albania, B&H and Syria) and 11% (Libya and Tunisia) respectively. Finally, for Orthophosphate, the percentages are: 11% (Spain and Turkey), 11 % (Albania and Syria) and 11% (B&H and Libya). It is interesting to notice the absence of monitoring of DO in Cyprus (as it is not regarded an issue of concern) and in Libya (where instead BOD appears to be monitored).

In general these indicators can be regarded not only as well developed but also implemented in EQS Assessments. The trophic state of the Greek coastal and marine waters has been ascertained based on the combination of the above criteria (and in conjunction with chlorophyll-a) and the same applies for Egypt (based on Total N and P values). This high level of development is important as nutrient in coastal and marine environment are considered suitable MPIs, for assessing the ecological quality of the environment and relevance to policy and management (Barcelona Convention and Protocols –LBS Protocol, Prevention and Emergency Protocol).

It is interesting that the rest on eutrophication related parameters, Chlorophyll-a and BOD/COD although a bit lower in the scoring scale (after hazardous substances: Heavy metals in biota and Bacterial levels in bating water, described below) with 53 % and 47% of the counties declaring the parameter as fully developed. The fact that these are is also at a significant level of development in the Mediterranean basin makes them important for eutrophication assessment and assessing the ecological quality of the environment in general (particularly chl-a) along with their relevance to policy and management (Barcelona Convention and Protocols) as the rest of the nutrient related indicators. The lower score attained for chlorophyll-a is attributed to the fact that in 21% of countries no data exist/or has not been available (B&H, Libya, Morocco and Syria), while it is poorly developed in 5 % (1/19:Albania), and partially developed in 21% of the cases (Lebanon, Slovenia, Spain and Turkey). The respective levels for BOD/COD were 16% (Egypt, Lebanon and Tunisia), 26% (5/17: Albania, B&H, Greece, Libya and Syria) and 11% (France and Slovenia) respectively.

The parameters not associated to eutrophication follow, namely hazardous substances. Monitoring of heavy metals in biota and of bacterial levels in bathing water are fully developed in 63% of the countries. In the case of heavy metals in biota the percentages of countries partially, poorly and where no data are existing /available are 5% (Turkey), 16% (Egypt, Lebanon and Syria) and 16% (Albania, B&H and Libya) respectively and in the case of bacteria 5% (1/19: Syria), 16% (Albania, B&H and Croatia) and 16% (Lebanon, Libya and Slovenia).

Once again this high level of development is important as heavy metals tend to bioaccumulate in biota hence they reflect the quality of the environment (and label the

suitability of edible marine resources), and bacterial level in bathing waters pose a serious and well document threat to human health. Both are regarded as suitable MPI indicators, (UNEP/MAP, 2005) with high relevance to policy and management (Barcelona Convention and Protocols – LBS Protocol, Prevention and Emergency Protocol) [8]. Specific management target exists in the case of bacterial levels but not in the case of heavy metals.

However concern has also been raised in the case of heavy metals over the issues of collaborating institutes (even within MEDPOL programme) and data comparability (common methodologies intercallibration, QA/QC). It is important to adapt common analytical and QA/QC procedures and methodologies for the scientific development of a relative indicator. Further work is also required in determining background / reference values in order to calculate the enrichment factor and thus to quantify the impact of the metals on the quality of the environment.

The other parameters stipulated under the UNEP/MAP MPI Strategy namely heavy metals in effluents, and organochlorines in biota are placed in the middle of the ranking scale whereas organochlorines in effluent, Hydrocarbons in effluent and bacterial level in shellfish growing waters are placed in the bottom of the scale.

Heavy metals in effluents, and organochlorines in biota are adequately monitored in Mediterranean with 36% and 47% of the countries having a fully developed set. Heavy metals in effluents are partially, poorly and where no data are existing available, developed in 11% (Cyprus and Spain), 32% (Albania, B&H, Croatia, Lebanon, Libya, and Syria) and 21% (Egypt, Italy, Slovenia, Tunisia) of countries respectively, and in the case of organochlorines in biota 0%, 16% (Albania, Malta and Syria) and 36% (B&H, Egypt, Lebanon, Libya, Slovenia, Tunisia and Turkey).

Organochlorines in effluent, Hydrocarbons in effluent and bacterial level in shellfish growing waters are poorly monitored in Mediterranean with just 16% (Algeria, France and Malta), 11% (Algeria and Turkey) and 5% (France) of the countries having a fully developed set. The percentage for organochlorine monitoring in effluents for partially, poorly and where no data are existing development in are 16% (Cyprus, Greece and Spain), 21% (Albania, Croatia, Israel and Syria)) and 47% for hydrocarbon monitoring 5% (Greece), 21% (Albania, Israel, Lebanon and Syria) and 63% respectively, and in the case of bacterial level in shellfish growing waters 5% (Syria), 0% and 90%.

Organochlorines being highly toxic persistent and bioaccumulative compounds and petroleum hydrocarbons with their significant impact in the form of a spill in marine areas, can have a significant impact on environmental quality affecting all aspects of marine ecosystem and are regarded as suitable MPI indicators (UNEP/MAP, 2005) with high

relevance to policy and management (Barcelona Convention and Protocols –LBS Protocol, Prevention and Emergency Protocol) [8], but no specific management target exists. The same applies for heavy metal in effluents and bacterial levels in shellfish growing areas as described previously.

For these reasons the poor state of development of the Organochlorines in effluent, Hydrocarbons in effluent and bacterial level in shellfish growing waters and the average of heavy metals in effluents, and organochlorines in biota should be developed further as the availability of data does not fully support their development in PanMediterranean scale. The concern described above for heavy metals on data comparability, standardisation of methods and QA/QC intercalicartion apply also in the case of organochlorines. In their case in particular it should be emphasised that despite their importance as hazardous substances in the marine environment their quantification remains very difficult.

Issues of concern

An interesting points from this **ranking exercise** is the scoring of parameters not in the MEDPOL Strategy set which in some cases surpassed that of those 'endorsed' in the set e.g. TRIX and Heavy metals in sediment reflecting the importance of these parameters for the countries in the area and thus their inclusion in their monitoring programmes.

TRIX The case of TRIX is very interesting bringing forward the need for integrated indexes instead of several single index. Its lower score bears the peculiarity that its either present and applied (47% of the countries) or not applied at all (53% of the countries) as it still not endorsed. The Index has been evaluated by data collected in a number of pilot programmes form Slovenia, Turkey, Greece and Italy towards the Eutrophication Assessment Report (2007). Results in all cases have proven the efficacy of the indicator (based on the collected data) in assessing the environmental quality status of the areas [3] although there is still debate on its endorsement as indicators (based primarily on the scientific merits)[4]

4.2. Biological effects

The use of biomarkers is relatively new when compared to traditional chemical monitoring. Even today in developed nations those biomarkers which are considered well understood often still lack historic track records and simple data management adequate for routine risk assessment and monitoring. For example in France, the programs corresponding to a strategy of inspection network are not for the moment operational. Furthermore, despite the important principle underlying the biomarker concept, that is, response should lead to

ecological effects, there are still few examples where biomarker measurements have been directly linked to community level responses.

Historical data in field application of biomarkers are rare. Unlike other European areas, where a number of field programs have been established, either at national or regional level (Conventions) and several biomarkers are applied for the measurement of the environmental condition, biomarkers in the Mediterranean are little studied. Some results were produced the last twenty years through individual research projects national or international programs in marine waters (BIOMAR, BEEP, IOC-IMO-UNEP funded programme of Global Investigation of Pollution of the Marine Environment). These relate to the design and validation of practical approaches and are mostly derived from laboratory experiments. So, it is unlikely that sufficient data will be submitted to the MEDPOL database.

Looking into biomarkers in detail

Results of the ranking exercise for the feasibility of using indicators on biological effects are presented in Figure 2 and Table 3. As in the exercise for chemical indicators, each indicator was scored (0, 1, 2 and 3) according to data availability/feasibility of using biomarkers. Bearing in mind that Italy has made significant progress but no report was delivered, the figures are based there are 18 countries, the maximum score an indicator can get is 54 (18*3).

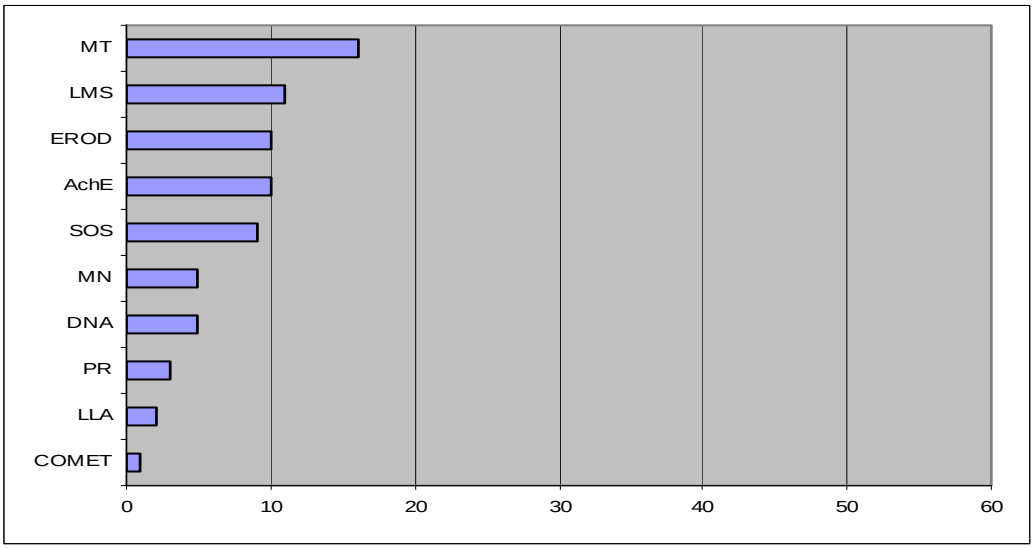

Figure 2. Ranking of indicators according to their level of development in Mediterranean (results from 18 countries)

Note:
MT = Metallothionein in mollusc cells
LMS = Lysosomal membrane stability in mollusc cells
EROD = Hepatic ethoxyresorufin-O-deethylase activity
AchE = Acetycholinesterase activity in mollusc cell

SOS= Stress on stress (survival in air) in molluscs
MN = Frequency of micronuclei in mollusc cells
DNA = DNA damage in Mollusc and fish cells
PR = Peroxisome proliferation
LLA = Lipofuscin lysosomal accumulation in mollusc cells
COMET assay, rate of unwinding

Table 3. Level of development per indicator (for 18 countries, Italy excluded)

MPI	level of development			
	Well developed	**Partially developed**	**Poorly developed**	**No data available**
MT	2	5	0	11
LMS	3	1	0	14
AchE	0	5	0	13
SOS	3	0	0	15
EROD	1	3	1	13
MN	1	1	1	15
DNA	1	2	1	14
PR	0	1	1	16
LLA	0	1	0	17
COMET	0	0	1	17

Metallothionein in mollusc cells appears to be the best monitored of the biomarkers indicator, however only 11% (Spain and Tunisia) of the countries have developed it at a full scale. The indicator is partially developed in 28% of the countries (Croatia, France, Greece, Israel and Slovenia) while no information exist on 11 countries.

Lysosomal membrane stability in mollusc cells, that follows in the ranking is fully developed in 17% (Greece, Spain and Tunisia) and partially developed in 6% (Croatia).

