EP

United Nations
Environment
Programme

UNEP(DEPI)/MED WG.343/3
18 November 2009

ENGLISH

MEDITERRANEAN ACTION PLAN

Consultation Meeting to Review MED POL Monitoring Activities

Rome, 1-2 December 2009

REVIEW OF MED POL MARINE MONITORING ACTIVITIES
ASSESSMENT OF THE STATE OF ENVIRONMENT AND POLLUTION TRENDS

UNEP/MAP
Athens, 2009

1. Introduction

According to Article 12 of the Barcelona Convention all Contracting Parties shall establish monitoring programmes and designate the competent authorities responsible for pollution monitoring. In addition, Article 8 of the Land–Based Sources Protocol stipulates that these monitoring programmes should aim:

a) to systematically assess, as far as possible, the levels of pollution along the Contracting Parties coasts, in particular with regard to the sectors of activity and categories of substances listed in Annex I, and periodically to provide information in this respect; and

b) to evaluate the effectiveness of action plans, programmes and measures implemented under this Protocol to eliminate to the fullest possible extent pollution of the marine environment.

In the framework of MED POL Phase III (1996-2005), monitoring activities were designed to consider the above general aims and having as specific objectives:

- to undertake periodical assessments of the state of the environment in hot spots and general coastal areas needed to provide information for decision makers on the basic environmental status of the areas which are under anthropogenic pressures
- to determine temporal trends of some selected contaminants in the coastal waters and specifically in hot-spot areas in order to assess the effectiveness of policy measures and actions taken, and
- to control pollution by means of compliance to national / international regulatory limits

In the framework of MED POL Phase IV (2006-2013) the general objectives relevant to monitoring remained similar to Phase III, i.e.:

- Assessment of pollution loads from all point and diffuse sources and load of pollution reaching the Mediterranean,
- Assessment of the status and trends in the quality of the marine and coastal environment as an early warning system for potential environmental problems caused by pollution and other anthropogenic pressures;
- Control land-based pollution by means of compliance to national/international regulatory limits (monitoring of the implementation of the action plans, programmes and measures for the control of pollution and assess their effectiveness)

With the addition of a new objective:

- to contribute, in cooperation with other MAP components, to the application of the ecosystem approach to the management of human activities within MAP, with MED POL as the monitoring and assessment component.

Also, in the framework of MED POL Phase IV, it was decided (MED POL Operational Document, Decision 17/7 Almeria, 2008) that monitoring needs to be better integrated into the scope of the Strategic Action Programme (SAP) and of any other pollution control measure adopted by the Contracting Parties in application of the LBS Protocol. As a result the scope (content) of the monitoring activities have to be readapted as appropriate, to respond to the above needs:

a) Monitoring, assessment and pollution control activities, as well as data quality assurance, data collection and handling, reporting and data management policies and procedures, <u>to be functionally harmonized with those adopted by regional,</u>

international and global bodies and organizations, such as the European Union and other UN Agencies and programmes;

b) MED POL assessment and reporting schedules to be synchronised, and the assessment and reporting procedures harmonised, with the schedules and procedures which will be adopted for the evolving global assessment of the state of the marine environment;

c) Monitoring and assessment of the environmental effects and ecological implications of fisheries management, including aquaculture, on ecosystems (as advocated by the ecosystem approach to the management of human activities and practised by other Europe-based regional seas programmes) as well as of sea water desalination activities;

d) Monitoring and assessment of environmental effects associated with energy production and maritime transport, in cooperation with other competent international and regional bodies;

e) Assessment of the health risk associated with the quality of bathing and shellfish-growing waters, tourist establishment and facilities.

Some of the above issues may appear as beyond the scope of a programme initially designed for marine pollution control. However, while sectoral and narrowly defined control of marine pollution may have been seen in 1975 as an effective remedy to the woes of the Mediterranean basin, the changes adopted since 1995 in MAP's legislative framework are a clear indication that the Parties to the Convention have shifted the focus of their attention from the *protection of the Mediterranean Sea against pollution* to a broader and more ambitious goal: to the protection of the marine environment and the coastal region of the Mediterranean.

In order to adapt to the new monitoring needs in the Mediterranean Region and following the decisions of Almeria on that issue, the MED POL Focal Points in their last meeting Kalamata, Greece, (UNEP(DEPI)/MED WG.334/8 29 July 2009), reached the following conclusions in relation to monitoring:

- The Focal Points asked the Secretariat to assess the current Monitoring Strategy with the aim of improving and streamlining it, ensuring the provision of data and results by Contracting Parties, and contributing to the revision of its objectives. Current gaps are considered not acceptable, in view of the importance of the activity for the LBS Protocol. The assessment will also pay attention to the monitoring programme necessary to evaluate the effectiveness of the measures agreed, the mobilization of external resources for capacity building and technical assistance and the cooperation with other multinational initiatives.
- The Focal Points recommended the establishment of a permanent monitoring committee and a permanent committee on programmes and measures which would regularly follow the progress of implementation of the related activities and advise on future developments. Specific mandates should be prepared in cooperation with the MED POL Focal Points and submitted to the Contracting Parties for adoption."

In order to assess and improve the current Monitoring Strategy, the following issues are presented in the present Working Document:

I. Review and analysis of the Monitoring Activities and Data collection

II. Review and analysis of the Data Quality Assurance Activities

III. Status and trend monitoring: Evaluation of environmental quality of the Mediterranean marine environment based on the MED POL database

IV. Progress in the development of marine pollution indicators

V. Towards a harmonized integrated monitoring programme in the Mediterranean Region

2. Review and Analysis of the Monitoring Activities

2.1. Participation of the countries in the MED POL Phase IV monitoring activities (2006-2009)

2.1.1 Status and trend monitoring activities: achievements and problems

During the last two biennia (2006-2007 and 2008-2009) Memorandums of Understanding (MOUs) and Small Scale Financial Agreements (SSFAs) for the implementation of National Monitoring Programmes were negotiated and agreed with 10 countries (Albania, Algeria, Croatia, Cyprus, Egypt, Montenegro, Morocco, Slovenia, Tunisia and Turkey - Table 2.1). The agreements (with the exception of Slovenia) included a small financial assistance to the countries, in order to facilitate the implementation of their monitoring programme.

During this period, with the exception of Cyprus and Slovenia, no new or revised national monitoring agreements were negotiated with the other EU countries (Greece, France, Italy, Malta and Spain). However, some of the EU countries continued to provide monitoring data during 2006-2009, but only for a part of the mandatory parameters agreed upon in MED POL Phase III and IV.

During the same period agreements for UNEP/MAP assistance for the participation in baseline surveys using transplanted mussels to assess marine pollution (MYTILOS, MYTIMED, MYTIAD, MYTIOR) were signed with 11 countries (Albania, Croatia, Cyprus, Egypt, Lebanon, Libya, Morocco, Montenegro. Slovenia, Syria and Tunisia – Table 2.1). Furthermore, MED POL financed the participation of one more country (Bosnia & Herzegovina) to the Workshop of the MYTIAD for the presentation and discussion of the results of the survey. The assistance provided by MED POL helped to the completion of the project with the participation of all interested Mediterranean countries. The survey will be completed during 2009 and MED POL will finance the participation of Tunisia and Turkey.

Eutrophication pilot projects were financed in Morocco (Lagoon of Nador) and Montenegro (Boka Bay). The results or Nador were presented and discussed in a special session during the 16th Meeting of the Contracting Parties to the Barcelona Convention in Marrakesh (Morocco) (3-6 November 2009).

Table 2.1. National monitoring programmes and baseline survey projects finalized during the period 2006-2009 (MOUs and SSFAs)

COUNTRY	**National Monitoring Programmes**				**Baseline surveys** (MYTILOS, MYTIAMED, MYTIAD, MYTIOR)			
	2006	2007	2008	2009	2006	2007	2008	2009
Albania		**X**					**X**	
Algeria	**X**							
Bosnia & H.								
Croatia		**X**		**X**			**X**	
Cyprus		**X**						**X**
Egypt	**X**			**X**				**X**
France								
Greece								
Israel								
Italy								
Lebanon						**X**		
Libya								**X**
Malta								
Monaco								
Morocco				**X**	**X**			
Montenegro.				**X**			**X**	
Spain								
Slovenia	**X***	**X***	**X***	**X***			**X**	
Syria						**X**		
Tunisia			**X**		**X**			
Turkey				**X**				

* Without financing

2.1.2. Status of provision of marine monitoring data

Not all countries transmitted monitoring data according to the MED POL Phase IV requirements. There are in general four groups of countries in relation to the provision of monitoring data to the MED POL database:

a) Countries that provide data regularly, for most of the parameters required in MED POL Phase IV

b) Countries that provide data regularly, but for only a small part of the parameters required in MED POL Phase IV

c) Countries that provide data only for a few years (time gaps)

d) Countries that do not provide data (special gaps)

In Table 2.2. are presented the available data which are up-loaded to the MED POL database since the year 1998 (MED POL Phase III and IV).

When examining cases of missing parameters or missing years it appears to be due to two reasons: either the country generates data but is not providing them to MED POL, or the country is not generating monitoring data because is not implementing a monitoring programme. In both cases, data are not available and cannot be used for regional assessments. However, the actions to remediate the lack of data are apparently different in the two cases.

It has to be reminded that all recent Contracting Parties Meetings (Porticos 8-11 November 2005, Algeria 19-20 January 2008), recent MED POL Focal Points Meetings (San Gemini, 2005, Hammamet 2007, Kalamata 2009) and recent MED POL Monitoring Meetings (Palermo 2005, Athens 2007) recommended to the Parties to formulate and implement marine pollution monitoring programmes pursuant to Article 12 of the Barcelona Convention and Article 8 of the amended LBS Protocol. Unfortunately the gaps in special coverage of the Mediterranean coastline still remain. The improvement the situation is one of the major challenges for the future of the MED POL monitoring programme in the region.

Table 2.2. MED POL Phase III and IV data provided (MED POL database)

Country	Nutri-ents	Chl-a	Biota Trace Metals	Biota Organic contami-nants	Sediment Trace Metals	Sediments Organic contami-nants	Rivers Nutrients etc.	Oceano-graphic parameters (Temp., etc.)
Albania	2005 2006		2001 2002 2003 2004 2005 2006 2007	2003 2004				
Algeria								
Bosnia-Herzegovina	2006 2007 2008							
Croatia				1999 2000 2003 2004 2005 2006	2002 2003 2004 2005		2000 2001 2002 2003 2004 2005	
Cyprus	2001 2007	2004 2005 2006 2007	1999 2001 2005 2006	2000 2001 2002 2003 2004				2001 2002 2003 2004 2005 2006 2007
Egypt	2006 2007 2008		2006					
France			1997 1998 1999 2000 2001 2002 2003 2004 2005 2006	1997, 1999 2000 2001 2002 2003 2004 2005 2006				
Greece	1999, 2000 (few), 2004 2005	1999, 2000 (few), 2004 2005	1999, 2004 2005	1999, 2004 2005	1999 2000 (few), 2004 2005			
Israel	2002 2003 2004 2005 2006 2007	2001 2002 2003 2004 2005 2006 2007	1999 2000 2001 2002 2003 2004 2005 2006 2007		1999 2000 2001 2002 2003 2004 2005 2006 2007			2003 2004 2005 2006 2007

Table 2.2. Status of provision of data MED POL Phase III and IV (MED POL database) (continued)

Country	Nutri-ents	Chl-a	Biota Trace Metals	Biota Organic contamni-nants	Sediment Trace Metals	Sediments Organic contami-nants	Rivers Nutrients etc.	Oceano-graphic parameters (Temp., etc.)
Italy	2001 2002 2003 2004 2005	2001 2002 2003 2004 2005	2001 2002 2003 2004 2005	2001 2002 2003 2004 2005	2001 2002 2003 2004 2005	2001 2002 2003 2004 2005		
Lebanon								
Libya								
Malta								
Monaco								
Montenegro								
Morocco	2006 2007 2008		1998, 2000 2001 2002 2003 2004 2005 2006 2007 2008	2006 2007	2006 2007			2006 2007
Slovenia	1999 2000 2001 2002 2003 2004 2005	1999 2000 2001 2002 2003 2004 2005	1999 2000 2001 2002 2003 2004 2005 2006	2000 2001 2002 2003 2004 2005 2006		1999 2000 2001 2002 2003 2004 2005 2006	2003 2004 2005	
Spain			2004 2005 2006 2007	2004 2005 2006 2007				
Syria	2007		2007		2007			
Tunisia	2002 2003 2004 2005 2006 2007 2008	2002 2003 2004 2005 2006 2007 2008	2001 2002 2003 2004 2005 2006 2007 2008	2007	2001 2003 2004 2005 2006 2007 2008	2001-2002, 2004 2005 2006 2007 2008		2005 2006 2007 2008
Turkey	2005 2006 2007 2008	2005 2006 2007 2008	1998 1999 2000 2001 2002 2003, 2006 2007 2008	2003, 2005 2006 2007 2008	1999 2000 2001 2002 2003 2005 2006 2007 2008	2005 2006 2007 2008	2001, 2006 2007 2008	2006 2007 2008

MED POL III and IV marine monitoring database

The MED POL database continues to be regularly updated with the new data provided by the countries. However, it was found that it is very difficult to combine data from previous MED POL Phases (I and II) with data provided during MED POL Phases III and IV. In fact, unlike for Phase I and Phase II, during Phases III and IV countries used similar methodologies in sampling and analysis and data were provided using standardized formats (Excel sheets). As a result, data generated during Phases III and IV are more compatible between them because:

- they are collected from the same stations every year and the stations have known geographical coordinates and can be placed on a GIS map

- they are collected following similar methods for sampling and analysis

- they are referring to similar parameters in comparable matrixes (water, sediment, biota)

- they are collected from Institutions which are asked to follow data quality assurance systems

As a result, after quality control of the data in order to correct editing mistakes and omissions, a new Database was created for the MED POL Phase III and IV data (from 1998 onwards).