EROD activity appears to be fully developed in Slovenia (many laboratories tests and field studies in more than 180 fish species confirmed EROD activity as a sensitive and reliable biomarker). Partially or elementary developed in 17% (Croatia, Israel and Spain) and 6% (Syria) of the countries respectively. No information on 13 countries

Acetycholinesterase activity in mollusc cell is not fully developed in any of the countries but is partially developed in 28% (France, Greece, Israel, Morocco and Spain). For the rest 13 countries no data on the indicator was presented in the reports and/or traced in the literature.

Stress on stress (survival in air) in molluscs is fully developed in 17% (Croatia, Greece and Tunisia) but no data available/existing on the rest 15 countries. However, SOS does not seem to bring of relevant information on the quality of water, taking into account the robustness of the species used (moulds).

None of the indicators on genotoxicity is fully developed and/or applied. Different countries have applied different methods with Spain, Israel, Greece and Croatia having made more progress (for details see Synopsis table). For example COMET was developed and applied to the Qishon River and Haifa Bay environment (northern shore) Israel.

The frequency of micronuclei is an extremely heavy indicator to implement in routine, taking into account the difficulty and time necessary to the reading of the plates. This technique is not easily realizable on a significant number of stations.

Issues of concern

- The use of biomarkers on fish poses a major problem for fish species, which are not sedentary. Even when the target species are sedentary, it is complicated to harmonize the data acquisition on the same species and identical classes of sizes This point induces necessarily a skew in the interpretation and the comparability of the results.
- The lack of reference materials for majority of the biomarkers proposed as MPIs makes it difficult to develop a national/international quality assurance system for data.
- Lack of long term data does not allow any conclusion on trends. It is fundamental to keep the biomonitoring Programme unchanged for a fixed period of time
- According to MPI-Israel (2006) report “The use of biomarkers should not be limited to the individual MPI cited in the Fact Sheets. The state of the art in the use of biomarkers as MPIs is based on a holistic approach of gene product biomarkers, namely pollution affected genes which are expressed as proteins or transcripts. This method was developed for use in Israel in the liver of the fish Lithognathus mormyrus but has not been applied in the field yet. Transcripts are evaluated by real time PCR and the available biomarker genes are: Cytochrome P4501A, metallothionein, vitellogenin, choriogenin and PGP”.

New tools for data management include the assessment of a pollution level Index based on a minimum (5) of biomarker of exposure. This Index procedure appeared to be particularly adequate for monitoring trends in low or moderately polluted sites but produced false negative results in heavily polluted areas such as hot spots. An integrated approach by setting an Expert System, that considers both biomarkers of exposure and toxic effects measured at different levels (from genes to tissues) may constitute a general methodology for multimarker data management in hot spots areas and sites along pollution gradients.

4.3. Ecological indicators

Benthic communities (phytobenthos, zoobenthos) have been used for almost a century as indicators of environmental health and proved to be a useful element in order to describe the

ecological status of a given geographical area. These communities which are rich in species that are predominantly stationary and relatively long-lived mirror quite accurately the degree of disturbance and thus are frequently used in Environmental Impact Assessment (EIA) studies. A large number of concepts and numerical techniques have been developed for the proper interpretation of data.

The number of benthic species (S) and **community diversity index H** have been widely used and tested in different marine environments along the Mediterranean. However, the data available comes from Regional networks, research Projects, Studies and Environmental Reports related to activities that may have impact on the Marine Environment. Most of the generated data is gathered in specific reports for each case and a general database does not exist neither at national nor at regional level.

The MPI country reports do not provide sufficient data on the implementation biotic indices due to the lack of data. However, considering their importance towards the implementation of the WFD, a dedicated group undertook the task to test their applicability in EU countries by performing an intercalibration exercise. The Mediterranean Geographic Intercalibration Group (MED-GIG), in operation since 2004, consists of national representatives from Cyprus, France, Greece, Italy and Spain while Slovenia and Croatia are observers. Some MS have identified existing reference sites/conditions, others consider virtual reference conditions.

According to the latest workshop (MED-GIG, 2007), there is a large amount of data but not for all biological quality elements and all countries. The most promising quality elements appear to be macroalgae and angiosperms. Finally there is a need to consider different sub-regions within the Mediterranean and differences in the reference values for different habitats (e.g. muddy/sandy bottoms).

Looking into Ecological MPIs in detail

A simple ranking exercise was carried out by adding the data availability scores (0, 1, 2 and 3) we have assigned to each indicator based on the best information available (Figure 3, Table 4). Considering the development of indicators in MS (MED-GIG, 2007) similar in principle to those proposed by UNEP/MAP (2004), the ranking is based on the combination of similar indices used.

Number of species (S) and **Community diversity (H).** It appears that France, Greece, Italy and Cyprus are the countries having developed them almost at a full scale. In 10 countries (42%) the indicator is partially developed and in Morocco and Tunisia poorly developed. No data exist/or have not been available for Albania, B&H and Libya.

The values of S and H are influenced by sample size, sampling methodology and identification procedures. Moreover, differences in granulometry recorded in the various French maritime areas influence greatly the diversity of the species, and can thus distort the application of certain indices (MPI-France, 2006). Species diversity values can only be compared if the same sampling methodology has been followed with equal efforts of taxonomic scrutiny. France considers the index H' as overall most interesting for the French coasts, but not applicable to the lagoons. Furthermore it is noteworthy that the Shannon-Wiener Diversity index for Zoobenthos fails to detect slight disturbance in cases of ecotonal transitional zones where the number of species is fairly high combined with significantly high densities of opportunistic species (UNEP, 2005).

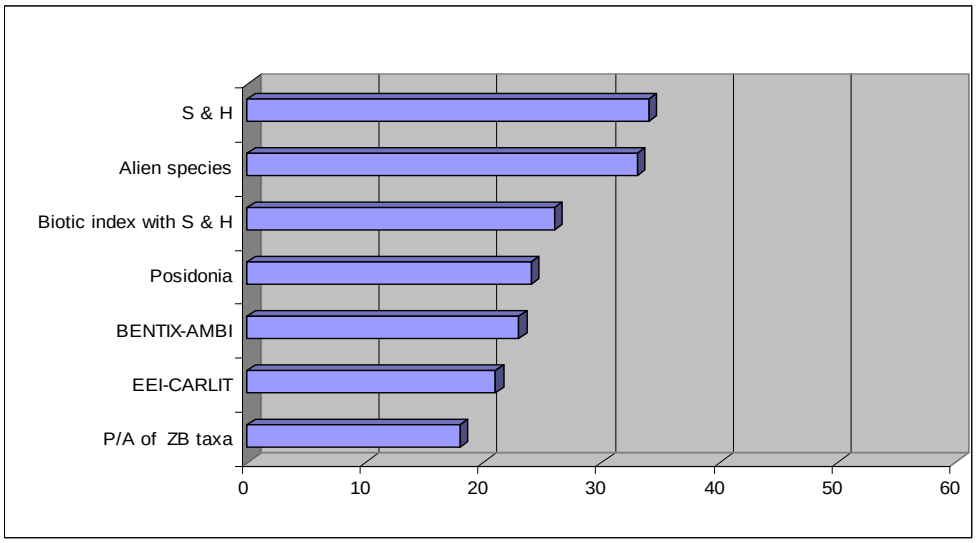

Figure 3. Ranking of indicators according to their level of development in Mediterreanean

Note:
S & H = Number of species S and community diversity index H
Alien Species
Biotic Index with S & H: Combination S, H, BENTIX / mAMBI
Posidonia: Presence and abundance/ coverage of phytobenthos (*Posidonia*)
P/A ZB = Presence and abundance of zoobenthos sensitive/opportunistic taxa
BENTIX/AMBI = Biotic indices based on zoobenthos
EEI /BENTOS-CARLIT= Biotic Index based on phytobenthos

Table 4. Level of development per indicator

	Number of counties developing MPI			
MPI	**Well developed**	**Partially developed**	**Poorly developed**	**No data available**
S & H	4	10	2	3
Aliens	5	7	4	3
Biotic index with S & H	7	1	3	8
Posidonia	5	4	1	9
BENTIX-AMBI	6	1	3	9
EEI-BENTHOS-CARLIT	6	2	0	11
P/A ZB	2	5	2	10

Most of the countries noted the need to a) develop the S index by defining reference values of benthic species number for normal or undisturbed communities and b) develop further the H index by creating a reference range values at subregional/national scale. Only under these conditions trends or changes in species diversity can be investigated. In the lack of fully developed scales for S and H, they are often used as complementary to a biotic index (see below).

Alien species. There is no national or regional monitoring network running to accomplish this objective. When a new species is observed within the frameworks of other monitoring networks (e.g. *P. oceanica* networks, benthic communities networks) or specific research projects, results of such findings are used for publishing. As the number of alien species introduced into the Mediterranean is constantly increasing (EEA, 2006), scientific interest has been raised on the issue.

Alien species appears to one of the best ecological indicators, however available data pertaining to all taxonomic groups and covering sufficiently the country is available only Greece, Israel, Italy, Slovenia and Turkey. According to the Italian ministry of Environment "*Introduced species….are among the most important factors responsible for the extinction of many species in the world and partially in Italy*"(http://www.minambiente.it). Italy, though not an ICES member, reports regularly since 2000 on the new alien species, in the annual ICES/IMO/IOC meeting of WGBSV (www.ices.dk), while Greece, Israel and Spain have presented the state of art in a few meeting. However, many publications are found in the literature for new findings in Israel, Turkey, Greece and Slovenia. In 8 countries the indicator is partially developed, in 3 countries (Egypt, Malta, and Morocco) poorly studied, and no data exist/or have not been available for (Albania, Algeria, B&H).

Alien species is of high relevance to a) the Barcelona Convention; b) the Common Fisheries Policy CFP (introductions from aquaculture and accidentally introduced species with them);

c) to the Bern Convention on the Conservation of European Wildlife and Natural Habitats which offers specific advice to countries and international organizations on measures to combat the threat of bioinvasions; d) to the International Maritime Organization (IMO) Convention for the Control and Management of Ship's Ballast Water and Sediments; e) the WFD: work is in progress focusing on how to evaluate impact of alien species for the assessment of ecological status as well as on how to take them in account when setting Reference Conditions for biological Quality Elements (DG, Environment, 2007). Finally, the implementation of the EU Marine Strategy Directive, currently under development, should include measures to limit the spread of invasive alien species in European Seas.

BENTIX- AMBI-MEDOCC-mAMBI

Two different biotic Indices based on zoobenthos have been developed in the Mediterranean. The BENTIX (Simboura & Zenetos, 2002) mostly implemented in the eastern Mediterranean and the AMBI (Borja et al., 2000) successfully applied in Spain. BENTIX was described and tested in Greece, Spain, Italy, Turkey (Izmir, Edremit), [UNEP/MAP, 2005). A third one, MEDOCC, proposed by Spain was presented in the IV MED-GIG workshop (MEDI-GIG, 2007)[4]. As concluded by the UNESCO/IOC, IMC (2005) the best assessment of EQS is achieved by a combination of BENTIX or AMBI with H (community diversity) and S (number of species). Consequently, the AMBI index was developed as to include in the assessment S and H and the new version is m-AMBI.

Considering the results of the Intercalibration exercise (MED-GIG, 2007), the country reports and available literature, the combination of S, H, BENTIX, and m-AMBI is/can be: fully applicable as ecological indicator in 37% of the countries (Algeria, Cyprus, France, Greece, Italy, Slovenia and Spain); partially applied in Turkey and poorly applied in Tunisia, Malta and Syria. No data exist/or have not been available for Albania, B &H, Croatia, Egypt, Israel, Lebanon, Libya, and Morocco.