One of the initial requirements in the preparation of the MED POL Phase III and IV database was to indicate the exact location of the sampling stations and to ensure their reproducibility year after year. To this end, at the beginning of Phase III, countries identified the monitoring stations with exact coordinates and with a specific station name. The idea was to use the same stations every year to track the changes in the quality of the marine environment. Although some countries followed this pattern, in some cases the reported stations changed names or coordinates from year to year. When it was needed, the Secretariat contacted the countries concerned and tried to clarify the exact name and coordinates of stations. **It is very important to underline that in the years to come, the locations (coordinates) and the names of the stations designated for monitoring remain the same, in order to be uploaded correctly in the database and avoid reporting the same station as a different one. In case that a monitoring station has to change, the country should inform MED POL accordingly in order to update the database accordingly.**

The MED POL Information System is under development and it is actually ready to be tested by the countries with real data.

3. Data Quality Assurance

3.1. Hazardous contaminants

The IAEA-MESL has had the prime responsibility of running the data quality assurance programme (DQA) for chemical contaminants for MED POL for the last 30 years.

The DQA comprises several components:

- Reference methods
- Provision of reference materials and standard solutions
- Training in the analysis of chemical contaminants in sediments and biota
- Training in good laboratory practice, including notably QA/QC procedures
- Laboratory performance studies (inter-comparison exercises, proficiency tests)
- Split sample analysis

3.1.1. Proficiency tests

Particular emphasis was placed on the laboratory performance studies. Such proficiency tests have been held regularly for the determination of both organic and inorganic contaminants. In the alternate years, the test material is either a sediment or biota sample. Laboratories were given about six months to complete analyses and provide results to MESL. The organic compounds encompass petroleum hydrocarbons, including notably polycyclic aromatic hydrocarbons (PAHs); polychlorinated biphenyls (PCBs); several chlorinated pesticides, especially DDT and its breakdown products, and a range of sterols on some occasions. Several metals were tested, especially mercury and cadmium, together with methyl mercury in recent studies.

During the period 2006-2009, the following intercalibration exercises were completed and relative reports were published by IAEA/MESL:

a) Inter-laboratory study of sample IAEA-435: *World-wide and regional intercomparison for the determination of organochlorine compounds and petroleum hydrocarbons in tuna homogenate IAEA-435*, Report IAEA/MEL/78, February 2006). Participation of 31 laboratories from 14 countries.

b) Analytical performance study for MED POL: determination of chlorinated compounds and petroleum hydrocarbons in the sediment sample IEAE-159, Report June 2007). Participation of 24 laboratories from 10 countries.

c) Analytical performance study for MED POL: determination of chlorinated pesticides and petroleum hydrocarbons in biota samples IAEA-432 mussel tissue (IAEA Report March 2008). Participation of 19 laboratories from 11 countries.

d) Inter-laboratory study of sample IAEA-436: *World-wide Intercomparison Exercise for the determination of trace elements and methylmercury in tuna fish flesh homogenate IAEA-436*, Report IAEA/MEL/77, February 2006). Participation of 31 laboratories from 13 Member States.

e) Proficiency test of samples IAEA-436 (*Proficiency test for the determination of selected trace elements in biota* - Tuna Fish homogenate) (IAEA Report 2008). Participation of 21 laboratories from 12 countries.

f) Analytical performance study for MED POL: determination of trace element in estuarine sediment MESS-3 (NRCC Canada) (SD-MEDPOL/TM PT 2008), IAEA Report 2009. Participation of 27 laboratories from 13 countries.

Furthermore, two Analytical Performance Studies for MED POL are actually underway for the determination of trace element (IAEA-158) and chlorinated compounds and petroleum hydrocarbons (IAEA-159) in sediments. A statistical evaluation will be made after all results are received and reports will be available within 2010.

Also, two samples of marine biota have been prepared for interlaboratory study of organic contaminants (IAEA-451) and metals (IAEA-452). One of new emerging pollutant, PBDEs (flame retardant) is now included in the organic contaminants samples. IAEA-451 and 452 samples were distributed in December 2008. IAEA-451 samples were sent to 64 laboratories from 19 Mediterranean countries and IAEA-452 samples to 55 laboratories from 13 countries. The deadline for reporting was set for the end of December 2009.

Overall, the records of laboratories' participation in the DQA exercises for hazardous substances in biota and sediments over the last years indicate that most of the Mediterranean countries participate in the proficiency tests organised by IAEA/MESL.

The countries that for various reasons did not participate consistently until now have to try to encourage the laboratories involved in the National marine monitoring programmes in the framework of MED POL to participate in futures proficiency tests in order to ensure quality to the monitoring data. Furthermore, the National MED POL Focal Points have to assure that all laboratories which are involved in the country's national monitoring programme, are participating in these tests. However, because of financial constraints, only MED POL-participating laboratories should participate in the tests offered by MED POL.

Table 3.1. Number of Laboratories and countries participating in recently completed intercalibration exercises organized by IAEA/MESL

Sample tested	IAEA-435 2006	IAEA-159 2007	IAEA-432 2008	IAEA-436 2008	MESS-3 2009
	Chlorinated compounds in Tuna fish	Chlorinated compounds and PHCs in sediment	Chlorinated compounds and PHCs in mussel tissue	Trace elements in Tuna fish flesh	Trace elements in marine sediments
Albania	2	1	2	1	1
Algeria					
Bosnia-Herzegovina					1
Croatia	7	5	1	3	3
Cyprus	1			1	1
Egypt	1			1	
France	4	5		1	1
Greece		2	1	3	5
Israel	1	2		2	2
Italy	1	2	3		
Lebanon					
Libya					
Malta					
Monaco	1	1			
Montenegro					
Morocco	2	1	3	2	3
Slovenia	3	2	3	1	1
Spain	2	3	2		1
Syria	1		1	1	2
Tunisia	2		1	2	2
Turkey	3		2	3	4
TOTAL	31	24	19	21	27

In the IAEA/MESL Reports a detailed analysis is made on the quality of data for every single participating laboratory and the potential causes of errors are highlighted. However, more active feedback and follow up are needed in order to assure that the errors are corrected and the quality of the analytical data provided by the non-performing laboratories is improved.

A survey of the participation and performance of Mediterranean laboratories in recent MED POL organized Proficiency Tests and Interlaboratory Tests for **Trace Metals** is presented in Table 3.2. (2003-2009).

Table 3.2. Participation and performance of Mediterranean Laboratories in Proficiency Tests and Interlaboratory Tests for Trace Metal analysis

Exercise	Year	Matrix	Nb of Participants[1]	Nb of results reported
IAEA 452	2009	Scallops	24	17 (71%)
MEDPOL PT	2008	Sediment	33	25 (76%)
MEDPOL PT	2007	Fish	36	21 (58%)
IAEA 158	2006	Sediment	20	11 (55%)
SD MEDPOL/TM	2005	Sediment	24	13 (54%)
IAEA 436	2004	Tuna	30	16 (53%)
IAEA 433	2003	Sediment	28	15 (54%)

[1] Number of laboratories that had received the material

NOTE:

For Proficiency Test (MEDPOL PT's and SD MEDPOL/TM) a selected list of laboratories was determined in collaboration with MEDPOL and all laboratories in that list received the PT material.

For interlaboratory comparison (all IAEA samples) laboratories recorded as MEDPOL in our database received before the exercise a letter of invitation (reminding them that this exercise was done under MEDPOL project) and only laboratories that accept the invitation received the material.

The overall assessment of the MEDPOL laboratories per exercise is presented in Table 3.3. The better performing laboratories of Group 1 and 2 represented respectively 27-64% and 19-28% of the total participating Laboratories (for both groups 52-82%). These results indicate that the DQA in the Mediterranean Laboratories is still far from satisfactory and needs urgent upgrading.

Table 3.3. Number of laboratories in the different performance groups (trace metals)

Exercise	Year	Group 1	Group 2	Group 3	Group 4
MEDPOL PT 2008	2008	7 (28%)	7 (28%)	6 (24%)	5 (20%)
MEDPOL PT 2007	2007	10 (48%)	4 (19%)	4 (19%)	3 (14%)
IAEA 158	2006	7 (64%)	2 (18%)	2 (18%)	0
SD MEDPOL /TM	2005	7 (54%)	3 (23%)	1 (8%)	1 (8%)
IAEA 436	2004	8 (50%)	0	6 (38%)	2 (13%)
IAEA 433	2003	4 (27%)	3 (20%)	7 (47%)	1 (7%)

Group 1: laboratories with $|Z|$ <3 for ≥ 90% of their data
Group 2: laboratories with $|Z|$ <3 for 75% to 90% of their data
Group 3: laboratories with $|Z|$ <3 for 50% to 75% of their data
Group 4: laboratories with $|Z|$ <3 for < 50% of their data

Table 3.4. Percentage of outliers │Z│>3 (mean and range) in the results submitted for organic pollutants by different participating laboratories.

Year	Chlorinated pesticides	PCBs	Petroleum Hydrocarbons
2008	5% (0-18.2%)	10% (9-100%)	6% (0-15.4%)
2007	17% (0-86%)	23% (0-50%)	17% (0-89%)
2006	18% (0-100%)	21% (0-100%)	21% (0-50%)
2005	48% (33.3-60%)	38% (0-50%)	26% (3.7-50%)
2004	6% (0-50%)	6% (0-40%)	13% (0-66.7%)

As a conclusion, it appears that the organization of Proficiency tests cannot alone guarantee the improvement of the quality of the monitoring data produced. Although the results are communicated to the participating laboratories and the MED POL Focal Points of the countries, a more dynamic approach is needed. One possible way is to contact directly the bad-performing laboratories in order to assist them to improve their analytical performance. IAEA could act as a DQA consultant in this context. However, the cost of the Analytical Performance test follow-up has to be estimated.

Training courses

During 2006-2009, 8 training courses financially supported by MED POL have been organized in MESL for the training of Mediterranean scientists. Every year, one course is dedicated to the analysis of organic pollutants (chlorinated pesticides and PCBs) and one to the analysis of heavy metals in marine samples. The participation of Mediterranean scientists in these training courses during the period 2006-2009 is presented in Table 3.5.

The records indicate that during the last 4 years many countries have sent trainees to the training courses organised by IAEA/MESL and financed by MED POL. However it is not clear if the training courses have contributed to the improvement of the DQA in the laboratories from which the scientists originate. It would therefore be appropriate to follow up on the performance of the laboratories where these trained scientists are working after the completion of their training course and also to ensure that they are involved in the generation of data in the framework of MED POL.

Table 3.5. Participation of Mediterranean scientists in training courses for metals and organic contaminants

Country	2006		2007		2008		2009	
	Metals	Organics	Metals	Organics	Metals	Organics	Metals	Organics
Albania						X		
Algeria	X						X	X
Bosnia-Herzegovina		X			X		X	X
Croatia				X		X		X
Cyprus	X		X		X		X	
Egypt	X			X			X	X
France								
Greece								
Israel		X				X	X	X
Italy								
Lebanon		X						
Libya		X						
Malta						X		
Monaco								
Montenegro					X		X	
Morocco			X	XX	X	X	X	
Slovenia						X		
Spain								
Syria	X				X			
Tunisia			X		X		X	X
Turkey	X	X	X	X			X	X
TOTAL	5	5	4	5	6	6	9	7

3.2 Eutrophication

For eutrophication parameters an intercalibration exercise was completed in 2008 using the services of QUASIMEME. MED POL supported the participation of 15 Mediterranean laboratories in the exercise for the determination of nutrients and chlorophyll-a in seawater Table 3.6.).

Table 3.6. Participation of Mediterranean laboratories in intercalibration exercises for nutrients and chlorophyll-a (QUASIMEME)

Country	AQ1 (Nutrients in seawater)	AQ2 (Nutrients in low salinity seawater	AQ11 (Ch-a in seawater)
Albania	XXX		X
Algeria			
Bosnia-Herzegovina			
Croatia	X		X
Cyprus	X		X
Egypt	X		X
France			
Greece	X	X	X
Israel	X	X	X
Italy			
Lebanon	X		X
Libya			
Malta			
Monaco			
Montenegro			
Morocco	X		
Slovenia			
Spain			
Syria	X	X	
Tunisia	X	X	X
Turkey	XX	XX	XX

3.2 Biological effects monitoring

Following the positive experience of previous years, in order to improve DQA for the biological effects monitoring, a new agreement (SSFA) was signed between MED POL and DiSAV (February 2009) for the organization of an intercalibration exercise with the participation of Mediterranean and non-Mediterranean laboratories (from OSPAR and HELCOM). The intercalibration exercise will be finalized within 2009 and a Workshop to discuss its results will be organized in 2010.