The above indices were criticized at the MPI reports as "*subjective based authors own experience. Further evaluation is needed with data sets from various Mediterranean areas and validation of results always combined with other metrics and chemical parameters if possible"* and *"as particularly sensitive to enrichments of organic matter*."

[4] *The MEDOCC index, presented in MED-GIG, 20007, is an adaptation to the Western Mediterranean area of the AMBI index developed for the Atlantic coast (Borja et al., 2000) based on sensitivity/tolerance of the species*. The MEDOCC index is able to detect organic enrichment following communities succession The main differences with the original AMBI method proposed by Borja et al. (2000) are the following: 1) Change in the categories of the ecological groups in some species. 2) Four ecological groups have been considered (instead of five in AMBI) and 3)change in the algorithm for the calculation of the index.

The Intercalibration exercise contacted by MED-GIG (results presented in table 5) revealed that there is no consensus between the EU countries. A constrain in the use of the aforementioned indices is that they are successful in coastal waters (not transitional) at a certain body type, that is soft bottoms at 30m depth (MED-GIG, 2007). And they are sensitive indeed to organic pollution. The development of this type of environmental tools requires

a) the consensus of scientists in the assignment of species to a particular ecological group.

b) definition of ranges per ecological class at a subregional level

c) definition of reference values at subregional level

d) definition of reference values for different habitats (e.g. muddy/sandy bottoms).

Table 5. The national methods that have been assessed in this intercalibration exercise (MED-GIG, 2007)

Member State	***Method***	***Status***
Cyprus	BENTIX	Finalized
France	Multimetric approach (AMBI, Shannon Diversity, BQI Trophic Index)	Under development
Greece	BENTIX	Finalized
Italy	m-AMBI with factor analysis BENTIX	Under development
Spain - Catalunya	MEDOCC	Finalized
Spain- Balearic Islands	MEDOCC	Finalized

EEI- BENTHOS/CARLIT

Due to lack of sufficient information from the MPI country reports, the country progress and development described here is based on the conclusions of last MED-GIG meeting (MED-GIG, 2007). Six different Mediterranean countries participated in the subgroup of macroalgae MEDGIG workshop. The intercalibration procedure was applied in the macroalgal communities of the upper infralittoral zone (3.5 to 0.2 m depth) of rocky coasts. Within MEDGIG intercalibration approach two methods EEI (developed by Greece) and CARLIT/BENTHOS[5] (developed by Spanish) were tested.

[5] A new biotic index for macroalgae is proposed for EQS in Spain the BENTOS/CARLIT index. This biotic index is included in the Catalonian control network of coastal benthiccommunities of rocky bottoms (CARLIT) and it is has been applied since 1999. The studied communities are the same than in the Catalonian BENTOS network, but in this case the grade of cover of the main species is assessed by visual methods. *For more details see* Arévalo et al., 2007

Table 6. Countries decisions for macroalgal methodologies (MED-GIG, 2007).

QE 3: Macroalgae	*Assessment Method*	*Status*
Cyprus	EEI	Finalized
France	CARLIT	Officially accepted
Greece	EEI	Finalized
Italy	CARLIT	Under consideration
Slovenia	EEI	Finalized
Spain	CARLIT/BENTHOS	Officially accepted

The intercalibration results are not very different at the good-high and the moderate-good boundaries. Some problems emerge at the moderate-low and low-poor boundaries, due to the presence of calcareous species (Corallinaceae) which have different “meaning” in the two methods. However, this problem is minimized when the procedure of intercalibration of a site is based on seasonal data (not intercalibration based on a single sample).

Between the Greek and Spanish methodology only EEI was successfully tested across Mediterranean coastal waters of Greece and Spain. These data confirmed that the EEI is very sensitive to nutrient concentrations index and therefore could be used in the WFD classification system within at least the Mediterranean Sea.

Besides the six EU countries, EEI has been tested successfully with data from Algeria (UNEP/MAP, 2004). Data availability has been confirmed also for Egypt [macrophytes from 32 sites are included in the EIMP database for the period 1999 & 2000: MPI-Egypt, 2006]. **In general these indicators can be regarded not only as well developed but also implemented in EQS Assessments.** Biotic indices based on macroalgae offer to water managers worldwide a tool for comparing, ranking and setting management priorities at different spatial levels without a demand for specialized knowledge in seaweed taxonomy.

The ecological role of specific species like *Corallina elongata* and its community will be further clarified.

Presence and abundance/ coverage of sensitive/ opportunistic species/ taxa phytobenthos

Among sensitive species of phytobenthos, the one most widely used as an indicator per se is the angiosperm *Posidonia oceanica*. As opposed to marine invertebrates, the choice of *Posidonia* is most promising. The species is widely distributed and well studied by most countries. Although no data exist/is available for 8 countries (Albania, B&H, Israel, Lebanon, Morocco, Slovenia, Tunisia and Turkey), data acquisition/availability is not a major problem for the implementation of the indicator. (see also table 7).

Different metrics have been proposed a) Abundance of **P***. oceanica* expressed as Shoot density and Leaf surface per shoot and b) use of descriptors of *Posidonia* quality, not only of its abundance POMI[6]

Reference conditions have been defined based on

- existing sites, where pristine areas are present (e.g.: PosWare)
- virtual sites, using the best existing values for each parameter (e.g. POMI)

However, reference conditions should be defined at sub-ecoregional level (see issues of concern).

Table 7. Countries decisions for *Posidonial* methodologies (MED-GIG, 2007).

QE: Posidonia	Data availability	Metrics	Classification
France	yes	Extended	yes
Greece	yes	Extended	In progress
Italy	yes	Extended	yes
Spain	yes	Extended	yes
Malta	yes	Extended	yes
Cyprus	no	-	-
Slovenia	no	-	-
Croatia	no	-	-

While the two basic metrics used in this intercalibration do not fully reflect the meadow status, they are commonly used and helpful to reach common understanding. It is strongly recommended to proceed with an international standardization of the corresponding methods, and to diffuse those methods to other Mediterranean countries (MED-GIG, 2007)

Presence and abundance/ coverage of sensitive /opportunistic species / taxa – zoobenthos

The countries where the Presence and abundance/ coverage of sensitive /opportunistic species / taxa of zoobenthos is well covered in terms of data availability are Italy and Spain. In 5 countries (Algeria, Israel, Malta, Morocco and Slovenia) the indicator has been at the development stage while in 2 countries some data exist and is occasionally reported. No information exist/ is available for 10 countries

Establishing a list of the most sensitive species in each community need to be defined and the reference values of their abundance

[6] The POMI index has been developed by members of the Department of Ecology, Faculty of Biology, University of Barcelona (Main researcher: Romero J. T: romero@porthos.bio.ub.es) and the Centre for Advanced Studies of Blanes (CEAB) (Main researcher: Alcoverro T.T: teresa@ceab.csic.es). This POMI Group advise to the Catalan Water Agency and the results obtained has allow to ACA to assess the coastal water status using the BQE *Posidonia oceanica*, which is fully coherent with data obtained through other BQE or with water quality data.

Issues of concern

The main problems highlighted in the MED-GIG (2007) meeting were the lack of data in the MS and comparability. According to the present report, a great amount of data does exist in the Mediterranean countries but never used in this direction, not even as a testing exercise.

Clear-cut standards or reference values have been only defined for *P. oceanica* seagrass. Reference values have to be defined and agreed among MEDPOL countries for all proposed MPI's. There is need to consider different sub-regions and differences in the reference values for different habitats (e.g. muddy/sandy bottoms, within each typology). Tentatively proposed subregions include: SE Spain, Catalunya, Balearic Islands, Languedoc-Roussillon, Provence-Alpes-Côte d'Azur, Corse, Italy (to be confirmed), Malta, Ionian, North Aegean, and South Aegean.

SYNOPSIS TABLE

Country	***Indicator***										
	Heavy metals			**Organochlorines**			**Petroleum hydrocarbons**			**Bacterial levels**	
	Effluent	*sediment*	*biota*	*effluent*	*sediment*	*biota*	*effluent*	*sediment*	*biota*	*Bathing water*	*Shellfish growing areas*
Albania❖	1	1	0	1	0	1	1	0	0	1	0
Algeria	3-	3-	3-	3-	3-	3-	3-	3-	3-	3-	0
Bosnia Herzegovina	1❖	0	0	0	0	0	0	0	0	1	0
Croatia	1❖	3	3	1❖	3	3	0	0	0	1❖	0
Cyprus❖	2	0	3-	0	0	3-	0	0	0	3-	0
Egypt	0	1	1	0	0	0	0	0	0	3+	0
France	3	1	3	3	1	3	0	1	2	3	3-
Greece	3-	3+	3+	2	2	3	2	2	0	3❖	2❖
Israel	3❖	2❖	3	1	0	3	1	0	0	3	0
Italy❖	0	3	3	0	3	3	0	3	3	3❖	0
Lebanon	1	1	1	0	0	0	0	0	0	0	0
Libya❖	1	1	0	0	0	0	1	0	0	0	0
Malta	3-	2-❖	3-	3-	0	1	0	1❖	0	3	0
Morocco	3-	3-	3-	0	0	3-	0	0	0	3-	0
Slovenia	0	3	3	0	0	0	0	3	3	0	0
Spain	2	0	3+	2	0	3+	0	0	0	3❖	0
Syria	1	1	1	1	1	1	1	1	1	2	0
Tunisia	0	3-	3-	0	0	0	0	3-	3-	3-	0
Turkey❖	3-	0	2	0	0	0	3-	2	0	3-	0

1= Indicator poorly developed (very limited temporal and /or spatial scale, no trends)

2= Indicator partially developed (limited temporal and /or spatial scale, and minimal trends)

3= Indicator almost fully developed (neither temporal scale nor trends presented in the national report, but apparently exist

3= Indicator fully developed (data series exist according to national report and sometimes actually presented in the report)

3+ = Indicator fully developed and used for EQS assessment ❖ = not from MPI report

Country	***Indicator***											
	Nutrients				*Chlorophyll*	*DO*	*TRIX*	*BOD,COD*	*T & S*	*pH*	*Transparency*	
	N, P	$N\text{-}NO_2$ $N\ NO_3$ $N\text{-}NH_4$	$P\text{-}PO_4$	$Si\text{-}SiO_4$								
Albania❖	1	1	1	0	1	1	0	1	1	1	1	
Algeria	3^-	3^-	3^-	3^-	3^-	3^-	0	3^-	3^-	3^-	3^-	
Bosnia Herzegovina	1	1	0	0	0	1	0	1	1	1	$1^❖$	
Croatia	3^+	3^-	3^-	3	3	3	3	3^-	3	3	3^-	
Cyprus❖	3	3	3	0	3	0	$3^{-❖}$	3	3	3	3	
Egypt	3^+	3^+	3^+	3^+	3^+	3^+	$3^{-❖}$	0	3^+	3^+	3^+	
France	3^-	3	3	3	3	3	0	2	3	3	3	
Greece	2	3^+	3^+	3	3^+	3	$3^❖$	1	3^-	3^-	$3^❖$	
Israel	3	3	3	3	3	3	0	3	3	3	3	
Italy❖	3^-	3^-	3^-	3^-	3^-	3^-	3^-	3^-	3^-	3^-	3^-	
Lebanon	2	3^-	3^-	0	2	2	0	0	3^-	2	2	
Libya❖	1	0	0	0	0	0	0	1	1	1	1	
Malta	3^-	3^-	3^-	0	3^-	3^-	0	3^-	3^-	3^-	3^-	
Morocco	3^-	3^-	3^-	0	0	3^-	0	3^-	3^-	3^-	3^-	
Slovenia	3	3	3^-	3^-	2	3	$3^❖$	3	3	$2^❖$	$2^❖$	
Spain	2	2	2	2	2	2	0	2	2	2	2	
Syria	1	1	1	0	0	2	0	1	$2^❖$	$2^❖$	$2^❖$	
Tunisia	3^-	0	0	0	3^-	3^-	$3^{-❖}$	0	3^-	3^-	$2^❖$	
Turkey❖	3^-	2	2	2	2	2	3	3^-	3	3	3	

BIOMARKERS

	Biomarkers of exposure	**Biomarkers of stress**	**Biomarkers of genotoxicity**
	EROD activity, *Metallothionein in mollusc cells* ***MT*** *Peroxisome proliferation* ***PR***	*Acetycholinesterase activity in mollusc cell* **AchE** *Lipofuscin lysosomal accumulation in mollusc cells* **LLA** Lysosomal membrane stability in mollusc cells **LMS** Stress on stress (survival in air) in molluscs **SOS**	Frequency of micronuclei in mollusc cells ***MN*** **DNA** *damage in Mollusc and fish cells-* ***COMET*** *assay, rate of unwinding*
Albania❖			
Algeria	1: Indicators non specified : laboratoire de la Faculté des Sciences, Département de Biologie Es Senia d'Oran, spatial coverage		
Boznia-Hergegovina	0: Biomarkers for B&H Sea. Neum municipalities, in the front of the biggest Neum hotels include only microbiological data related to the Bathing water Directive		
Croatia	3: multixenobitoic resistance (MXR), EROD, MT	3: toxicity (Tox – Microtox assay), genotoxicity (Gtox – SOS/umu test) and mutagenicity (Mtgn – Ames test	3: DNA integrity (DNAx).
Cyprus❖	0	0	0
Egypt	0: Data which have been collected are only related to the laboratory studies and not to the Egyptian Mediterranean aquatic environment		
France	2: *MT*	2: AChE	
Greece	2: *MT*	2*: LLA,* AChE 3: LMS, SOS	2: *MN*
Israel	2: EROD, MT Cytochrome P450 dependent monooxygenases	**2:** AChE in a few fish and molluskc from the northern and central shore.	**2** DNA or COMET Qishon River and Haifa Bay
Italy			
Lebanon	0	0	0
Libya❖			
Malta	1	0	1
Morocco	1: péroxydation lipidique	**2:** AChE	
Slovenia	2: MT, EROD suggested	0	0
Spain	3: MT 2: EROD 2: PR	1: AChE 2: LMS 0: SOS, LLA	1: MN 2: DNA
Syria	EROD, Cytochrome P450	0	0
Tunisia	3: MT	3: LMS,SOS	2: MN
Turkey❖			

ECOLOGICAL PARAMETERS

Countries	*Number of species **S** and community diversity index **(H)***	***BENTIX***	*EEI CARLIT*	*Combination S, H, BENTIX (ZB) m-AMBI EEI (PB)*	*Presence and abundance/ coverage of sensitive /opportunistic species / taxa zoobenthos*	*Presence and abundance/ coverage of sensitive /opportunistic species / taxa Phytobenthos*	*Alien species*
Albania❖							
Algeria	2	2	2:EEI	3	2	2 *Posidonia*	1
B & H*	0: Studies in Neum municipalities, in the front of the biggest Neum hotels include only microbiological data related to the Bathing water Directive						
Croatia	2	0	0	0	0	2:*C. taxifolia Posidonia*	2
Cyprus❖	3	3	3: EEI	3	0	2	2
Egypt	2		2		0	2	1❖
France	3	3: AMBI, BQI, BENTIX	3: CARLIT	3	1❖	3: *Posidonia*	3F*: PB 2: other
Greece	3	3	3: EEI	3	0	3 *Posidonia*, *Cystoseira*	3
Israel	2	0	0	0	2	0	3-❖
Italy	3	3 AMBI BENTIX	3: CARLIT	3 m-AMBI	3	3	3
Lebanon	2L*	0	0	0	0	0	2❖
Libya❖							
Malta	2	1		1	2	3: *Posidonia, Caulerpa*	1
Morocco	1❖	0	0	0	2		1❖
Slovenia	2	3: m-AMBI	3: EEI	3: m-AMBI	2		2
Spain	2	3:AMBI MEDOC	3: CARLIT/BENTHOS	3: m-AMBI	*3:maerl.sponges corals, cnidaria*	3: *POMI*	3❖: PP, PB 1-2: other groups
Syria	2	1: BENTIX	0	1	1: sponges, mammal, fish	1: *Posidonia*, *Cystoseira*	2 ❖
Tunisia	1	0	0	0	1❖		2
Turkey❖	2	2		2			3❖

2L*: indices applied in meiobenthos, 3F*: well known for phytobenthos from research in the framework of EU funded research programmes i.e ALIENS

5. CRITICAL ANALYSIS OF THE REGIONAL STATUS OF INDICATORS

ALBANIA

Since 1992, Albania is cooperating with UNEP/MAP under the MEDPOL program in compliance and trend monitoring of several environmental indicators related to Barcelona convention and Protocols, defined by common MoU and supported financially both by UNEP/MAP and Government of Albania.

Wastewaters are currently the main sources of pollution in the coastal area, along with leaching from urban solid wastes (industrial pollution is now active only in the industrial hot spots). The increased loads of nutrients in some areas of coastal waters, have caused increasing eutrophication. Monitoring of coastal waters is regarded as partial both in space and time and the development of indicators is at early stages. Parameter under partial monitoring according to NDA and questionnaires are the eutrophication related Nitrate, Nitrite, Ammonia, Total Nitrogen, Orthophosphate, Total phosphorous, chlorophyll a, Temperature, Salinity, Transparency and few hazardous substances: heavy metals in sediment and in water, organochlorines in biota and effluent and oil in water.

The problem of pollution in the marine environment is expected to become even more serious. A continuous monitoring and assessment of contaminants discharged in the environment should be in force under a legal framework, which should incorporate a strategic environmental assessment for avoiding long term negative impacts in the environment. Monitoring should follow the appropriate and internationally accepted methodologies and concentrate on the toxic elements released to the coastal waters from the “hot-spots”.

Although no report has been prepared, it has been possible to comment on the feasibility of MPIs against the set criteria based on the available information (see above). Particular issues of concern appear to be the comparability of the data and availability of QA/QC programmes where a minimal participation in quality assurance exercise has been ascertained (based on the questionnaires), and the availability of adequate time series and reasonable spatial coverage (according to both the NDA report and the questionnaires). From these it is obvious that the **development of MPIs is at early stages in Albania**.

ALGERIA

The feasibility of proposed MPIs in Algeria (MPI-Algeria, 2006) was performed using mainly the results from the MED POL national programme of continuous monitoring of the quality of marine

environment of Algeria for the year 2005. Within this framework monitoring and analysis of the designated chemical, biological indicators and biomarkers are carried out on the whole of the Algerian coast or at least in theory in the zones where anthropogenic pressure is exerted e.g. urban and industrial settlements and points of effluent water of their associated activities, beaches, and ports. Additional monitoring programmes are covering the rest of coastline.

Such monitoring is used for the implementation of the environmental policy whereby the quality of bathing water is ensured through vigorous sampling and analyses, inspections ascertain the efficacy of sewage treatment plants and Environmental Impact Assessment are carried out prior to the permission of starting a new enterprise. Nevertheless sewage (urban and industrial) treatment needs to be intensified further and a denser monitoring network should be put in place to assess their performance.

With regard to biomarkers, there is some data on spatial coverage, but the parameters measured are not specified in the report.

Ecological indicators for macrobenthic fauna, macroalgae & phanerogams are sufficiently covered (see case studies in UNEP/MAP, 2004, REBZANI-ZAHAF & BELLAN, 2006). Studies on bioinvasions are limited to phytobenthos (Gómez Garreta et al., 2001).

Monitoring of marine pollution through the use of the proposed chemical indicators appears to be well developed in Algeria, although the report only presents the 2005 status. Available data on biological indicators result from Ph.D theses and research projects of Université des Sciences et de la Technologie Houari Boumédiène (FSB/USTHB) and Institut des Sciences de la Mer et de l'Aménagement du Littoral (ISMAL). **However it is safe to assume that past data exist and the monitoring will continue in the future**.

BOSNIA AND HERZEGOVINA

According to the country's feasibility study (MPI-Bosnia & Hergegovina, 2006) a limited monitoring programme is in effect covering Neum tourist area (for chemical parameters covered and additional information see Table 2). Biomarkers are measured in Neum municipalities, in the front of the biggest Neum hotels but include only microbiological data related to the Bathing water Directive. There is no information on data for ecological indicators and no information on the temporal coverage of the indicators monitored. In fact there is no available data about pre-war or present analysis of Chemical Indicators.

However, as no database exists, chemical data are not analysed or processed in a comprehensive manner that could lead to a management plan or '*official conclusions*'. The early stages of developing the proposed indicators prohibits a systematic test of their feasibility as MPIs against the UNEP/MAP set criteria (as stated in the methodology).

CROATIA

Despite the fact that the development of MPIs had an early start (in early 70s at the beginning of MEDPOL Monitoring Programme) and the establishment of a **National Monitoring Programme** (late 80s), the formulation and implementation of a comprehensive monitoring programme in Croatia was delayed until the late 90s due to financial constrains. Since then a project was launched **('Adriatic'**) based on national and international monitoring and data collection activities (MPI-Croatia, 2006).

Under 'Adriatic' the monitoring of eutrophication is well established where basic nutrients (nitrogen, phosphorus, and silica) have been measured with a long time series. Following this long monitoring, the "TRIX" indicator has been developed and adopted for assessing eutrophication of the area. Similar long data series exist on monitoring heavy metals and chlorinated hydrocarbons in mussels and sediment. With the onset of the later stages of MEDPOL programme the rest of the physicochemical parameters are also monitored. (UNEP/ MAP, 2007a)

Biological data collected in the framework of Adriatic' include macroflora and macrofauna (qualitative and quantitative), as well as alien species (their introduction and excessive reproduction e.g. *Caulerpa taxifolia* expansion.) Besides the data derived in 'Adriatic", other sporadic data on alien species (De Min and Vio, 1997) and other ecological indicators, probably exist in scientific institutions as a part of research projects, but are not available at present.

With regard to biomarkers, frequency of sampling was sufficient and gives reliable data set to calculate MPIs for each year as well as for longer periods. Calculation of Tox, DNAx, EROD and Mtion give insight in spatial and temporal changes in marine environment while determination of Gtox, Mtgn and MXR allow detection of contamination incidents. Each MPI represent the quality of the environment itself and taking together give general insight in pollution load of contamination at particular sampling site, discrimination among sampling sites and detection of "hot spots".

Official national list of indicators in Croatia does not exist. Croatian Environment Agency (CEA)

has formed a board to establish the list, between others, for marine environment Monitoring of environmental health status based on MPIs allows data base creation and modelling that should serve as a fundament of qualitative national environmental management. This approach is recognized by governmental bodies especially national agency for environmental protection (CEA). Also the need to revise the sampling strategy has been identified. At present, due to lack of adequate financial support, and scientists intention is to concentrate efforts, in pilot project phase, on some important areas to test indicators chosen, particularly TRIX.