Conclusions DQA

During the last 4 years, 19-31 laboratories form 10-14 countries have participated in the intercalibration exercises for hazardous substances and 14 laboratories from 11 countries for nutrients and Chl-a. In general, the countries which are participating in the tests are those which are also providing data. It is necessary to increase the participation of countries to the analytical performance tests and to improve the quality of the analytical results. Participation in data quality exercises (organized by MED POL or other international/regional bodies) is considered as mandatory for all laboratories providing monitoring data to the MED POL database. Furthermore, the laboratory performance should be adequate. Based on the MED POL intercalibration results, whereas the improvement in the regional capability to determine trace metals has been noted, the analysis of organic contaminants continues to pose a major analytical challenge for laboratories in the Mediterranean region.

It is believed that the time has come to look closely into the DQA activities that have been going on for many years in the framework of MED POL, in order to enhance their impact on the improvement of the quality of data generated in the region.

Regarding the training courses organized by MED POL and IAEA, since 1987 more than 130 Mediterranean scientists have been trained in the analysis of trace metals and organic contaminants. For some countries, more than ten people have been trained and in one case more than 20. It is therefore time to ask some questions on the results of this activity:

- Do we have a sufficient number of trained people in the countries;
- Are the MED POL / IAEA trained scientists working in the National monitoring programme?
- Have the participating Mediterranean laboratories introduced DQA systems in their routine work? If not, how we can assist them?
- Should we perform targeted training for specific analytical methods/pollutants in the laboratories with lower analytical performance?
- Should MED POL initiate training on other contaminants?

It is time to reconsider the benefits of the existing training programme and to introduce the necessary changes in order to improve the real capabilities of the Mediterranean laboratories in the analysis of pollutants.

4. Status and trend monitoring: Evaluation of environmental quality of the Mediterranean marine environment

4.1 Eutrophication (Based on the Assessment prepared by Mr. Antonio Cruzado)

Data from the MED POL III and IV database were used to prepare an assessment of the status of Mediterranean marine environment in relation to eutrophication. Eight countries provided data as contribution to the MED POL eutrophication monitoring programme (Albania, Cyprus, Greece, Israel, Morocco, Slovenia, Tunisia, Turkey). Most countries provided data on nitrogen forms (Tunisia did not provide NO3, NO2 and NH4 data and Albania and Turkey did not provide Total N data) and phosphorus forms (Israel did not provide Total P data and Tunisia did not provide PO4 data). Five countries reported data on Disolved Oxygen (Albania, Cyprus, Greece, Slovenia and Turkey).

Summary of the data in the MED POL Database

The MED POL files have 3,712 samples reported of which 3,686 have geographical coordinates. The 255 stations visited in total by the eight reporting countries, between 1999 and 2007, were monitored with frequencies ranging from one sample during the entire period (Albania) to 252 samples (Slovenia). More than half of the stations (56.4 %) had a number of samples smaller than 8 and only 7.5 % of the stations had more than 30 samples.

Assessment of the MEDPOL data

The assessment was made for each of the countries that had provided data. The geographical coordinates were plotted in Google's geographical database. (Figure.4.1)

Fig. 4.1: Position of the location of MED POL sampling stations

Some problems were encountered in preparing the visualization of the sampling stations, due to erroneous or incomplete (lack of adequate decimal points) entry of coordinates in the country Reports. In some cases, it was not possible to check the validity of occasional extremely high concentrations, values sometimes orders of magnitude greater than those expected to be found in the marine and coastal environment.

Country Reports

ALBANIA

The 6 data entries of the MEDPOL Database correspond to monitoring carried out in three different coastal areas. The monitoring took place during the years 2005 and 2006. The samples were taken at 0.1 m depth. Table 4.1 shows the range of the data.

Table 4.1. Minimum and Maximum values for the variables monitored

TEMP	DO	NH4	NO2	NO3/NO2	NO3	PO4	TP
13,60	2,15	0,71	0,14	1,75	0,29	1,02	0,39
19,20	9,05	21,42	0,75	8,64	7,86	8,30	3,97

The measurements took place in winter and spring. At the reference station, the oxygen concentration was around 7 ml O_2 L^{-1} but, at the northern station, near Durrës, the dissolved oxygen concentration showed great variations, between 2.15 and 9.05 ml O_2 L^{-1} as did all the nutrients, particularly ammonium that showed values of 21.42 µg-at L^{-1} in one of the two measurements. Interestingly enough, also the reference station gave values of 12.85 µg-at L^{-1} for ammonium, 4.79 µg-at L^{-1} for nitrate, 4.57 µg-at L^{-1} for phosphate and 8.30 µg-at L^{-1} for silicate while Total P gave only a value of 0.39 µg-at L^{-1}, thus casting some doubt as to the quality of the data reported.

From the scanty information, it may be concluded that, at least the station located north of Durrës (ALB2_C1), had some signs of eutrophication (low oxygen, high nutrient concentrations).

CYPRUS

The 466 data entries of the MED POL Database correspond to monitoring carried out between 1999 and 2007 in various areas of the Southern Cyprus coastline..
Values ranged at bottom depth from 0.5 to 400 m and samples were taken mainly at the surface (under 1 m depth) but some were taken up to 50 m depth.

Table 4.2 Minimum and Maximum values for the variables monitored

TEMP	SALIN	DO	NH4	NO2	NO3	PO4	TN	TP
15,7	3,7	4,2	0	0	0	0	0,90	0,32
39,6	40	15,8	16,49	14,29	1642,86	102,14	130,97	310,97

Surface waters at station TOXEFTRA, on Coral Bay, a pristine area to the West of the Island, showed Total N values as high as 2,23 - 30,00 µg-at L^{-1} and Total P values in the range 0,32 - 44,52 µg-at L^{-1}, comparable to the range of values reported for Agrotis Outfall, thus pointing to a possible analytical problem. Extremely high nutrient concentrations are reported in other samples, including the Reference station to the east of the Akrotiri Peninsula, showing Total N values in excess of 30 µg-at L^{-1}. This is also the case in the Reference stations off Zigy fishing harbour.

Extremely high nutrient values (nitrate in excess of 1500 μg-at L^{-1}) were also reported for surface waters in various Aquaculture areas although the values at subsurface samples seemed to be normal. In other stations such as Sunwing, to the east of Larnaca, nitrate values as high as 197 or 714 μg-at L^{-1} are found, values worse that those found in most polluted areas near outfalls.

To judge from the nutrient values reported, various areas of the country may have been subject to strong pollution from land-based operations. However, data have to be evaluated again with the data providers for quality assurance, before conclusion.

GREECE

The 565 data entries of the MEDPOL database correspond to monitoring carried out between 1999 and 2004 in various areas of mainland Greece coastline and around the Aegean Sea.

Values ranged at bottom depth from 6 to 1000 m but half of the samples were taken at a depth of 10 m or less. No values for salinity were reported. Water temperature ranged between 12.69 ºC and 27.60 ºC, which indicates that all the seasons were covered. An important number of samples had DO below 4 ml O_2 L^{-1} in the areas GRE1 and GRE10, in Elefsina Bay and in the north of the Gulf of Aegina, with some of the samples at depths greater than 200 m.

High ammonium concentrations >10 μg-at L^{-1} were found in Aghios Giorgios, east of the Halkidiki peninsula, with highest values at 50 μg-at L^{-1}. Also nitrite showed very high values above 10 μg-at L^{-1} in some of the stations around Thessaloniki. Nitrate reached values > 10 μg-at L^{-1} with upper values of > 100 μg-at L^{-1} in the Gulf of Patras. Phosphate was > 1 μg-at L^{-1} that is three times higher than background in various stations of the Saronikos Gulf, Gulf of Patras and Kavala areas. Total Nitrogen concentrations in excess of 100 μg-at L^{-1} were found particularly in the Gulf of Patras.

Table 4.3. Minimum and Maximum values for the variables monitored

NH4	NO2	NO3/2	PO4	SiO4	TN	TP
0,00	0,00	0,08	0,01	0,31	0,00	0,09
51,11	15,22	163,18	9,79	298,07	163,18	0,69

To judge from the nutrient values reported, various areas of the country, particularly near the large cities Athens, Thessaloniki and Patras may have been subject to strong pollution by nutrients from land-based sources.

Samples with nitrate concentrations > 80 [μg-at L^{-1}] correspond to stations GRE2_1WH, GRE2_2WC, GRE2_3, WC GRE2_4WC, GRE2_5WH, GRE2_6WC and GRE2_7WH all located in the Gulf of Patras (Patraikos Kolpos) between the Rio/Antirio bridge and Messolongi. On the other hand, concentrations of nitrate ranging between 15 and 60 [μg-at L^{-1}] correspond to station GRE3_THE7_WRI in the Gulf of Thessaloniki just in front of a treatment plant of a drain in the Chalastra area. Other samples are with some exceptions all within reasonable limits <10 [μg-at L^{-1}]. . On the other hand, high Chlorophyll values were found at stations GRE3_PIE1_BS, GRE3_STR-3 in the Kavala area and GRE3_THE1, GRE3_THE3, GRE3_THE4 in the Gulf of Thessaloniki.

ISRAEL

The 105 data entries of the MED POL database correspond to monitoring carried out in various areas of Israel between 2001 and 2007: Ashdod, Tel Aviv near the Yarkon River and the industrial harbour, Mihmoret off the harbour and Alexander River, Caesarea off the river draining a large aquaculture area, and Haifa Bay from the entrance to Haifa port, a liquid/gas storage facility, the Almogim outfall and Acre Bay industrial area and harbour.
Values ranged at bottom depth from 0.5 to 12 m and samples were always taken at the surface (under 1 m depth). Temperature ranged from 28 to just over 33 ºC and salinity ranged between 38.45 and 39.95. Dissolved oxygen ranged between 5.35 and 9.73 $mlO_2\ L^{-1}$ except one observation in Ashdod that gave a value of 2.69 $mlO_2\ L^{-1}$.
All nutrients give very high values at one or more samples: for example ammonium, nitrite and nitrate were very high off the industrial area of Acre, while phosphate was extremely high off the Marina zone in Ashdod and at the entrance of the port of Haifa.

Table 1.4: Minimum and Maximum values for the variables monitored

NH4	NO2	NO3/2	NO3	PO4	SiO4	TN
0,00	0,00	0,00	0,00	0,01	0,22	0,08
12,29	1,50	11,97	10,47	20,91	15,48	24,26

The stations ISR_TMC_22, ISR_TMC_23, ISR_TMC_26 and ISR_TMC_39 showed the highest Nitrate and Chlorophyll values. To judge from the nutrient values reported, harbour and industrial areas in various parts of the country, particularly off Haifa and Acre, were subject to strong pollution from land-based and/or ship operations (stations 22, 23, 26 and 39). The oxygen values pointed out to only one area off the Yarkon River in Tel Aviv where the values could be the result of oxygen depletion.

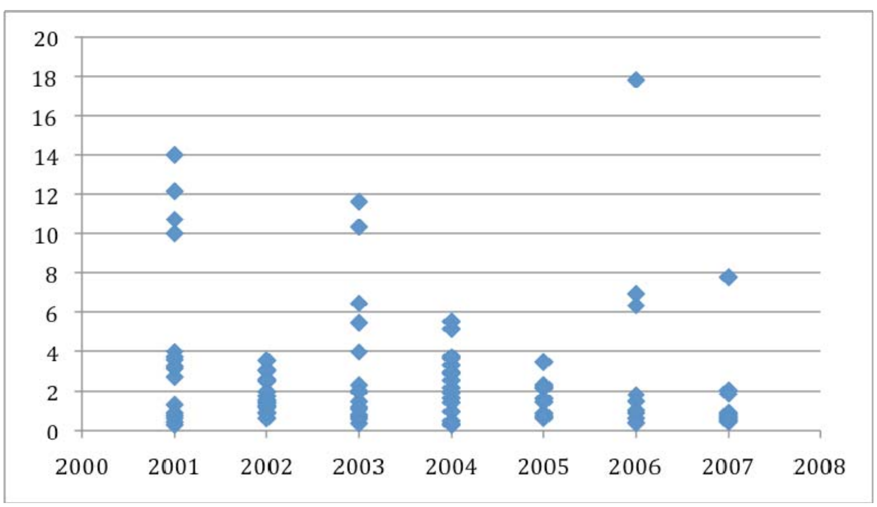


Figure 4.2. Chlorophyll a concentrations [$\mu g\ L^{-1}$] in MED POL samples from Israel

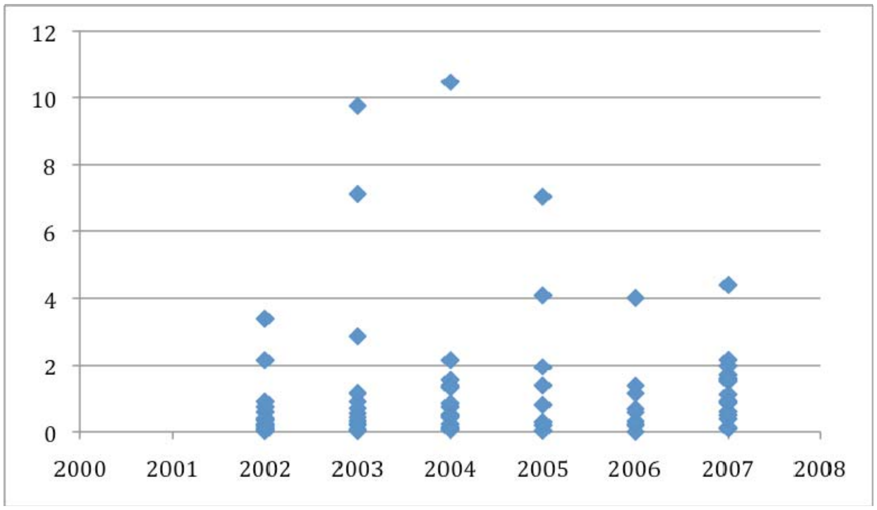


Figure 4.3. Nitrate concentrations [μg-at L^{-1}] in MED POL samples from Israel

MOROCCO

The 48 data entries of the MED POL database correspond to monitoring carried out in various areas of northern Morocco from Tangiers to Nador.