Croatia has recently joined the Mediterranean Geographical Intercalibration Group for intercalibration of ecological quality status indicators. It is to be expected that Croatia, **having qualified and experienced scientists, even lacking data for some areas, could generate national assessment report** on the basis of eutrophication indicators and experience in marine research.

CYPRUS

Although no report on the feasibility of MPIs has been prepared it is known that Cyprus is implementing the MEDPOL monitoring framework. Annual National Monitoring Programmes were undertaken the MED-POL Phase II and III, that provided data for the assessment of pollutants inputs into the marine environment and the assessment of the quality of coastal waters (UNEP/ MAP, 2007a; NDA, Cyprus, 2003).

Urban wastewater, pesticides and heavy metals pollution are not issues of concern for Cyprus, and organic loads (nutrients, suspended matter and BOD) are issues of only local concern. According to MEDPOL *Questionnnaire* (UNEP/MAP, 2007a) parameters regularly measured include temperature, salinity, DO, Chlorophyll –a, total N and P, nitrate, nitrite, ammonium and phosphate. PCBs pose a slight treat to the quality the marine environment.

As a result of these identified threats a regular monitoring programme has been set for the assessment of nitrate pollution, the identification of waters polluted or threatened by nitrate pollution from agriculture sources and the identification of vulnerable zones. Similarly the concentration pesticides and PCBs and heavy metals is monitored in fish but limited studies exist on the concentration of pesticides and heavy metals concentration in coastal waters.

Cyprus has recently joined the Mediterranean Geographical Intercalibration Group (MED-GIG) for intercalibration of ecological quality status indicators for the WFD. The first intercalibration exercise revealed that BENTIX compared with m-AMBI and H, produced successful results and

is suggested to be used for EcoQS at national level. (MED-GIG, 2007). EEI has also been tested with success, although there is some debate for its use in areas with high coverage by invasive alien species. (M. Argyrou, pers. Commun.). Studies on alien species have focused on a few taxa such as polychaeta (Çinar 2005), mollusca (Buzzurro & Greppi , 1997; Cecalupo & Quadri, 1994) and phytobenthos (many studies on *Caulerpa racemosa)*.

Although no report has been prepared it has been possible to deduce the feasibility of MPIs against the criteria especially on the issues of comparability of the data and availability of QA/QC programmes based on the questionnaires (QA/QC exercises should be extended to cover chlorophyll-a). Similarly the availability of adequate time series and reasonable spatial coverage can be deduced from the NDA report and the questionnaires, at level appropriate to support the development of MPIs. From the questionnaires it is obvious the development of MPIs is in advanced stage in Cyprus. The monitoring can be advanced further by extending its coverage to issues of no current concern but which can pose a threat in the future and ensuring that the capacity (expertise and resources) will be there to face those issues.

EGYPT

Monitoring of marine pollution through the use of the proposed chemical indicators appears to be well developed in Egypt (MPI-Egypt, 2006). Chemical indicators were the major component of the national Environmental Information Monitoring Program (EIMP), which have helped to provide an overview of the extent and degree of marine pollution of the coastal waters around Egypt. Even more, it has identified the major sources of pollution to coastal waters and provided information on changes in the pollution situation during the period 1998-2005. However, data related to effluents only focus on the outlets of the main Canals and drains to the Mediterranean. On the other hand there is information available to the authors of this report that the TRIX indicator has been developed in the country.

For the development of biological indicators there are limited data; benthic fauna and benthic macrophytes data from 32 sites are also included in the EIMP database for the period 1999 & 2000. There is a lack of the data regarding Biomarkers**;** the available data are excessively based on laboratory studies not to the field studies. The EIMP monitoring program includes a component of quality assurance and quality control of chemical indicators which was established within the program. A general issue of concern to the program sustainability lies in the

dissemination of information and the utilization of the monitoring data in the planning for coastal zone development.

Further improvement in the EIMP monitoring program is required regarding monitoring the hazardous substances, nutrient load and organic load in the discharged effluents to the coastal environment. Monitoring benthic fauna still need further development and continuation as a routine work activity and more research in defining limits of the quality classes in order to improve on the limited data and render them suitable for pollution indicators. The lack of the data regarding Biomarkers could be explained by the difficulty of carrying out these analyses and the high cost needed to do it.

FRANCE

Monitoring of the marine environmental quality in Mediterranean France is carried out within the framework of DCE and associated national and regional networks of institutions on behalf of the Ministry for Ecology and the Sustainable Development (see Box) (MPI-France, 2006).

BOX 2: Networks engaged in monitoring of the marine environmental in France

- the network of control of monitoring (DCE),
- the meadows of *Posidonia* and macrophytes in the lagoons.
- the REPHY for the phytoplankton
- the RSP for the Posidonia in area Provence-Alp-Coast of Azure and Corsica
- the RSL in the lagoons in Languedoc-Roussillon area and Corsica

The objective of the DCE is to evaluate the ecological state of the coastal and transitional waters and to develop an operational strategy to the reach a good ecological and chemical coastal status, following the EU Water Framework Directive. Nevertheless, France envisages to set up with the MED-POL a monitoring program to fulfil all requirements for the development of MPIs.

The feasibility test was performed on data gathered through the DCE framework to ensure the provision of “real data” from reliable sources, repetitive, reproducible and comparable. It also made it possible to guarantee an information system coherent and perennial, since all the data gathered within the framework of these programs are stored in data bases ensuring their validity and their availability like that of the associated metadata. QA/QC are thus guarantied as the approved methods are uniformly applied and tested in exercises of intercalibration.

The chemical data as a whole make it possible to develop most of the chemical MPIs and to draw up temporal trends (which represent series of more than 20 years) mainly on chlorophyll-a, salinity, temperature, turbidity, dissolved oxygen, and heavy metals (Cd) organochlorines in water. These data available have a satisfactory spatial coverage (covering coastal zone and transitional waters) space cover very largely satisfactory. Similar data also exist on nutrients (Total N and P, nitrates, nitrites, ammonium, orthophosphate and orthosilicic acid) *[Questionnaire*] and BOD/COD. Additional data include sporadic monitoring of phytoplankton and organic enrichment in sediment and is also possible to have reproducible data concerning the rest of the MPIs (namely heavy metals organochlorines and hydrocarbons in sediment and biota).

The only concern lies in **the need to harmonize the formats of the archived data to facilitate the diffusion of the results and their synthesis**. It should be noted under the DCE it is possible to have reproducible data concerning the rest of the MPIs (namely heavy metals organochlorines and hydrocarbons in sediment and biota

Regarding ecological indicators, available data on zoobenthos, phytoplankton and *Posidonia* relate to the following networks:

- DCE -benthos of soft substrata (coastal zone and lagoon) - sufficient space cover, 235 stations distributed on all the frontage, great majority being localised in Languedoc-Roussillon but not temporal
- the meadows of Posidonie and macrophytes in the lagoons.
- the REPHY:- time series for 20 years, in data base
- the RSP- time series for 20 years
- the RSL-phytoplankton, macrophytes and benthos of soft substrate: in data base

Besides the above, there is a large quantity of data concerning the soft bottom benthos of movable substrate gathered in France, within the framework of a work of thesis and the work of intercalibration completed for the DCE. The data on benthos will be stored soon in this in the national database QUADRIGA lodged by IFREMER. For the zoobenthos, several types of indices are used in France. Within the framework of work of the DCE, a specific work of tests was completed to identify most relevant for the whole of the frontage: H’ (indice de Shannon log2), AMBI, BQI, BENTIX. France as a EU member participated MED-GIG for intercalibration of ecological quality status indicators for the WFD. According to the national experts, the best

indicator to be used at national level in phytobenthic communities is the BENTOS-CARLIT (for details see section xxx) and AMBI for zoobenthos. (MED-GIG, 2007). Alien species (with focus on macrophytes) are monitored mostly in lagoons. Data is also available from the output of the research project ALIENS (Verlaque & Boudouresque., 2005). It is also important to stress that there is a rather great number of large-scale maps (1: 500 to 1: 5000) on the French coasts, in particular within the framework of patrimonial assessment or impact studies.

Regarding biomarkers, available data on acéthylcholistérase, métallothionéine and activité P 450 come from the projects RAMOGE (1998) and RINBIO (2000 & 2003).

GREECE

The feasibility of proposed MPIs in Greece (MPI-Greece, 2006) was performed using mainly the results from the MED POL national programme of continuous monitoring of the quality of marine environment of Greece over the past decades, supplemented by numerous reports (scientific and technical) as published in a synthetic work of SoHelME (State Of Hellenic Marine Environment. SoHelME, 2005).

Although the detailed methodologies behind the quantification of indicators (data collection and analysis) are not presented, it is mentioned that they refer to common standardised and well known general analytical procedures (as described in detail in the background ‘Strategy for the development of MPIs (UNEP/MAP 2005).

Monitoring of marine pollution through the use of the proposed chemical MPIs is well developed in Greece. Under the endorsement of the MEDPOL monitoring programme, heavy metals in coastal environment (water, sediment and bioaccumulated in biota), hazardous substances in biota, and nutrients and chlorophyll-a are adequately monitored for the endorsement as a suitable and applicable indicator of chemical pollution in Greek Seas. In particular the synthesis of the latter (nutrients s and chlorophyll- a has been proven to lead into a classification of environmental quality similar and comparable to the environmental status of the WFD combining both biotic and abiotic components of the ecosystem similarly to the TRIX indicator also in the same level of development. Temperature and Salinity time series exist that can support the development of these indicators, although one can argue of their relevance in terms of pollution.

Hazardous substances in water and sediment can easily developed and used as a tool of sustainable management if data coverage is extended and intercalibration of analytical methodologies and assessment are enforced. The same applies petroleum hydrocarbons along

with the adoption of common methodologies that should also be applied in the case of hydrocarbons ensure the homogeneity in results and valid interpretation of the indicator. In general biomarkers in Greek waters are understudied both in temporal and spatial scale.

With regard to ecological indicators, Species number (S), diversity index (H) are useful tools in monitoring the environmental quality across Greek coastal zones under various forms of anthropogenic stress particularly in organically enriched areas. Adequate time series at the time being are sparse. However all have certain limitations and are now considered as accessory tools for the ecological evaluation in the light of the requirement set by the WFD and the development of Biotic Indices

According to the national experts, the best indicators fully applied for EQS at national level are the EEI for phytobenthos and BENTIX for zoobenthos. (MED-GIG, 2007)

A more comprehensive and systematic monitoring program, in order to extend the data coverage and ensure comparability and QC/QA of the results, should be set in order to monitor the levels of organochlorines and petroleum hydrocarbons in coastal areas (water and sediment) particularly those under human influence and those regarded as hot spots. Concern has also been raised as even within MEDPOL different institutions have carried out analyses on petroleum hydrocarbons even in the same area and no intercalibration tests had been adopted ands implemented. It is important to adapt common analytical procedures and methodologies for the scientific development of a relative indicator. **Further work is also required in determining background / reference values** in order to calculate the enrichment factor and thus to quantify the impact of the metals on the quality of the environment.