No indication of the bottom depth or the sampling depth was provided and no salinity or dissolved oxygen data were given. Table 1 shows the range of the nutrient data in μg-at L^{-1}.

Table 4.5. Minimum and Maximum values for the variables monitored

NH4	NO2	NO3	PO4	SiO4	TN	TP
1800	8	0	10	21200	2800	10
103600	140	14300	9600	964000	136200	15800

None of these values seem to fall within a reasonable range for coastal or inland waters: only four values were lower than 10 μg-at L^{-1} for nitrate, four with less than 10 μg-at L^{-1} for phosphate and five values were below 100 μg-at L^{-1} for Total P.

Even taking into account that the samples were mostly taken at pollution Hot Spots, the numbers reported are too high even for waste waters; as a result, no assessment could be made of the impact on coastal or inland water bodies in terms of eutrophication. The data have to be evaluated with the collaboration of the data providers.

SLOVENIA

The 1063 data entries of the MED POL Database correspond to monitoring carried out between 1999 and 2005 in various areas of the Slovenia coastline. Some entries could not be analyzed as the coordinates of some sampling points were obviously not correct.
Values ranged at bottom depth from 0.4 to 24 m but half of the samples were taken at a depth of 10 m or less. No values for salinity were reported. Water temperature ranged between 1 ºC and near 28 ºC which indicates that all the seasons were covered. Most of the samples analyzed had DO concentrations between 4 and 10 ml O_2 L^{-1} but some stations had extremely low DO values, one sample showed 0 ml O_2 L^{-1} and 26 samples ranged <4 ml O_2 L^{-1}. No chlorophylls were reported.

Table 4.6. Minimum and Maximum values for the variables monitored

NO2	NO3	PO4	SIO4	TN	TP
0,01	0,01	0,01	0,1	0	0,1
47,16	1096,16	44,7	219,57	3821,7	54,17

Of the samples analyzed, 220 show ammonium concentrations > 2 μg-at L^{-1} and 45 show concentrations > 10 μg-at L^{-1} and five samples >100 μg-at L^{-1}. With regard to nitrite, 55 samples are above 1 μg-at L^{-1} while only five samples were > 5 μg-at L^{-1}. As far as Nitrate is concerned, 36 samples were recorded > 100 μg-at L^{-1} and one station 00BA showed nitrate concentrations above 1000 μg-at L^{-1}. With regard to Phosphate, 50 samples were above 1 μg-at L^{-1} and 11 samples were above 5 μg-at L^{-1}. Silicate was found to be higher than 10 μg-at L^{-1} in 247 samples and above 100 μg-at L^{-1} in thirty samples.

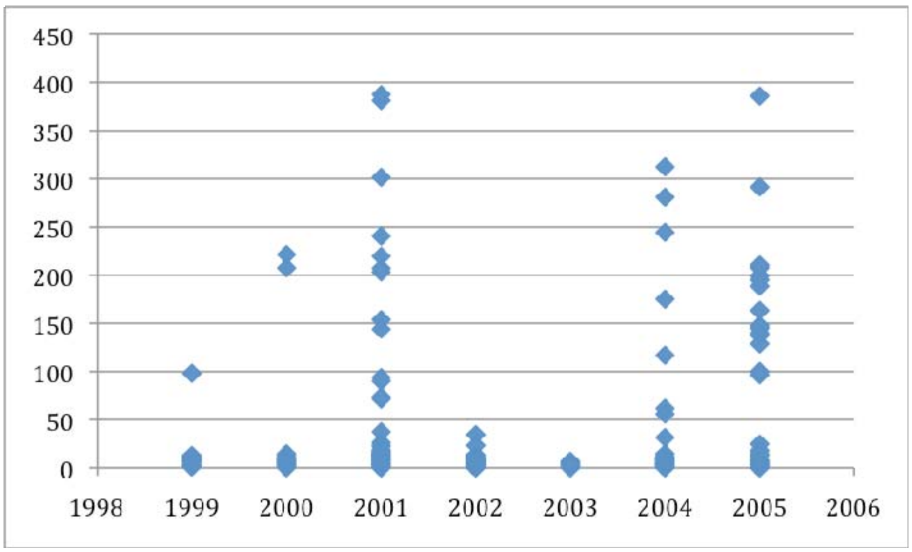


Figure 4.4: Trend in Nitrate concentrations [μg-at L^{-1}] in MED POL samples from Slovenia

Total N was above 1000 μg-at L^{-1} in three samples from stations SK04, 00BA and SK03 and above 100 μg-at L^{-1} in 80 samples. Total P was above 10 μg-at L^{-1} in seven samples of stations SK04, 00RI, SK03, SK04, 00IO, 00BA and 00DN.
To judge from the nutrient values reported (Nitrate > 100 μg-at L^{-1}), various areas of the country may have been subject to strong pollution by nutrients from land-based sources (samples 00BA, 00DN, 00DR, 00RI, SK03, SK04).

TUNISIA

The 44 data entries of the MEDPOL Database correspond to monitoring carried out in five different areas. One station is located in the Lac de Bizerte, a second is off Carthage, both on the northern coast. Three stations are located in the Tunis area, two in the channel giving access to the industrial harbour, in the Lac de Tunis, and one off Hammamet (although the given coordinates place the station about 3.5 km inland) and a fifth one in the Gulf of Gabès. Again some samples had coordinates located inland. The issue has to be discussed and clarified with the data providers.
The monitoring was carried out between 2002 and 2007 at depths ranging from 0.5 to 2 m and covered only Total N and Total P. However, eight of the data entries had abnormally high values between 9,000 and 90,000 μg-at L^{-1}, associated to the only observations of

salinity also with unacceptable values mostly above 300. After ignoring these data, the Total N values ranged 4.56 – 123.55 μg-at L^{-1} and the Total P ranged 1.46 – 123.51 μg-at L^{-1}, most of the values being on the high end. It is thus not possible to make an assessment of eutrophication in Tunisian waters with the data available.

TURKEY

The 83 data entries of the MED POL Database correspond to monitoring carried out at the vicinity of Mersin, a busy commercial port town on the southeastern coast of Turkey, during the years 2006 and 2007. The observations covered all seasons and depths ranging between the surface and 50 m.

Table 4.7: Minimum and Maximum values for the variables monitored

TEMP	DO	NH4	NO2	NO3	PO4	SIO4	TP
15,64	5,57	0,04	0,02	0,03	0,02	0,31	0,10
27,27	9,79	25,54	0,76	15,80	2,15	8,30	6,32

Most of the values were within reasonably normal ranges. Only 9 data entries showed completely anomalous nutrient values in the high end of the range. The stations in which such data were obtained are located off Mersin harbour. One of the stations EUTMR2 is just off the Dumlupinar beach zone, the other in front of the harbour EUTMR7 and a third, EUTMR4, not far from the Efrent River mouth.

The temperature of the monitored stations shows extreme values around 16 ºC in winter and above 27 ºC in summer. Dissolved oxygen was always high, even at 45 m depth were values maintained between 7 and 8 ml O_2 l^{-1}. Ammonium concentrations were mostly below 1 μg-at L^{-1}, a relatively high value for coastal waters but 26 out of the 83 data points showed ammonium concentrations above such a threshold and as high as 25 μg-at L^{-1}, many of which were from the Mersin harbour stations. Nitrite, a good indicator of relatively eutrophic waters, was always low < 0.3 μg-at L^{-1}, with only 16 values above this concentration but always below 0.76 μg-at L^{-1}. The highest nitrite concentrations were always at the surface, particularly high in the Mersin harbour stations. Nitrate, with concentrations ranging between 0.03 and 15.8 μg-at L^{-1}, shows a completely reverse trend to what would be expected, with high values at the surface and very low values near the bottom at around 45 m. The highest values corresponded to the Mersin harbour stations. Phosphate, very scarce in the Levantine basin, was above 0.3 μg-at L^{-1} only in the surface of the Mersin harbour stations where Total P was also above 0.3 μg-at L^{-1} and quite high in some of the samples. Silicate, with deep values around 1.5 μg-at L^{-1}, showed a high variation in the surface values ranging from 0.3 to 8.3 μg-at L^{-1}, with the highest values in the Mersin harbour stations.

One index of the *quality* of marine waters is the Nitrate/Phosphate ratio. Oceanic waters show a N/P ratio (Redfield ratio) close to 16 that for the Western Mediterranean goes up to 22 and even more for the Eastern basin. However, after removing what could be considered as *outliers* in the phosphate column, the N/P ratio was found to be close to 10, indicative of phosphorus polluted surface waters in the Bay of Mersin.

Assessment of Chlorophyll images of the Mediterranean Sea

What follows is based on a series of images obtained from the Giovanni online system derived from SeaWiFS/MODIS Aqua combined with 8-day images averaged between August 2002 and December 2008. Even though the spatial resolution is not very high (9 x 9 km) and therefore local effects cannot be properly evaluated, the use of remote sensors (SeaWiFS/MODIS, MERIS) can be considered an important tool.

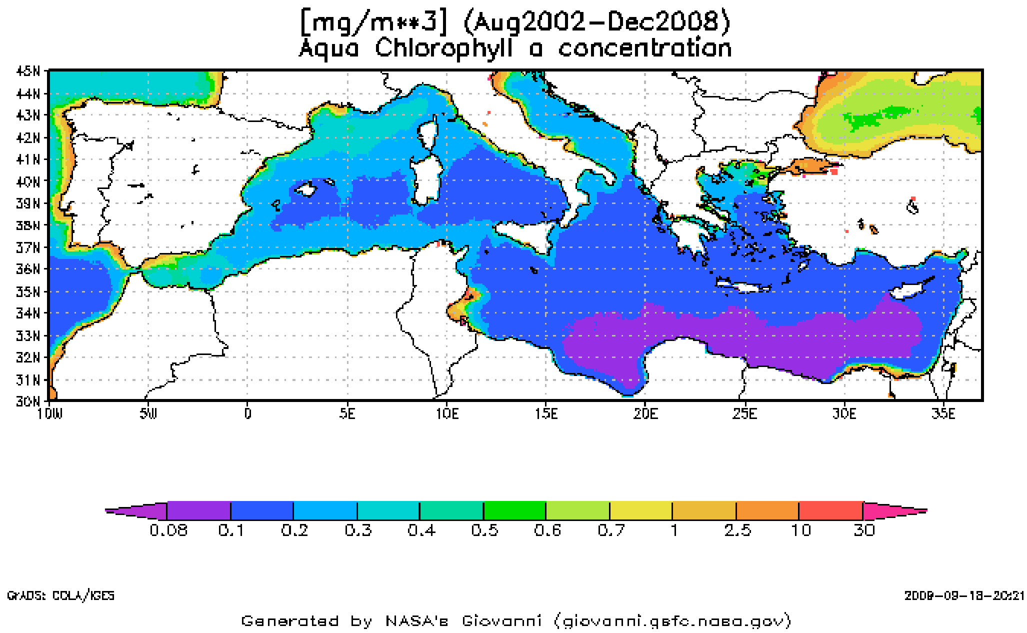
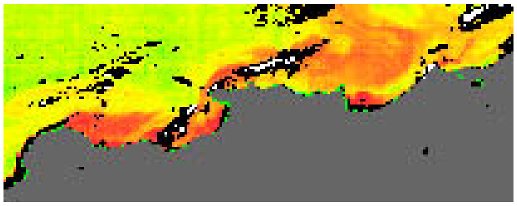


Figure 4.5: Composite image of Chlorophyll a in the Mediterranean Sea averaged between Aug 2002 and Dec 2008.

The example in Figure 4.5 shows the general low surface values of Chlorophyll a (< 0.5 μg L^{-1}) indicating the mostly oligotrophic waters of the Mediterranean Sea. Yet, several areas around the region show higher than average values. Among others, the Andalousian coast of Spain, the Gulf of Lions, the Northern Adriatic Sea, the Northeastern Aegean, along the North coasts, and the Egyptian coast in the Nile River delta and the Gulf of Gabès in Tunisia on the South shores. Other, less conspicuous, areas may show relatively high Chlorophyll a concentrations but the large scope of this image does not allow a precise site observation.

The use of remote sensors for the study of water colour has become a common strategy. Although the images and data have a quite reliable quantitative value, there is a need for important corrections for atmosphere transparency, sun glitter and other factors altering the colour of the water below, by using algorithms to extract sensible results from remotely sensed spectrometric values.

The information freely available has relatively low resolution (9 x 9 km). However, images may be obtained from either NASA or ESA with full resolution (300 m for MERIS in coastal areas). Examples of high resolution imagery from MERIS are the two images in Figure 4.6 below, (right) the coast of Spain from Tarragona to Cabo de Palos and (left) the coast of Algeria. Individual images show the impact of rivers and other discharges and the impact on the system of hydrodynamic structures. They constitute a very important tool for assessing the extent of the impact of freshwater discharges on the coastal system. However, Eutrophication is not a generalized phenomenon in the Mediterranean Sea. Only very specific zones show symptoms of this phenomenon as areas receiving nutrient-rich freshwater discharges may be exposed to active hydrodynamics that allow easy dispersion of the nutrients received and of the phytoplankton produced subsequently.



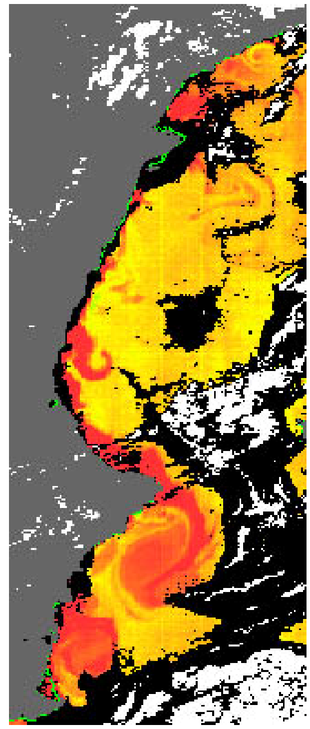


Figure 4.6: Two images of surface chlorophyll obtained from ESA's MERIS sensor of the Algerian coast (above) and of Eastern Spain (right).

Conclusions eutrophication

The Mediterranean basin as a whole is not experiencing wide spread eutrophication problems. In fact, surface chlorophyll values are extremely low and comparable to the most oligotrophic areas of the world's oceans like the Sargassos Sea in the subtropical North Atlantic.

On a smaller scale, from tens to hundreds of kilometers, there are important zones that may show signs of eutrophication, because of the existence of important sources of man-made nutrients that increase the otherwise low productivity of coastal waters. It is however difficult to separate man-made from naturally occurring sources of nutrients. River waters in fact naturally carry nutrients from decomposition of organic matter being produced all over their watershed, leading to similar symptoms that we call eutrophication. Excess nutrients added by anthropogenic activities (agriculture, industry, urban development with sewage systems) generate cultural eutrophication.

Cultural eutrophication appears to be a widespread phenomenon in most coastal areas of the world's oceans. Yet, the intensity with which this phenomenon appears at a particular location and the environmental impact it has is an important element that should lead administrations to control and when possible to reduction of the amount of extra nutrients discharged. The context in which the nutrient discharges enter the marine environment is extremely important. Local hydrodynamics play an extremely important role in determining the receiving capacity of a coastal area. The effect of nutrients discharged by the Rhône River in the Gulf of Lions is not the same as that produced by the nutrients discharged by the Po River in the North Adriatic. The nutrients discharged by the metropolitan area of Barcelona do not have the same effect than those discharged by the city of Izmir with about the same population (> 4 Million).

Some areas of the Mediterranean Sea have high values of surface chlorophyll-a indicating the possible existence of medium scale cultural eutrophication problems. They are mostly adjacent to large rivers' mouth such as the Ebro, Rhône, Tevere, Po, Aliakmon, Seyhan and Nile. Other areas may show the effect of point sources such as urban agglomerations and harbours (e.g. Valencia, Barcelona, Marseilles, Athens, Izmir, Mersin, Tunis, etc.). Still other areas may show high chlorophyll values due to natural phenomena (e.g. Alboran Sea, NW Mediterranean Sea, North Adriatic, NE Aegean, etc.).

Remote sense information, when used in a comprehensive way, is an excellent complement to field work and its use has to be encouraged.

4.2. Hazardous substances in sediments and biota (based on the Assessment prepared by Prof. Joan Albaiges, in cooperation of Mr. Jordi Pon and Ms. Carla Murciano)

The monitoring activities in the framework of MED POL III and IV basically covered heavy metals (mainly mercury and cadmium) and halogenated hydrocarbons (mainly PCBs and DDTs) in sediments and marine biota. A major outcome of these Phases was the setting up of a Database (MEDPOL.mdb) and the inter-linked web version (http://195.97.36.231/medpol/). The MEDPOL monitoring database is at the moment hosting monitoring data of 14 Mediterranean countries, and although the content is highly variable and the portion of data for each component and country is uneven it constitutes a relevant source of information which has been assessed in the present report.

In principle, the attention for this assessment was focused on sediments and biota, as these are the most indicative compartments of the state of the environment. Moreover, only representative data was used, basically considering the existence of sufficiently large datasets. In this respect, only trace metals were found suitable for assessment at the regional level in sediments. In the case of biota, the Database includes a large number of marine species, but the report was focused on one bivalve (*Mytilus galloprovincialis*) and one benthic fish (*Mullus barbatus*) as they are the more common and widely analyzed species in the region.

As far as the parameters are concerned, they were selected taking into account the total number of samples and the geographical and temporal coverage. Thus, the selection of metals was performed on the basis of those considered of priority concern, namely Cd, Hg, Pb, Zn and Cu. Among chlorinated hydrocarbons, the study was primarily focused on the families of DDTs and PCBs, as the more representative POPs. The Drin's (aldrin, endrin and dieldrin), HCB and lindane were also considered.

In order to harmonize the database, all concentrations were recorded in μg g^{-1} or ng g^{-1} dry weight. In cases where they were reported in other units or in wet weight basis, they were converted accordingly. In summary, after selection and harmonization of data, a total of 28,210 observations, corresponding to more than 400 stations monitored during the MEDPOL Phases III and IV (1999-2007) have been included in the assessment. The assessment is divided in three sections: i) occurrence and geographical distribution of trace metals (in sediments and biota) and chlorinated pesticides and PCBs (in biota); ii) risk assessment and identification of hot spots; and iii) temporal trends.

4.2.1. <u>Occurrence and geographical distribution of trace metals and chlorinated compounds</u>

a) *<u>Metals</u>*

<u>Sediments</u>

In general, good data coverage was found for the Northern part of the Mediterranean basin while only a small number of sampling points are present in the Southern riparian countries. Although the number of samples is far from being representative of the basin and the lithology of the continental shelf may influence the occurrence of trace metals in sediments, the values given in Table 4.8. provides an overall picture of the region concerning the concentration ranges of Cd, total Hg, Pb, Zn and Cu, the first two exhibiting values several orders of magnitude lower than Zn, being Pb and Cu in an intermediate and similar position.

Table 4.8. Trace metals in sediments. Median (and range) values (μg g^{-1} dw)

Eco-region	**Cd**	**Total-Hg**	**Pb**	**Zn**	**Cu**
Adriatic	0.21 (0.01-18.5)	0.10 (0.01-166.9)	9.5 (0.39-1033)	65.7 (5.0-980)	16.1 (1.39-122)
Aegen-Levantine	0.11 (0.01-8.47)	0.16 (0.00-5.18)	5.9 (0.03-132.3)	26.8 (0.07-1505)	11.2 (0.31-198)
Central Mediterranean	0.53 (0.38-0.65)	0.05 (0.01-6.00)	4.3 (0.33-50.4)	34.4 (0.05-176)	5.14 (0.29-52.9)
Western Mediterranean	1.60 (0.23-7.61)	0.16 (0.02-12.6)	19.4 (0.24-256)	50.1 (1.0-731)	13.9 (0.68-107)

In general, these values are in the lower range than those reported in previous assessments derived from MEDPOL I and II (UNEP, 1996). For example, the reported values for Cd, Pb, Zn and Cu were, respectively, of 0.02-64, 3-3000, 1.7-6200 and 0.6-1890 μg g^{-1} dw (UNEP, 1996). The individual analysis reveals the occurrence of some stations with high levels of Hg, Pb and Zn sediment concentrations in Croatia, and Zn and Cu in Turkey and Israel. A wide range of values for all metals was found in Italy, particularly for Pb. Average values of Zn and Cu in the higher range were also found in Morocco (Figures 4.7 and 4.8).

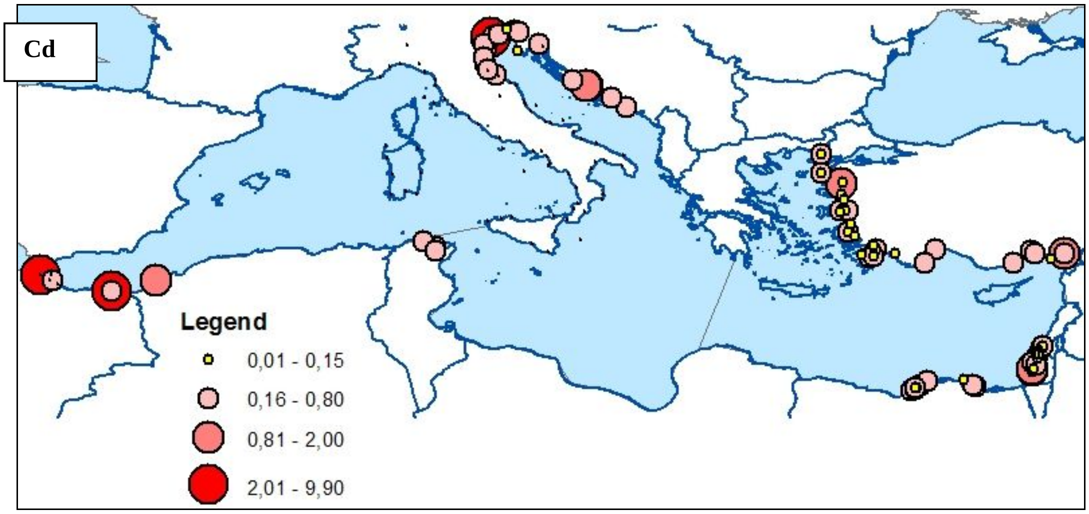


Figure 4.7. Mean concentrations of Cd in sediments (µg g^{-1} dw).

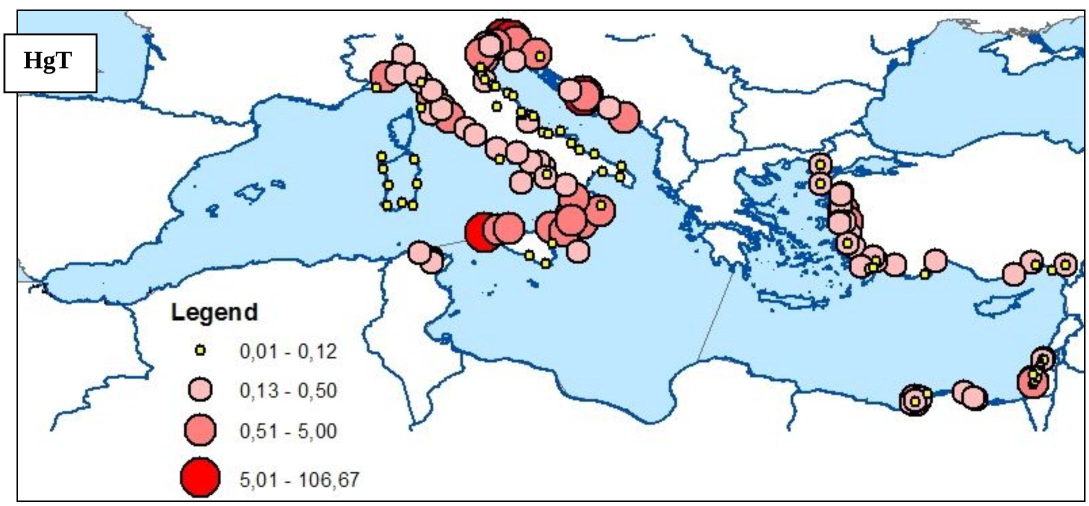


Figure 4.8: Mean concentrations of Hg in sediments (µg g^{-1} dw).

Biota

The summary of data corresponding to trace metals in *Mytilus galloprovincialis*, shown in Table 4.9 provides the range of values found in each sub-region. The accumulation in mussels follows a similar trend than for sediments Cd > HgT > Pb > Zn. The average levels of Hg and Pb in Spanish mussels seem to be above and below the usual ranges, conversely to Italy and France, whereas Cd, Zn and Cu exhibit a more homogeneous distribution, with the exception of Spain for the latter, which is also below the average values.
Table 4.9: Trace metals in Mytilus galloprovincialis. Median and range values (µg g^{-1} dw)

Eco-region	Cd	Total-Hg	Pb	Zn	Cu
Adriatic	0.75 (0.03-2.73)	0.15 (0.01-8.45)	1.49 (0.07-67.5)	121 (5.7-467)	7.92 (0.51-81.6)
Aegen-Levantine	0.36 (0.05-5.27)	0.06 (0.01-0.63)	2.09 (0.84-5.97)	68 (6.7-325)	5.90 (1.01-36.1)
Central Mediterranean	0.44 (0.13-3.40)	0.18 (0.01-7.00)	0.81 (0.07-5.36)	87 (11.6-565)	9.32 (1.36-70.5)
Western Mediterranean	0.66 (0.01-10.0)	0.16 (0.01-259)	1.30 (0.01-79.1)	122 (0.01-5337)	5.91 (0.04-114)

The Adriatic and the Western Mediterranean are, in general, the regions with the higher values (Figure 4. 9). The concentrations of trace metals in sediments and mussels exhibit a fair correlation except in the case of Zn, which can be attributed to a major influence of the sediment lithology.