In conclusion, monitoring of marine pollution through the use of the proposed MPIs is well developed in Greece under the endorsement of the MEDPOL, and individual projects such as the Saronikos monitoring funded by the Ministry of Environment (HCMR technical reports)

ISRAEL

Most of the proposed chemical MPIs are routinely measured in Israel and are used to generate regular (annual) national assessment reports under a National Monitoring Programme and to describe the state of the marine environment in scientific papers over the pat years (the annual report presents trends of environmental changes based on analysis of long-term monitoring data which extends from the late 1970's to date) (MPI-Israel, 2006; UNEP/ MAP, 2007a). The

monitoring capacity of the country can expand as capability exists to complement the data in certain localized areas that are not currently covered by monitoring programs. (MPI-Israel, 2006)

Hence it is apparent the development of chemical MPIs in Israel is in an advanced stage, with long data series archived. Most of the MPIs go through strict QC/QA programs in the laboratory and as part of international intercalibration exercises. Reference standards materials for nutrients in seawater and metals in biota are used routinely.

Regarding the development of biomarkers, most of the available data have been acquired in connection to research and development of the methods. There are few field data, and the existing ones are localized and without temporal continuity, hence inadequate to generate a national assessment report based on biomarker MPIs. However, the analytical and research capabilities exist in Israel and can be applied in the field.

Data on ecosystem biological indicators are collected within the framework of monitoring programs and in basic research; however in most cases they are not used as MPIs but in basic research. In some areas, community diversity and presence of opportunistic species were used to follow or determine the effects of land-based discharges on the marine environment. Given the significance of bioinvasions, although not explicitly reported, data on alien species are regularly published by experts. For selected groups see CIESM atlases (Golani et al., 2002; Galil et al., 2002; Zenetos et al., 2004)

Monitoring of the quality of the environment can be improved by including indicators related to the sediment (as it is known that the sediments are more indicative of long term processes and provide an integrated picture) and a measure of bioavailability of the metals concentrated there (speciation of metals). Also, nutrients and their relative molar proportions should be viewed as one indicator of eutrophication (thus developing integrated high order indicators) and not each nutrient by itself.

As a general comment '***MPIs in environmental research should be utilized as an integrated, multidisciplinary and holistic manner****. They also should be geared towards the establishment of an integrated database that could be incorporated into ecosystem models'.*

ITALY

Although no report on the feasibility of MPIs has been prepared it is known that Italy is implementing the MEDPOL monitoring framework and thus data are available for the

assessment of pollutants inputs into the marine environment and the assessment of the quality of coastal waters (UNEP/WHO, 2003, UNEP/MAP, 2007a)).

Among the Land-Based Pollutant Sources, the sources of pollution to the marine environment are the industrial and agricultural activities, as well as urban wastewater. As a result of these identified threats a regular monitoring programme appears to be in force under MEDPOL monitoring has been set for the assessment of bathing water quality. Parameters such as nutrients (total N and P, ammonia, nitrate, nitrite, orthophosphate, silicate) physical parameters (T, S, DO), chlorophyll-a, and heavy metals, petroleum hydrocarbons, and organochlorines in sediment and biota are monitored in a systematic way since 2001 (UNEP/WHO, 2003; UNEP/ MAP, 2007a) Similarly the TRIX indicator appears to be successfully tested and implemented. (UNEP/ MAP, 2007a) The result of the monitor revealed 15 'hot spot' and 6 areas of major environmental concern. An interesting suggestion is the support to TRIX and the development of other 'integrated' index related to benthos instead of several single index. In general there is a need to improve data flow because only a limited amount of MPIs data is now available despite the capacity of the country to develop more.

Although no report has been prepared it has been possible to deduce the feasibility of chemical MPIs against the criteria especially on the issues of comparability of the data and availability of QA/QC programmes based on the questionnaires. Similarly the availability of adequate time series and reasonable spatial coverage can be deduced from the NDA report and the questionnaires, at level appropriate to support the development of MPIs. From the questionnaires it is obvious that the development of MPIs is in advanced stage in Italy.

Considering the vast bibliography and the high level of expertise of scientists, all zoobenthic and phytobenthic biological indicators have/are widely applied in EQS assessments. However, according to national experts the indicators tested in the frame of the MED- GIG exercise include the BENTIX and m-AMBI (see section 4.3) for zoobenthos and the CARLIT for macroalgae (MED-GIG, 2007). The issue of bioinvasions is considered of high relevance and thus the Ministry of Environment has funded the development of a database (ICRAM) while new introduction every year are reported to the IOC/IMO WGBOSV.

LEBANON

According to the country's MPI feasibility study (MPI-Lebanon, 2006) The Monitoring programme of Lebanon was established at 1985 with limited spatial and parameter coverage;

since then it has been expanding in temporal coverage as well in new parameters and reference sites and identified hot spots. An extensive monitoring programme is however carried out only since 2000.

The parameters regularly analysed are water temperature, salinity, nitrates, nitrites, orthophosphates, and phytoplankton. During the last few years new parameters were included in the monitoring scheme namely ammonia, pH and chlorophyll a in water. At that time monitoring was extended to a limited identified 'hot spots' where DO, trace elements (Hg, Cd, Pb) in sediments and in effluent water (Hg, Cd, Pb) and biological indicators are now covered. Biological data restricted to meiobenthos. Meiobenthic population analyses were conducted in the frame of a doctoral thesis in cooperation with the French universities. These MPIs will also be integrated in the monitoring program. Data on alien marine species is sporadically reported by scientists (Bitar, G. & Kouli-Bitar, S., 2001; Zibrowius H and Bitar G (2003); Harmelin-Vivien, *et al*., 2005).

The major drawback for the development of MPIs in the area is the **lack of financial means (Research funds, equipments...) and human resources.**

LIBYA

Monitoring in Libya is at its early stages. Since no report on the feasibility of MPIs in Libya has been prepared, information was extrapolated from the NDA (NDA, Libya, 2003,) The 2003 NDA study was carried to obtain assess stress on marine environment by obtaining a baseline data, identifying hot spot and to establish a framework for future studies that will focus on the conservation and protection of the marine natural resources. A national action Plan for the environment is underway in order to formulate national environmental policies which will adopt a new strategy for the protection and conservation of the marine environment in cooperation with Mediterranean Sea Action Plan (MAP).

The current activities (under the General Environmental Authority -EGA) are directed towards the monitoring of the sea and pollution prevention. Sewage input to the sea, oil pollution, solid waste and urban settlements have been identified as the most important environmental problems of the coastline. Excessive input of nutrients (phosphorus and nitrogen) are regarded to have contributed largely to the acceleration of eutrophication phenomena at certain areas however data coverage under monitoring programme are limited including also BOD and transparency. Concerning hazardous substances, there are limited data on the existing levels and the distribution of selected heavy metals has been in surface sediments and water, but

there is no data on the enrichment of organochlorine pollutants on the marine environment. In addition studies on pollution by hydrocarbons of the Libyan coastal water are limited.

In general the absence of a system of continuous monitoring of the seawater makes it very difficult to evaluate the changes of eutrophication related substances and hazardous substances in the marine environment. Their monitoring should be considered as paramount in the future National Action Plan.

Since no report has been prepared it is difficult to deduce the feasibility of chemical MPIs in criteria other than data availability and even that approach should be treated with caution (as there is no information on the issues of comparability of the data and availability of QA/QC programmes). From the NDA it is **obvious the development of MPIs is very primitive in Libya.**

MALTA

The feasibility of proposed MPIs in Malta was tested by the Maltese experts against a subjective set of criteria (based on the actual existence of the data, the timeframes over which the data is available, its spatial representativeness, its quality, the drive to acquire the data on the bases of legal obligations or public expectation, and the local resources available to be devoted to its gathering. (MPI-Malta, 2006).

Fifteen chemical indicators, five biological indicators and three biomarkers have been selected as being the most feasible for use in Malta. Testing revealed that '*in Malta there are still many limitations to the practical implementation of the indicators examined'*. Even for those selected as most feasible, the available time series data cover a period of 6 years i.e. since 2000 (however for other parameters, especially those concerning pollutants in effluents, the time series is much less) and with limited spatial coverage (coverage restricted to parts where most pressures are located and where the coast is mostly accessible; and extends only to coastal waters. Furthermore with reference to the 6 UNEP/MAP criteria the whole data set cannot be deemed to be comparable, and no QA/QC programmes are in place for chemical indicators as reference/background values are available only for some indicators. It has though to be pointed out that they fulfill the first 3 UNEP/MAP (relevance) criteria [actual existence of the data, the timeframes over which the data is available, its spatial representativeness].

The chemical indicators are in more advanced stage of development than biological and biomarkers counterparts. Furthermore as the report concluded '*it is recognized that these*

indicators are an important component…. which need to be compiled in order to produce, implement and monitor environmental policy'For a number of biomarkers no data is presently available and thus the feasibility index was worked out by evaluating the complexity of the methodology and whether the resources (human/equipment) are potentially available to carry it out. Data available covers short time spans (1-3 years), and is usually discontinuous in time and space.

The different datasets used for testing the ecological indicators pose a problem when trying to obtain comparable time series and spatial coverage suitable for indicator development. . Available data on benthic macrophytes that has been considered as having reasonable spatial coverage may not be available for an adequate time series, since such data would often be a result of one time study. In contrast, certain data (such as zoobenthos) may be available through medium term assessment studies or monitoring programmes, but then this would lack spatial coverage. Data on alien species is available mostly for macroalgae (CORMACI et al, 1997) and scarcely for other taxa. Thus the **availability of adequate time series and reasonable spatial coverage varies according to the available dataset**. Malta as a EU MS has tested the feasibility of using *Posidonia* as an indicator species within the MED-GIG and agreed that it is fully applicable (MED-GIG, 2007).

The main issues of concern for the Biological indicators include a) The high costs incurred for the collection of data b) comparability of the data. c) the fact that different indicators may lead to similar results, hence a reduction is required.

MOROCCO

A monitoring programme is effective in Morocco as it appears form the Feasibility Study based on data from the MEDPOL reports, the data base of the Ministry for the regional planning, water and Environment (MATEE) and from technical reports (MPI-Morocco, 2006).

Monitoring of marine pollution through the use of the proposed chemical indicators appears to be well developed in Morocco, although the report does not cover the availability of time series. **However it is safe to assume that past data exist and the monitoring will continue in the future.** With respect to the UNEP/MAP criteria, monitoring appears to be of high relevance to the costal zone as it appears to cover near all the littoral in the case of microbial loads and at least the principal 'hot spots' in the case of nutrients and heavy metals and is in compliance with the Barcelona Convention and the related Protocols**.** Internal and external controls,

standardization methodology (standard and reference samples) and intercalibartion exercises ensure the comparability of the data and provide the necessary quality assurance of the results and values of reference.

With regard to Biomarkers the results obtained within the framework of the national monitoring program are very limited in space. The scarcity of the studies does not allow a testing approach.

Although no mention is made in the report on ecological indicators, some data is available on alien species, mostly macroalgae (González, & Conde, 1991). In addition on testing some data on the presence/abundance of opportunistic zoobenthic taxa, the results were very promising (see UNEP MAP, 2004).

The main concern for the development of proposed MPIs lies in the fact that **available means (personnel, material and financial resources) are insufficient for the spatial scale** required for an effective monitoring bearing in mind the distance between the laboratories and the sampling areas and the accessibility of the latter.

SLOVENIA

Data on chemical MPIs to generate national assessment reports in Slovenia, exist under the framework of MEDPOL (Phases I, II and III) and are supplemented by data from smaller monitoring program. However, only the post 1999 data collected within the framework MED POL Phase III are archived (at the MBS/NIB).