Metals in *Mullus barbatus* have only been reported for the Aegean-Levantine region. In general, concentrations are within similar ranges but certain stations from Greece and Turkey exhibit the higher levels of Cd and Cu.

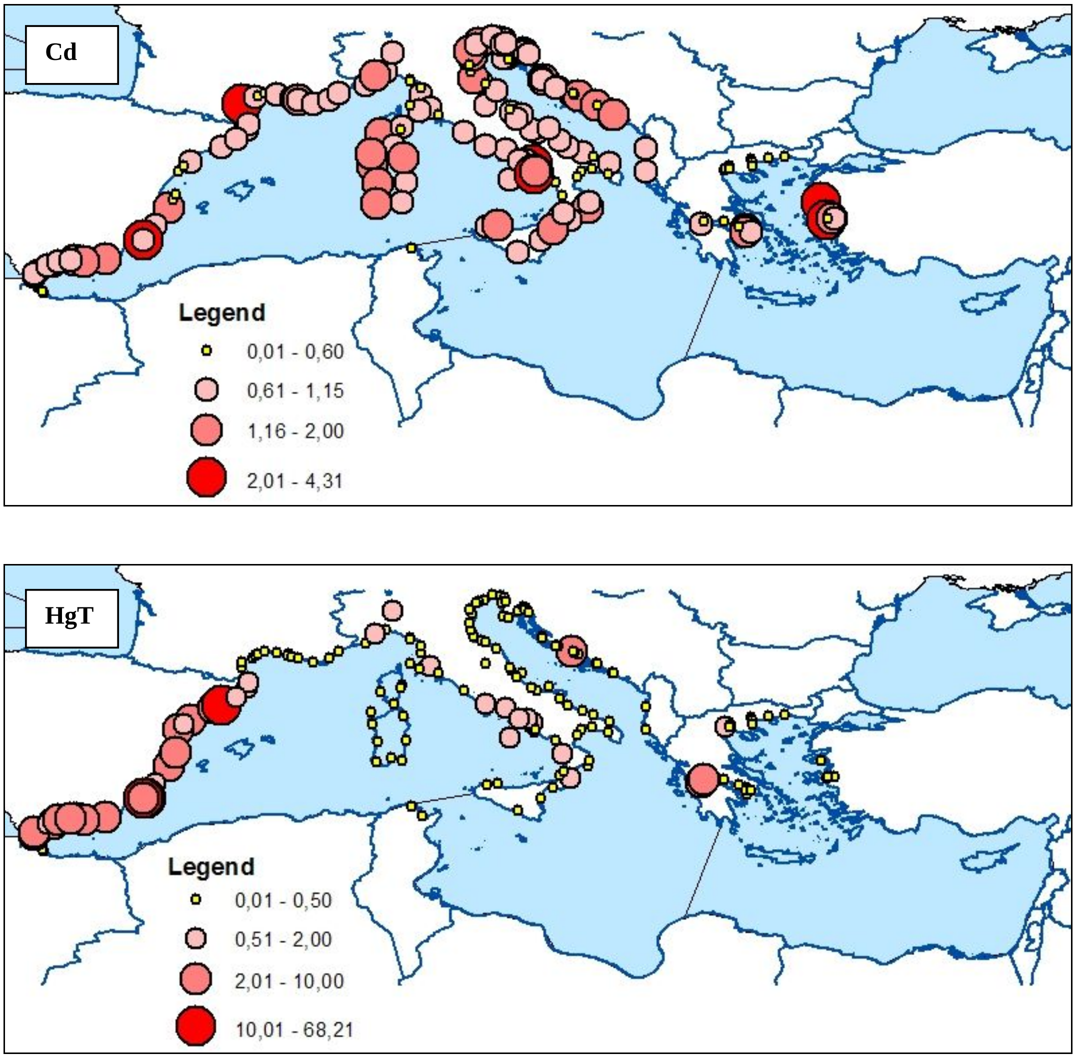


Figure 4.9. Mean concentrations of trace metals in *Mytilus galloprovincialis* (µg g^{-1} dw).

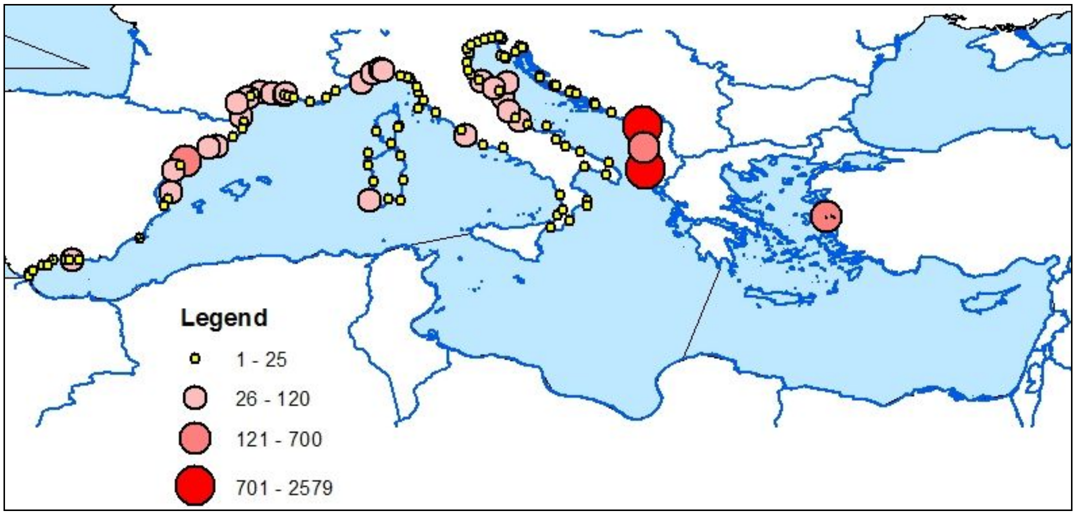
b) Chlorinated compounds

Chlorinated pesticides have been extensively analyzed in Mediterranean biota since the inception of MEDPOL (UNEP, 1990). Mussels and mullets have been the most widely studied organisms in the whole basin as part of many case studies published in the literature and recently assessed on the occasion of the implementation of the Stockholm Convention (UNEP, 2002). However, it has been only since the last decade that they have been continually monitored, and data gathered in the MEDPOL Database.

Concentrations of aldrin, dieldrin, endrin, lindane and hexachlorobenzene in *Mytilus galloprovincialis* are in the low ng g^{-1} range, with the exception of some stations from Turkey and Albania. As shown in Table 4.10, concentrations of DDTs were one order of magnitude higher, with p,p'-DDE being, in general, the predominant component, although recent inputs of DDT in some areas cannot be ruled out. Concentrations up to 9,779 ng g^{-1} dw of total DDTs were found in mussels from the Albania coast, probably indicating the presence of stockpiles of DDT in the country, as well as of lindane (Figure 4.10).

The geographical distribution of the median values of the 7 ICES PCB congeners in mussels (Figure 4.11) shows the higher levels in the Adriatic where the Albania samples are well above the average, with values up to 1500 ng g^{-1} dw in one station of France.

DDT



a) Lindane

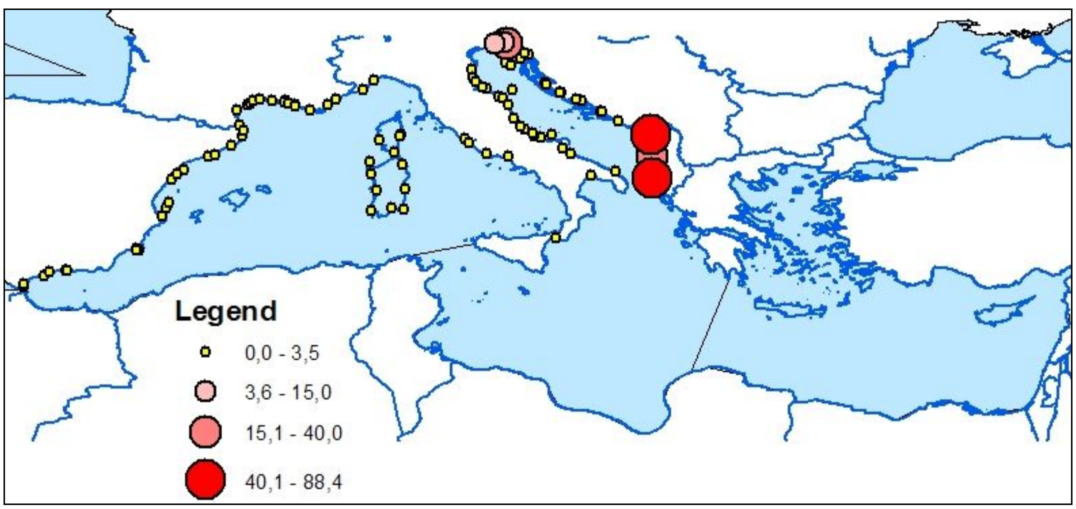
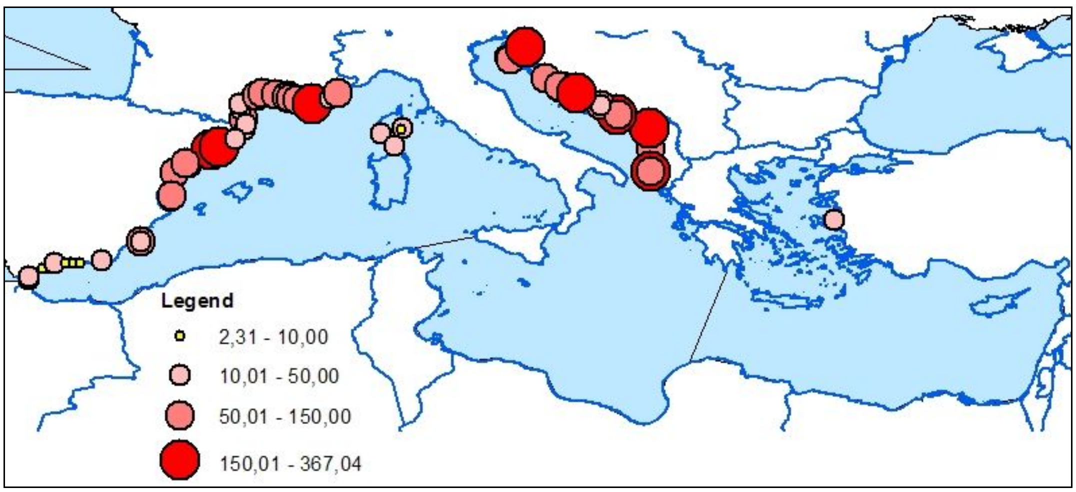


Figure 4.10: Mean concentrations (ng g^{-1} dw) of DDTs (a) and lindane (b) in *Mytilus galloprovincialis*

Table 4.10: Chlorinated compounds in *Mytilus galloprovincialis.* Median and range (ng g^{-1} dw)

Eco-region	Σ DDTs	Lindane	CB138	CB153	Σ7CBs
Adriatic	11.45 (0.01-9779)	0.24 (0.001-88.4)	6.67 (0.1-350)	5.00 (0.05-85.5)	96.6 (4.0-875)
Aegen-Levantine	17.44 (6.02-440)		0.21 (0.01-20.6)	0.33 (0.02-32.4)	1.13 (0.07-110)
Central Mediterranean	10.24 (0.40-26.0)	0.11 (0.1-1.40)	5.00 (0.30-23.0)	4.27 (0.70-38.0)	
Western Mediterranean	17.99 (0.60-322)	0.60 (0.01-20.95)	10.12 (0.09-566)	12.68 (0.19-603)	29.8 (1.58-1501)

Figure 4.11: Mean concentrations of Σ7CBs (ng g^{-1} dw) in *Mytilus galloprovincialis*



The values can be considered in the low range, taking into account the higher accumulation capacity of fish with respect to mussels.

On a regional scale, a summary of the data corresponding to trace metals and chlorinated compounds in sediments and mussels from the four Mediterranean eco-regions is shown in Table 4.11 and Figure 4.12.

In general, the Adriatic and the Western Mediterranean are the regions where concentrations are higher. The concentrations of trace metals in sediments and mussels exhibit a fair correlation except in the case of Zn, which can be attributed to a major influence of the sediment lithology.

As far as the chlorinated compounds are concerned, DDTs and lindane concentrations are higher in the Adriatic whereas the higher concentrations of PCBs are found in the Western Mediterranean.

Table 4.11: Median and concentration ranges of:

a) trace metals in sediments (μg g^{-1} dw)
b) trace metals in *Mytilus galloprovincialis* (μg g^{-1} dw)
c) chlorinated compounds in *Mytilus galloprovincialis* (ng g^{-1} dw)

a)

Eco-region	**Cd**	**HgT**	**Pb**	**Zn**	**Cu**
ADR	0.21 (0.01-18.5)	0.10 (0.01-166.9)	9.5 (0.39-1033)	65.7 (5.0-980)	16.1 (1.39-122)
AEL	0.11 (0.01-8.47)	0.16 (0.00-5.18)	5.9 (0.03-132.3)	26.8 (0.07-1505)	11.2 (0.31-198)
CEN	0.53 (0.38-0.65)	0.05 (0.01-6.00)	4.3 (0.33-50.4)	34.4 (0.05-176)	5.14 (0.29-52.9)
WMS	1.60 (0.23-7.61)	0.16 (0.02-12.6)	19.4 (0.24-256)	50.1 (1.0-731)	13.9 (0.68-107)

b)

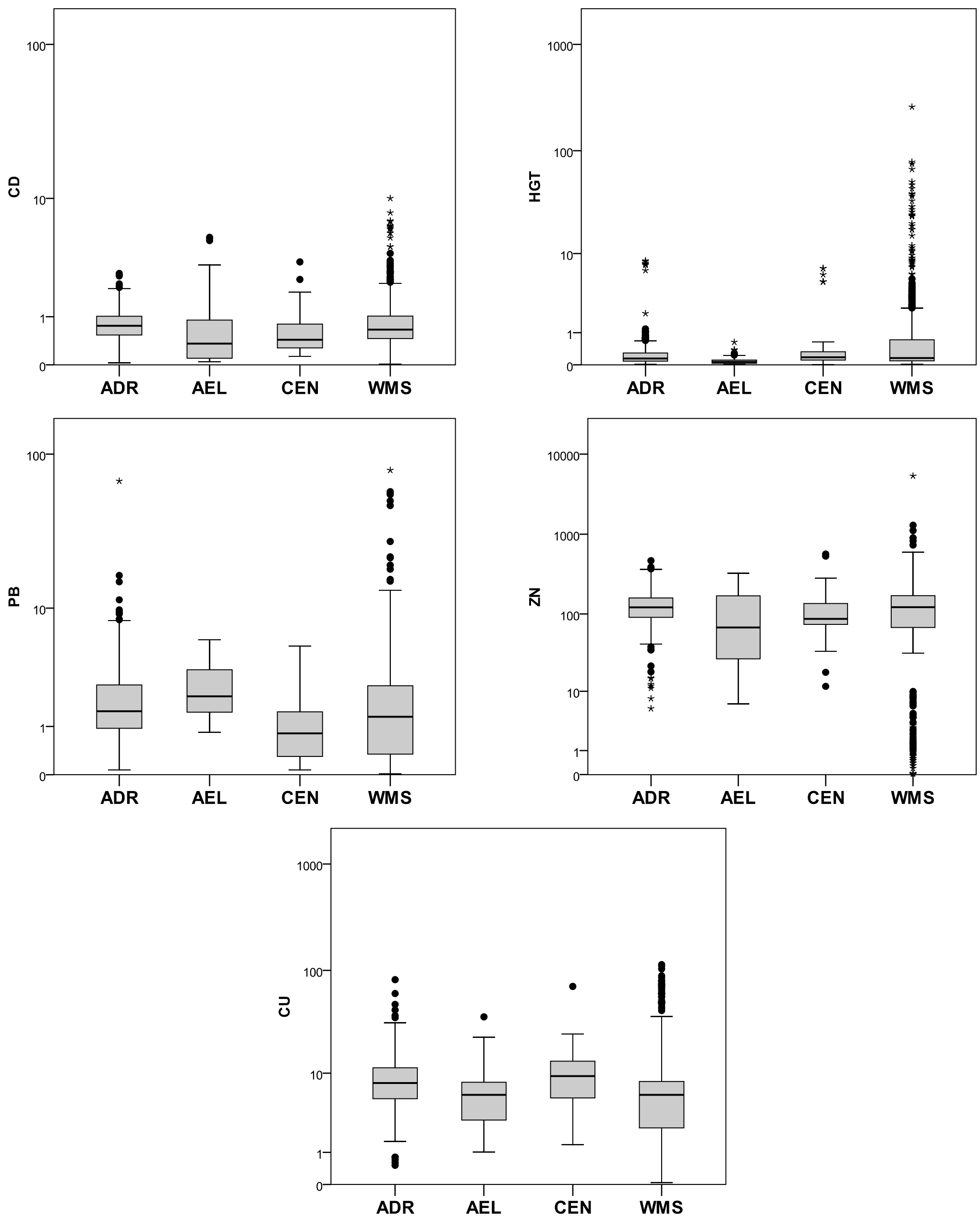
Eco-region	**Cd**	**HgT**	**Pb**	**Zn**	**Cu**
ADR	0.75 (0.03-2.73)	0.15 (0.01-8.45)	1.49 (0.07-67.5)	121 (5.7-467)	7.92 (0.51-81.6)
AEL	0.36 (0.05-5.27)	0.06 (0.01-0.63)	2.09 (0.84-5.97)	68 (6.7-325)	5.90 (1.01-36.1)
CEN	0.44 (0.13-3.40)	0.18 (0.01-7.00)	0.81 (0.07-5.36)	87 (11.6-565)	9.32 (1.36-70.5)
WMS	0.66 (0.01-10.0)	0.16 (0.01-259)	1.30 (0.01-79.1)	122 (0.01-5337)	5.91 (0.04-114)

c)

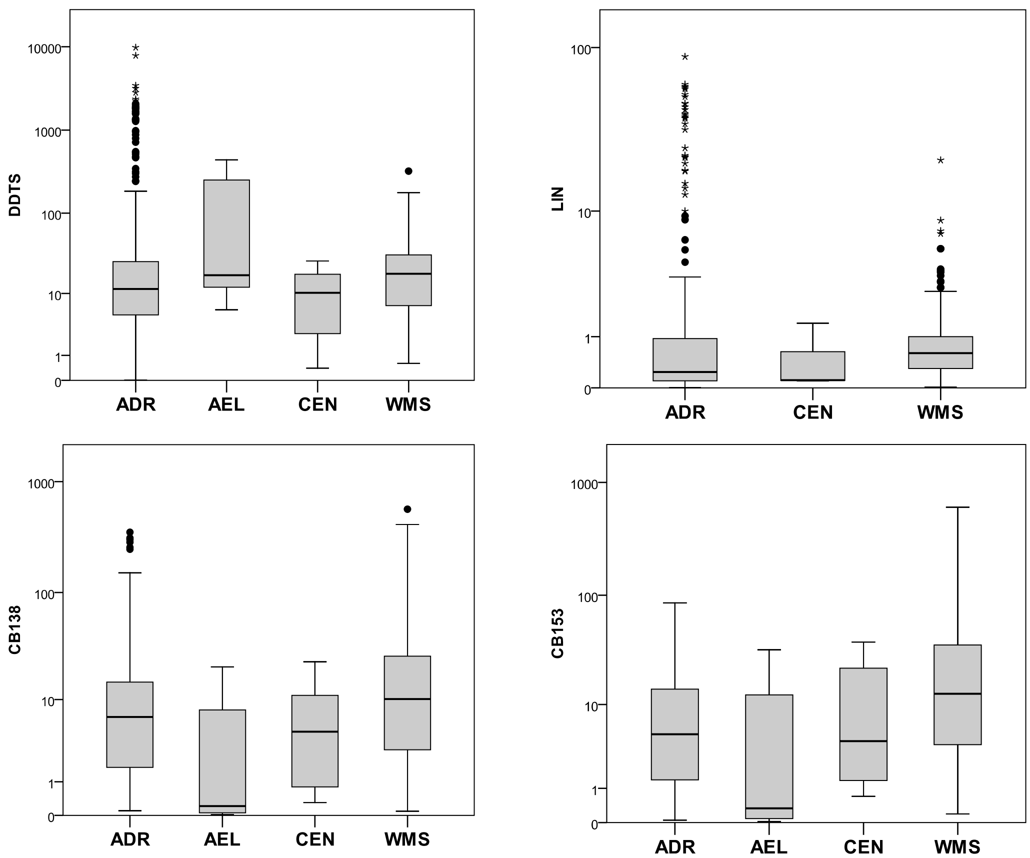
Eco-region	**Σ DDTs**	**Lindane**	**CB138**	**CB153**	**Σ7CBs**
ADR	11.45 (0.01-9779)	0.24 (0.001-88.4)	6.67 (0.1-350)	5.00 (0.05-85.5)	96.6 (4.0-875)
AEL	17.44 (6.02-440)		0.21 (0.01-20.6)	0.33 (0.02-32.4)	1.13 (0.07-110)
CEN	10.24 (0.40-26.0)	0.11 (0.1-1.40)	5.00 (0.30-23.0)	4.27 (0.70-38.0)	
WMS	17.99 (0.60-322)	0.60 (0.01-20.95)	10.12 (0.09-566)	12.68 (0.19-603)	29.8 (1.58-1501)

Figure 4.12: Concentrations of (A) trace metals (µg g^{-1} dw) and (B) chlorinated compounds (ng g^{-1} dw) in *Mytilus galloprovincialis* from the different Mediterranean sub-regions.

A)



B)



A useful outcome of the database can be the establishment of background concentrations for the target compounds in Mediterranean biota and sediments. This is necessary in order to have reference values for comparison with experimental data.

When dealing with synthetic compounds the theoretical background concentration should correspond to the zero value. However, POPs are ubiquitous in the environment and can be found worldwide, even in remote or pristine places (AMAP, 1998). Therefore, a method for estimating real background concentrations is necessary. Two main approaches have been used at this respect (OSPAR/ICES, 2004); the first is based on the analysis of core samples, with a view of determining concentrations preserved in a historical record, before the use of the target chemicals. The second involves the estimation of concentrations in current surface sediments in areas relatively remote from contamination. From this point of view, the study of contaminant concentrations found in the open sea, far away from the coastal sources, could be a reliable estimation of background levels of contaminants in Mediterranean sediments. In this respect, Gomez et al. (2007) tentatively established the background values in the interval of 1-5 ng g^{-1} (median 2 ng g^{-1}) for PCBs as 7 ICES, 0.08-5 ng g^{-1} (median 1 ng g^{-1}) for DDTs, and from 0.04 to 0.5 ng g^{-1} (median 0.2 ng g^{-1}) for HCB.

On the other hand, a detailed statistical data analysis, taking into account the values identified as outliers for each chemical population, shows a good representation of areas especially contaminated and thus to be considered as hot spots.

Conclusions on the assessment of the pollutants levels in sediments and biota and the potential risk in the Mediterranean marine coastal environment

The MEDPOL monitoring database (MEDPOL.mdb) and the inter-linked web version (http://195.97.36.231/medpol/) constitutes a relevant source of information for assessing the state of the Mediterranean Sea. The efforts made during the MEDPOL Phase III and Phase IV have been successful in building up and improving this essential instrument of environmental policy. Although at the moment is hosting monitoring data of only 14 Mediterranean countries, and the portion of data for each component and country is uneven, it constitutes the most comprehensive record of monitoring data for the whole basin and, therefore, it should be consolidated.

From the above analysis, it must be stressed that there is a need to establish monitoring programs in more countries to fill the geographical data gaps. These programs must be able to generate comparable and accurate data, taking into account the intrinsic variability of the environmental matrices considered. For example, the adoption of normalization procedures which could account for the differences in sediment characteristics (organic carbon content and particle size) as well as the implementation of quality assurance/quality control procedures is considered essential.

Moreover, the conceptual approach of the MEDPOL Program, updated with the recent knowledge and experience generated by the scientific community needs to incorporate relevant assessment tools for hazardous substances in marine sediments and biota. Specifically, there is a need to establish environmental assessment criteria (EAC) for the hazardous substances included in the MEDPOL database: trace metals, chlorinated pesticides and PCBs.

4.3**.** Trend monitoring (Based on the Assessment prepared by Mr. Robert Precali)

One of the major components of the MED POL Phase III and IV monitoring activities was the monitoring of contaminants at Mediterranean hot spots and coastal waters to attain site-specific temporal trends by applying an appropriate and consistent monitoring strategy. The first evaluation of the data collected in the MED POL Database was made in 2003 to identify the sampling and analytical variances underlying each monitoring practise. In 2005 a second attempt was made mainly to identify the weakest parts of the adopted sampling strategy. The aim of the present work is to perform a detailed analysis of variances and trends – where possible - for each monitoring site. Merging the MED POL Database with some national data sources was required to perform the trend tests with long-term time series of data. An initial attempt was made to evaluate both inorganic and organic contaminants data collected for biota for each sampling site included in the MED POL Phase III. However, the data sets were too large to be finally evaluated. Therefore, the evaluation mainly concentrated on inorganic contaminants (TMs) data and a complete analysis was performed for that and only some of the results for organic contaminants will be presented in this report. All country based analysis was recorded separately on CDs to be provided to the respective countries and laboratories. The CDs also include reference material and the software suite used for the analysis.

Data quality and statistical analysis of the available data

In temporal trend monitoring programmes of contaminants in biota, the emphasis is given on controlling sampling, analytical and seasonal variations to provide information on temporal patterns of changes. There are various ways of controlling the unwanted variations. For example, sampling variations can be reduced by taking more animals, analytical variations by doing replicate analyses, or by improving analytical procedures, and seasonal variation by taking samples at the same time each year. The first evaluation of the measured data performed after three years of ongoing programmes, presented at the second review meeting of monitoring activities (UNEP(DEC)MED WG.243/3, 2003), was meant to point out the weakness of the defined strategies as to address the main problems in the fulfilment of the defined goals.