The data coverage includes the monitoring of chemical contaminants in biota and sediments and of Aliphatic and Polyaromatic Hydrocarbons (PAH) in sediment, since 1999), the monitoring of loads from land-based sources (temperature, salinity, BOD/COD, dissolved oxygen, nitrate, total nitrogen, total phosphorus (since 1988) and the monitoring of the same loads in effluents (since 1999 with and some data are available since 1988), all primarily through MEDPOL (MPI-Slovenia, 2006; UNEP/ MAP, 2007a).

The ecological status of coastal waters is also covered through the monitoring of temperature, salinity, dissolved oxygen, pH, alkalinity, transparency, orthophosphate, total phosphorous, nitrate, nitrite, ammonium, total nitrogen, ortosilicic acid, Chlorophyll a under MEDPOL III, at a smaller spatial scale, along with phytoplankton studies (MPI-Slovenia, 2006, UNEP/ MAP, 2007a). The development of chemical MPIs in Slovenia is well in advanced stage. Most of the parameters are under strict QA/QC programs and some of them under international intercalibration exercises. Reference standard materials are regularly used. Chlorophyll *a* and

dissolved oxygen are already used as MPIs to describe the state of the shallow and enclosed marine environment and the trophic index TRIX is used to characterise the trophic state of the coastal environment. As a result sensitive areas, under the direct and indirect negative consequences of various human activities, have been identified (e.g. the entire area of the Bay of Trieste). Based on their monitoring programmes, experience and collected data on phytoplankton (as well as harmful algal blooms), the Slovenian experts have identified phytoplankton as a MPI.

Most of the data on biomarkers were collected as a preliminary study within the NMP Slovenia in the 2000-2005 period. However, most of the data are preliminary and are not sufficient enough for a national assessment report based on biomarker MPIs. Some data from coastal areas show MT levels comparable to those from the reference areas. For that reason it is proposed to compare data with chemical analysis of biota and sediment.

In Slovenia, data on zoobenthos and phytobenthos are collected within individual biological surveys as basic or applied research; there is also data on identity and abundance of alien species, endangered species and habitat types. The data are used in basic research and are compiled in inventories, reports, and publications. Recently, for the assessment of EQS in view of WFD needs, data is collected on benthic community diversity (zoobenthos/ phytobenthos), abundance of zoobenthic species, presence and coverage of benthic macrophytes. Data on alien species is also available (De Min and Vio, 1997; NDA Slovenia). According to the latest MED-GIG workshop (MED-GIG, 2007) the best indicators to be used at national level are m-AMBI for zoobenthos, EEI for macroalgae (Lipej et al., 2006).

SPAIN

Monitoring in Spain is conducted on national as well as regional level (Spanish autonomous regions). Data reliability depends on the parameter measured and the authority conducting the monitoring. National monitoring focuses on trend monitoring in hot spots and in reference and coastal areas on heavy metals, organohalogenated compounds and polycyclic aromatic hydrocarbons in sediment and biota. These data are gathered in a single database and is managed by the Ministry of Environment. According to the report the development of ‘integrated’ index e.g. TRIX, instead of several single index should be promoted.

Heavy metals (Cd, Hg) and Halogenated hydrocarbons in effluent waters are partially covered temporally with a good spatial coverage and more sufficiently both spatially and temporally in

biota. The former under international QA/QC assurance protocols and the latter under national and international intercomparisson exercise. MPIs related to eutrophication (nutrients, BOD/CDOD, Chlorophyll-a and hydrological parameters) are partially covered in terms of temporal scale but have a better spatial coverage with international QA/QC assurance protocols.

Data on hazardous substances in marine biota are considered reliable as their common reference methods for the analysis and a very strict quality control programme have been followed. Furthermore the use of certified reference materials and common analytical methods provide a good approach to the collection of meaningful data, allowing their comparison on a Iberian Mediterranean-wide scale.

Trend monitoring also covers biomarkers i.e. the biological effects of the contaminants. Lysosomal membrane stability and Metallothionein are measured in *Mytilus galloprovincialis*; EROD activity (Ethoxyresorufin-O-deethylase), Metallothionein and DNA alterations are measured in *Mullus barbatus*. This monitoring is carried out by the IEO.

There is no National Monitoring Programme to apply Biological (Ecological) indicators to along the Mediterranean littoral of Spain. The majority of the existing data comes from regional monitoring networks, research projects, environmental impact assessment studies, technical assistance, etc., which makes it difficult to identify its origin and availability. As a result no general database exists on biological elements. However, four biotic indices are being applied; two on benthic macrophytes presently being applied in the Catalonian coast: POMI and CARLIT (both proposed and tested by the Catalan Water Agency (ACA), in collaboration with CSIC experts) and two on macrobenthos (AMBI and its development m-AMBI, and MEDOCC). According to the latest intercalibration exercise (MED-GIG, 2007) the latter two have been tested and considered fully applicable for zoobenthos in Spain, while the most appropriate for macroalgae was considered the BENTOS-CARLIT. Regarding alien species, there is no national or regional monitoring network running to accomplish this objective. When a new species is described within the framework of another monitoring network (e.g. fisheries monitoring) or specific research projects, results of such findings are used for publishing. Some *Posidonia* networks also include monitoring activities related with some invasive species such as *Caulerpa prolifera*, *Caulerpa racemosa*, *Womersleyella setacea*, etc. An overview of alien macroalgae was carried out n the Framework of the ALIEN project (Verlaque & Boudouresque, 2005).

These facts have made difficult to compile the necessary information to write up this report, showing that there is a need to promote, among the Spanish Scientific Community and

competent Authorities, the MED POL Programme as well as the strategies of the Contracting Parties to the Barcelona Convention.

In the report it is concluded that although the capacity to provide annual data for the development of the proposed MPIS exists, it is not possible at the current monitoring frame to provide data at the requested spatial scale (MPIs related to the phenomenon of eutrophication do not cover all the area of Mediterranean). In general there is a need to improve data flow because only a limited amount of MPIs data is easily available. Nevertheless, the majority of MPIs are being tested and that the existing data can be considered as an excellent starting point with documented relevance to Barcelona Convention and Relevance to LBS, dumping and hazardous waste protocols.

SYRIA

A National Monitoring Program in cooperation with MEDPOL-phase III was initiated in 2003 in Syria. The program is carried out on limited number of stations in two geographical areas (hot spots) and so far has established the need for control measures and the necessity to establish long-term monitoring based on time series of data and background/ reference sets. Despite the existence of the monitoring programme the data presented in the report suggest that it is still at an early stage (understandable as it has started in 2003) and as such cannot fully support the development of the proposed MPIs.

With respect to chemical MPIs there are some data (based primarily on scientific research) concerning heavy metal, petroleum hydrocarbons and organochlorine analyses in effluent, sediments & biota. The same applies for analyses of nutrients (N and P), Nitrate, Nitrite, Ammonium, Orthosilicic acid, orthophosphate, and BOD/COD in effluents. The capacity exist to measure Chlorophyll- a, temperature and salinity and pH but are not currently monitored. Monitoring of DO and bacterial level in bathing water is at a better stage where some spatial and temporal trends have been determined. (MPI-Syria, 2006; UNEP/ MAP 2007a).

On the positive side, the analyses have the appropriate QA/QC assurance as they are carried out under the UNEP/MAP methodology protocols and intercalibartion exercises and controls have been imposed by MEDPOL Phase III. Based on that and from the first results, the monitoring programme adopted by Syria can be expanded and developed to support the proposed MPIs under the condition that more support will become available to the institution involved in the monitoring.

There is no other source of data about biomarker, except for EROD, and Cytochrome P450. Monitoring for Biomarkers analysis should be included in the national monitoring programme and when a suitable data set will become available, their efficacy as MPIs can be tested.

No information exists in the report on community indices. Scarce data on zoobenthos have been derived from scientific research. (Ammar, 2002). Zenetos et al, 2005 have applied the S, H index and tested feasibility of using BENTIX (UNESCO/IOC, 2005) with no successful results attributed. Although the report does not refer to alien species either, it appears from scattered data that bioinvasions is a key issue (Saad, 2002; Saad *et al*., 2005; Ammar, 2002).

TUNISIA

Tunisia has recently acquired the capacity to measure most of the required parameters. Monitoring of marine pollution through the use of the proposed chemical indicators appears to be well developed in Tunisia. For the time being annual monitoring is conducted only on the following: Temperature, pH, Dissolved oxygen, Salinity, total Nitrogen, total phosphorus, heavy metals (Cd, Pb and Hg), hydrocarbons and Chlorophyll-a, and bacterial levels. The analysis of heavy metals (Cd, Hg and Pb) is performed in sediment and biota, same for Hydrocarbons whereas bacteria levels in bathing water (MPI-Tunisia, 2006, UNEP/ MAP, 2007a). Although the MPI report does not cover the availability of time series**, it is safe to assume that past data exist and the monitoring will continue in the future**.

With respect to the UNEP/MAP criteria, monitoring appears to cover near all the littoral in the case of microbial and effluent loads and at least the principal ‘hot spots’ in the case of nutrients, data comparability is ensured through standardized methods, reference material and intercalibrations and established QA/QC programmes in the majority of the monitoring schemes. Finally such monitoring is in compliance with the Barcelona Convention and the related Protocols.

Regarding biomarkers, the availability of data allows to draw up temporal tendencies but not at an acceptable space cover. Currently, the spatial coverage is limited and does not allow proper assessment considering the number of stations (two to Bizerte, in Tunis and in Sfax).

No monitoring project exists for biological indicators. Data is available within the framework of doctoral studies or research projects focusing in the fringes of the littoral, but limited in time. However, technical reports are available at the library of the INSTM or faculties. Thus, the availability of data is considered adequate so as to draw up temporal tendencies and an

acceptable spatial cover. Currently, results relating to the application of the indicators of benthic ecology in the objective of continuous monitoring do not exist. However, testing presence and abundance/ coverage of sensitive /opportunistic species / taxa of phytobenthos and zoobenthos with data from Tunisia produced promising results (see UNEP/MAP, 2004).

Although monitoring of alien species does not exist, the scientific interest has focused on some taxonomic groups (macroflora (Djellouli et al, 2000); ascidia (Melian. 2002); fish (Bradai et al., 2004); and mollusca (Enzenross & Enzenross 2001).

In conclusion, the three groups of MPIS (chemical, biological indicators and biomarkers) are not studied by the same institutions. **The capacity exists to cover most of MPIs** as the INSTM and the CITET institutions are able to carry out analyses covering the required parameters under the guidance and assistance of MEDPOL. The main concern lies in the fact that available means are insufficient for the spatial scale required for an effective monitoring. In addition there is room for improvement in the field of QA/QC as some smaller laboratories do not follow this intercalibration.

TURKEY

Although no report on the feasibility of MPIs has been prepared it is known that Turkey is implementing the MEDPOL monitoring framework and thus data are available for the assessment of pollutants inputs into the marine environment and the assessment of the quality of coastal waters (NDA, Turkey 2003).

A regular monitoring programme appears to be in force under MEDPOL monitoring for the assessment of nutrient (total N and P, nitrate, nitrites, ammonium, orthophospates, orthosilicic acid), chlorophyll DO, BOD/COD and the hydrographic parameters although both temporal and spatial scales are not adequately extended (UNEP/ MAP, 2007a). The TRIX indicator has also been successfully tested (UNEP/ MAP, 2006). Petroleum Hydrocarbons in water and sediment, heavy metals and bacterial load, in water and to a lesser degree organichlorines, are also under regular monitoring. From the results of the monitoring programme ten areas appear to pose a pollution threat for the Mediterranean Sea; and 5 hotspots and 6 sensitive areas have been identified in the Mediterranean and Aegean Regions.

Bioinvasions, is considered a serious threat to the ecosystems and as such it has drawn significant attention. Trends in alien species can be seen in both the Levantine and the Mediterranean coasts (Cinar et al., 2005). Data from macrozoobenthic studies, although not part

of a national monitoring program, are collected in the framework of local studies, often as results of PhD theses. Thus there is good spatial coverage, but not temporal (with the exception of Izmir Bay. The proposed ecological MPIs have been tested with Turkish data for Izmir Bay (Dogan, 2004) and Marmara Sea (Albayrak et al., 2006).

Although, no report has been prepared it has been possible to deduce the feasibility of MPIs against the criteria especially on the issues of comparability of the data and availability of QA/QC programmes based on the questionnaires. Similarly the availability of adequate time series and reasonable spatial coverage can be deduced from the NDA report, scientific publications and the questionnaires, at level appropriate to support the development of MPIs. From the questionnaires it is obvious the development of MPIs in Turkey is possible in the near future especially if monitoring is extended to cover all parameters and with the provision of adequate time series.

6. GENERAL PROPOSALS FOR IMPROVEMENT

From the testing procedure for the feasibility of applying the MED POL Marine Pollution Indicators at a national level, made by 14 countries, it appeared that many of the problems, issues of concern and constrains were common among the countries and consequently most of their suggestions for improvement of MPI's at a national level were universal in the Mediterranean scale. Some of the suggestions were general, applying to the whole spectrum for MPI's; others referred only to particular Thus suggestions were made on:

- ✓ Data acquisition
- ✓ Data storage / Data base organization
- ✓ Increasing funding and human/laboratory capacities (thus also covering the need for intercalibration, QA/QC programmes
- ✓ Harmonization with EU initiatives/International collaboration
- ✓ National Strategy
- ✓ Adoption of Reference values/stations (in particular for biological/biomarkers)
- ✓ Reducing proposed MPI's
- ✓ Adding new MPI's
- ✓ Developing further the proposed MPI's

Data acquisition

Inadequate temporal and spatial data series appeared to be the commonest problem in developing MPIs either for particular parameters or for the set. Particular concerns include:

- the lack of coherence and the gaps on data in temporal and geographical scale did not make possible to draw up trends and tendencies of environmental quality (Morocco)
- insufficient current means (as a result of limited political will) hampers the monitoring conducted by a network of several organizations and institutions (Tunisia)
- the development of biological indicators in the Egyptian Mediterranean coastal waters as appropriate pollution indicators, still need more work either by research or routine monitoring activities to cover the current lack of data. Similarly the lack of data prohibits the development of biomarkers (Egypt)
- need to acquire adequate time series and reasonable spatial coverage for the proper development of biomarkers in the future (Slovenia)

Suggestions were also made to that direction:

- the spectra of monitoring parameters needs to be enlarged (Bosnia and Herzegovina)
- a monitoring strategy has to be developed and applied, in terms of sampling frequency and spatial coverage (Croatia)
- Benthic monitoring studies should be extended both in spatial and temporal coverage in order to acquire a comprehensive picture of the fauna and flora in Greek seas (Greece)
- reorientation of the current monitoring programmes in order to fulfill National requirements in homogenous way; Proper data provision should be a part of proper monitoring programs based on intensive monitoring of temporal as well as spatial trends under standardized sampling and analytical methods under the appropriate provision if resources (Spain)
- extension of the temporal coverage and long-term assessment of the monitored parameters in all relevant waters, particularly marine (Malta)

Data storage / Data base organization

The need for a properly managed database of the collected data was highlighted through the suggestions to**:**

- develop a database to cover current and future sampling and analysis (Bosnia and Herzegovina)
- collect and populate a data base with the historical data (Croatia)
- improve existing basic system of data gathering by archiving data on biocoenoses (France).
- organize and assemble the data on biological elements collected during basic research, biological surveys and monitoring before performing a general national assessment (Israel)

and concerns on :

- the dispersion of information through the various administrations, the lack of knowledge on the existing inventories, difficult to reach data contained in reports (Morocco)

Increasing funding and human/laboratory capacities (thus also covering the need for intercalibration, QA/QC programmes

All countries emphasised the need for increased funding for the maintenance and expansion of the monitoring schemes. Most of the South Mediterranean countries called for increased capacities (humans and laboratory) in order to:

- expand laboratories capacity to include all required parameters, both under the appropriate QA/QC programmes (Bosnia and Herzegovina)
- remedy the lack of the data regarding Biomarkers attributed to the difficulty of carrying out the relevant analyses and the high cost needed to do it; these types of indicators need specialized laboratories with highly sophisticated equipment and specialized members. Hence, there is a need for technical and financial assistance from those countries that have a gross experience in this field (Egypt)
- to work on the identified issues of harmonization and standardization of methods to ensure comparability between data sets and determination of reference values (Malta)

- remedy the current status of MPI development through exchange of personnel and reference material for the proper development of MPIs as the application of the MPIs could be possible with the new phase of the MED POL. (IV) subject to reinforced assistance of the various laboratories (Tunisia)
- Improve QA/QC as some smaller laboratories do not follow this intercalibration. The situation has to be remedied through exchange of personnel and reference material for the proper development of MPIs. (Tunisia)
- employ training specialists who will be able to control benthic ecology, to imply in adequate and to place at the disposal the material and consumable training schemes necessary (Tunisia)
- reinforce the capacities of the institutions of the monitoring network by developing further the insurance and quality control between laboratories, enhancing the intercalibration capacity and granting of the financial means and resources and reinforced assistance through MEDPOL (Morocco)
- to support scientific research on the monitoring of marine environment , especially biological and biomarker monitoring (Syria)
- enhance the human capacity of the field (Lebanon)
- formulate a proper monitoring program based on intensive monitoring of temporal as well as spatial trends under standardized sampling and analytical methods with improved QA/QC protocols under the appropriate provision of resources (Spain)

Harmonization with EU initiatives/International collaboration

In line to the need for increasing human/laboratory capacities (described above), comes the suggestion for harmonisation and collaboration with similar initiatives through:

- networking of the laboratories participating in the MPI development so that the tasks will be distributed according to the possibilities offered by the collaborating scientists and technical staff (Morocco)
- cooperation with relevant institutions of other countries, especially Italy and Slovenia, and international bodies (e.g. UNEP). (Croatia)

- training schemes (for benthic ecology) as well as assistance and experience sharing schemes between Northern and Southern bank of the Mediterranean (Tunisia)
- the adoption of a set of agreed methodology standards governing the whole procedure required in the preparation of indicator based assessments under a common legal framework that can supplement by national and international (e.g EU) initiatives (Malta)

Need for National Strategy

The adoption of a National Monitoring Strategy is essential for the overarching control of monitoring and subsequent implementation of environmental policies. Examples are:

- The adoption of a new scientific policy (STIP: Science and Technology Innovation Policy) to support sustainable development of the coastal zone will assist the development of MPIs as it will provide the necessary funds to extent the coastal survey system to cover the totality of the Lebanese coast; to adopt new coastal and offshore reference stations and the use of biomarkers, and most importantly will enhance the human capacity of the field (Lebanon)
- The need to develop an Integrated National Monitoring Programme for the assessment of MPIs in the Mediterranean coastal waters. At the same time there is a need of coordination of the existing regional networks. Since most of the existing information on the different MPIs proposed has been or is being generated by activities that are developed in framework different to MED POL Programme, a awareness campaign will be necessary so that the authors understand that the generated information will be revaluated if we can widen its field of application (Spain)

Adoption of Reference values/stations (in particular for biological/biomarkers)

Reference values and reference stations have been proposed by some countries for the proper assessment of the trends/ findings of the MPIs. Although the need is more general for particular parameters, specific needs have been put forward such as:

- a network of reference sites that should be established for biomarkers (Malta)
- fixation of permanent stations for the follow-up of the benthic ecosystems with a station of reference, presenting the minimum of disturbances of anthropic origin to be used as witness (Tunisia)

- extension of benthic monitoring studies (both in spatial and temporal coverage) in order to acquire a comprehensive picture of the fauna and flora in Greek seas and the necessary background reference levels for the development of Biotic indices required by the WFD (Greece)

Reducing proposed MPI's

Comments were made on the feasibility and 'usefulness' of some indicators followed by suggestions for their elimination from the MPI set:

- the frequency of micronuclei has been considered as extremely heavy indicator to implement in routine, taking into account the difficulty and time necessary to the reading of the plates (France)
- it would be reasonably feasible to select the most representative biological indicators since some indicators can target similar trends. Efforts are focussed on a limited set of biological indicators which could then be adequately developed, through harmonisation and fixed monitoring programmes, ensuring adequate sampling strategies, spatial coverage and time series generation.(Malta)
- there is a need to apply integrated index instead of several single index (Spain Slovenia, Israel)

Adding new MPI's

In the same lines new indicators have been proposed:

- sediment quality indicators (Malta)
- additional chemical parameters (Malta)
- the structure and diversity of plankton communities (Croatia)
- phytoplankton (Israel, Slovenia, Greece)
- biomarkers should not be limited to the individual MPI, the state of the art in the use of biomarkers as MPIs is based on a holistic approach of gene product biomarkers, namely pollution affected genes which are expressed as proteins or transcripts (Israel)
- biotic indices for zoobenthos: MEDOCC, AMBI, m-AMBI (Spain)
- biotic indices for phytobenthos: BENTHOS-CARLIT, POMI (Spain)

- A general suggestion is to introduce and support 'integrated' indexes instead of several single index, as is the TRIX indicator. The TRIX Index has been evaluated by data collected in a number of pilot programmes form Slovenia, Turkey, Greece and Turkey towards the Eutrophication Assessment Report (2007). Results in all cases have proven the efficacy of the indicator (based on the collected data) in assessing the environmental quality status of the areas (UNEP/MAP 2007b) although there is still debate on its endorsement as indicators (based primarily on the scientific merits) (UNEP/MAP, 2007c).

Developing further the proposed MPI's

Finally the MPI set can be further developed through the:

- inclusion of precautionary anticipation of novel environmental hazards e.g. introduction of new MPI that will detect contaminants rising from biotechnology and molecular nanotechnology (Croatia)
- development of the national classification schemes of macrophyta and defining the opportunistic, endemic and alien species (Egypt)
- Sampling and analytical methodologies need to be harmonized for intercomparison purposes (Malta)

7. CONCLUSIONS

Very few countries monitor all stipulated parameters; however many are monitoring supplementary parameters that they regard more important (based on scientific as well as local criteria) e.g. phytoplankton. EU countries appear to undertake more detailed monitoring programmes.

Chemical indicators are more advanced in terms of general scoring, followed by the ecological indicators, while biomarkers score last in the scale. Data on ecosystem ecological MPIs to generate national assessment reports exist as well as capability to complement the data in areas that are not currently covered.

With regard to chemical MPI's, and biomarkers, methodologies appear to be uniform and standardised following established analytical MEDPOL procedures under national and international QA/QC protocols and intercalibration exercises. In contrast, more work is needed in harmonisation of ecological indicators (defining limits of ecological classes, establishing reference stations, developing data bases).

Nevertheless it is obvious that the capacity and the will exist to extend the monitoring programmes in compliance to the MEDPOL MPI strategy, particularly if more resources (financial, manpower and expertise) become available.

MPIs in environmental research should be utilized as an integrated, multidisciplinary and holistic manner. They also should be geared towards the establishment of an integrated data base that could be incorporated into ecosystem models.

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