The present evaluation is mainly intended to go a step further in the identification of trends and also of the main problems in trend detection.

Requirements and criteria

After around ten year of ongoing trend monitoring programmes some countries still have no more than five years of useful data and also show problems with data quality. In order to understand if such programmes- where number of sampling years of for trend analysis is not enough- fulfil the designed objectives, only the compliance of within year variance with threshold values could be checked.

However, the trend evaluation can be performed of countries with more than five years of ongoing programmes and only for data series that fulfil this requirement. Some countries at earlier stages also provided additional data to extend the time duration of their data series. For the trend detection, the software suite "Trend-Y-tector" will be used. The software was developed by the Netherland National Institute for Coastal and Marine management (RIKZ) in order to achieve the requirements of the OSPAR countries for a harmonized, uniform and objective method or suite of methods to analyse the yearly collected data.

Investigation of within year variances

In general, the statistical objective for the programme was set to detect a minimum linear trend of 10 % per year in 10 years with a power of 90%. The power of the programme is the probability that the F-test reject the null hypothesis. For the considered linear trend the F-test power depends on both T (number of years) and the signal-to-noise ratio $|b|/\psi$. Nicholson *et al.* (1997) calculated a very useful table for $|b|/\psi$ corresponding to different powers as T varies from 5 to 25. For a 90% power and 10 years the signal-to-noise ratio is $|b|/\psi=0,409$. If it is supposed that b=0,1 (10% linear trend) then the acceptable variance to fulfil the objectives is $\psi=(0,1/0,409)$, so that $\psi=0,244$ and the acceptable programme variance is $\psi^2=0,060$. Even if the underlying trend for a data set is not always linear, the programme objective is fulfilled if the within year variance is below the threshold of 0,060. This limit is correct if we consider that in general the between year variance is always significantly lower than the within year variance (Nicholson et al. 1997).

Temporal trend detection

Nowadays, a variety of tests are available to analyze data record. Each one has its own capabilities and underlying assumptions and therefore considerable judgement is needed to select the appropriate one. OSPAR proposed three trend detection methods in a suite. The idea is to take the benefits of all methods, because there is not only one method which always offers the best analysis.

The three methods (Mann-Kendall, linear regression, lowess smoother) are amongst the most commonly used in this field. The order is from the simplest to the more complex method. Mann-Kendall is the most robust to outliers, but in case of a linear trend, the linear regression has more power and therefore is selected first. Since nature is not always linear, the smoother is taken to detect a non-linear trend. Based on above, the trend analysis was performed at a 5 % significance and 90 % power and the log-normal distribution was used, because log-concentration has often been found to be approximately normally distributed with constant variance.

At the first step, after data was treated with the Mann-Kendall test and if the trend is detected, the tail slope is calculated. When the Mann-Kendall test is negative (no monotonic trend was detected), the smoother method is used to test for a nonlinear trend. When the number of years N<7 case a 3-point running mean and when N>6, the lowess smoother is used in the trend evaluation. All the trend estimates are expressed in percentages.

Weighted trend assessments

Until now, during trend assessment when data was screened for analytical quality, it was a practice to classify it as “acceptable” or “unacceptable”. Only the data with “acceptable” QA were used for assessing trends using smoothers giving to each observation equal statistical weight. However, many data were rejected as “unacceptable” and this led to the shortening or loss of many time-series. Nicholson et al. (2001) suggested that the QA could be used in future assessments if an appropriate weight is given to data with questionable QA in the statistical analysis.

For the sake of this evaluation, only Data Quality Assured data was presented and commented for each country and included in the CDs prepared for countries. In general, the laboratory performance is acceptable for those which |z|<2 (Pedersen et al, 1997).

Albania

In 2004, the sampling strategy was changed from mussel watch strategy (one sample with 50-120 specimens) to 5 samples with 15-20 specimens in order to understand the underlying sampling variance and to better address the statistical issues related to the trend evaluation. At the same time a change in the location of sampling sites occurred and the sites were moved closer to the urban agglomeration of Durres and Vlore. No trend can for now be estimated due to the insufficient number of sampling years and the lack of data for the year 2002. The within year sampling variance was estimated for 2004 data and is very low and far below the threshold of 0,060. Besides, the analytical variance is even lower than the sampling variance and thus it can be expected that the programme objectives will be fulfilled. The intercalibration z-scores obtained by the laboratory for trace metals in biota indicate only few problems during the 2003 exercise related to very high levels of Pb.

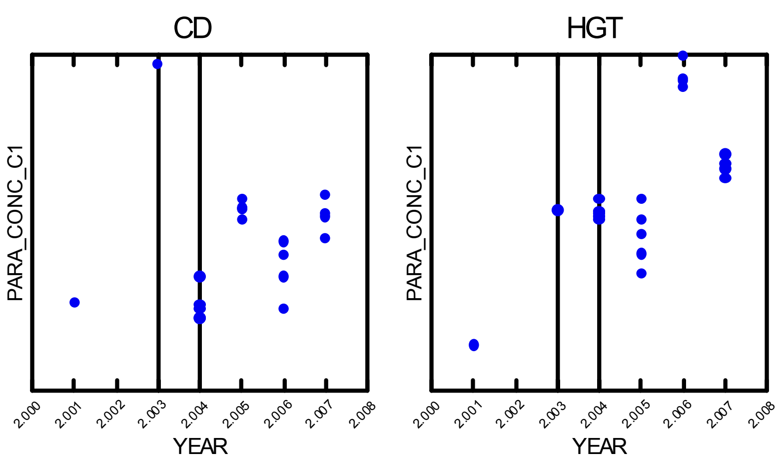


Figure 4.13: Values (Log scale) of trace metals mass fraction in *Mytilus galloprovincialis* (MG) by year at station C2.2 in Albanian coastal waters.

Croatia

Croatia adopted the suggested sampling strategy (5 samples – 15 specimens) in 2002. From the statistical analysis it is evident that from 2002 the within year variance is stable and low thus indicating an optimal sampling strategy. Only few cases of variance higher than the threshold of 0,060 were observed. The analytical within year variance is also very low and indicates good laboratory practice. The intercalibration z-scores are acceptable with the exception of Cd and Pb in 2003.

An interesting change in value can be observed at station IN (Inavinil – Kaštela Bay) were higher total mercury levels were measured and problems related to mercury contamination reported. In 2004 an order of magnitude higher levels than the already high values were measured. The length vs weight relationship for the MG samples (Figure 4.14) does not show any irregularity in sampling. Only a change in MG size with year can be noted that maybe indicates a shift in station location, closer to source of pollution

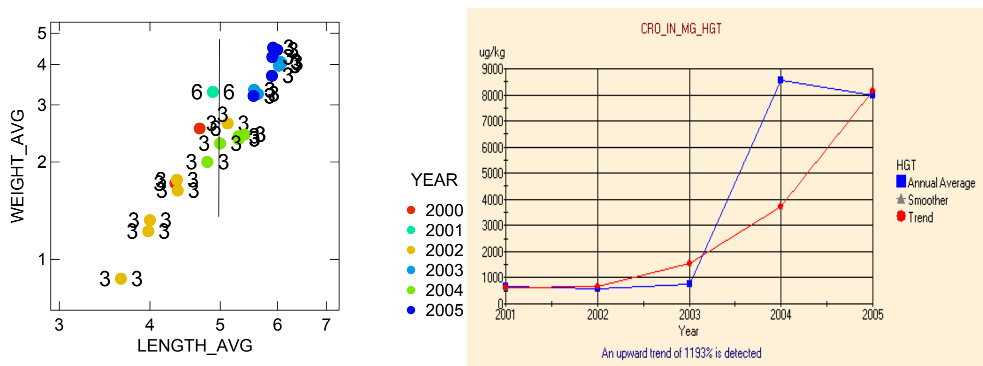


Figure 4.14: Length vs. weight and trend evaluation results (from Trend-Y-tector suite) for total mercury (HGT) mass fraction for *Mytilus galloprovincialis* samples collected at IN station (Croatia).

Cyprus

In 2003, Cyprus changed the laboratory in charge of the TM analysis and data were submitted to the Secretariat after 2005. Two stations, Limassol and Larnaca were regularly sampled for *Mullus barbatus* as mussel are not present in the area. With the change of laboratory the sampling position also changed. The new positions are from 4 to 6 km from the previous ones and introduced additional variance in the time series. The within year sampling variance is low and below the threshold of 0,060 and well on track for the programme objectives fulfilment. For the first period no QA data is available. The intercalibration z-scores are acceptable with the exception of Pb.

From the statistical analysis of the data, some questionable patterns were identified. Substantial changes in the levels can be observed between years. One of the possible explanations is the sampling operated in different seasons (March in 2005 and November in 2006 for both stations, and June and July for stations Limassol and Larnaca respectively) and the seasonal cycle that becomes the dominant signal in the data. It is clear that a more rigorous sampling strategy for the sampling period (pre-spawning) and size fraction (the central on a log scale) has to be adopted and maintained in future.

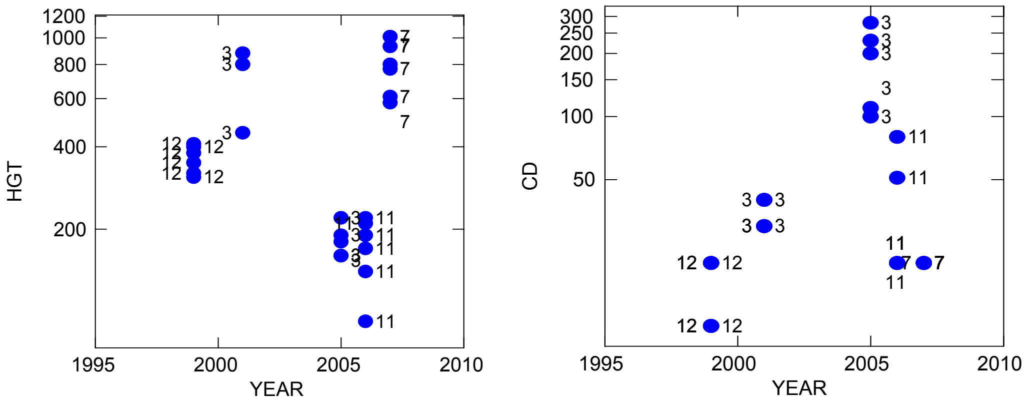


Figure 4.15: Values (Log scale) of total mercury (HGT) and cadmium (CD) mass fraction in *Mullus barbatus* by year at Larnaca stations in Cyprus coastal waters. To the data the sampling month is superimposed (Cyprus).

Greece

The only data sets of Greece available in the MED POL Database are related to 1999 and 2004.

During the previous data evaluation (UNEP(DEC)MED WG.243/3, 2003) the national institute implementing the programme was requested for additional data for the purpose of trend analysis at one of the designated monitoring sites in the NMP and data for the 1993-2001 period was provided to the Secretariat accordingly. The 1999 data of that specific site was elaborated and presented within the whole period. The sampling strategy was seasonal but for the trend evaluation only one season was selected. In consultation with the national expert, September was agreed to be the pre-spawning period in the area, and all results refer to that season.

Figure 4.16: Graphical output from “Trend-Y-tector” software suite for Fe at station C3 (A) and C8A (B), and ZN at station C3 (C) (Greece)

Israel

Israel regularly submitted data to the MED POL Database from 1999 to 2007. In agreement with the national MED POL designated institute, longer term data (1991-1998) were provided for the purpose of trend evaluation for more than a decade. Only the analysis for Cd and HgT data will be provided in this report. In the monitoring strategy of MED POL Phase III, for the eastern Mediterranean the target monitoring organism was chosen as *Mullus barbatus.* Also, two bivalves, *Mactra corallina* (and *Donax trunculus,* were adopted by Israel as biomonitoring species.

Since only four years of *M. barbatus* data was available, this data set could not be used for trend analysis. Therefore, only descriptive statistics for trace metals mass fraction in *M. barbatus* can be made. In general, data show low sampling variance with the exception for total mercury (HGT) for which the variances were substantially higher than the threshold of 0,060. The reason for such high variances is probably due to the values that are closer to the detection limit (DL). This is also true for cadmium for which all values were practically below DL. From explorative statistics it also emerged that the length class of sampled fish was large and changed by sampling year. To minimize the sampling variance, a better sampling strategy has to be formulated.

The *Mactra corallina* data were usable for 1991-2007 period and trend analysis was performed. Regarding Cd, the negative Mann-Kendall test indicates that the trend is not monotonic or linear. The lowess smoother test suggest that the trend is not linear and characterised with an increase of Cd mass fraction at the end of 1990s with a subsequent decrease at the end of the sampling period to lower than at the beginning values. This trend can be observed practically on all stations. Similarly, HGT exhibits a pronounced upward trend in all stations. Frequently the Mann-Kendall test is positive indicating a monotonic (linear) upward trend on some stations. HGT and CD trends show that probably the area processes are dominant, and the local effects are not pronounced. It also demonstrates that *M. corallina* can be a good monitoring organism for the area.

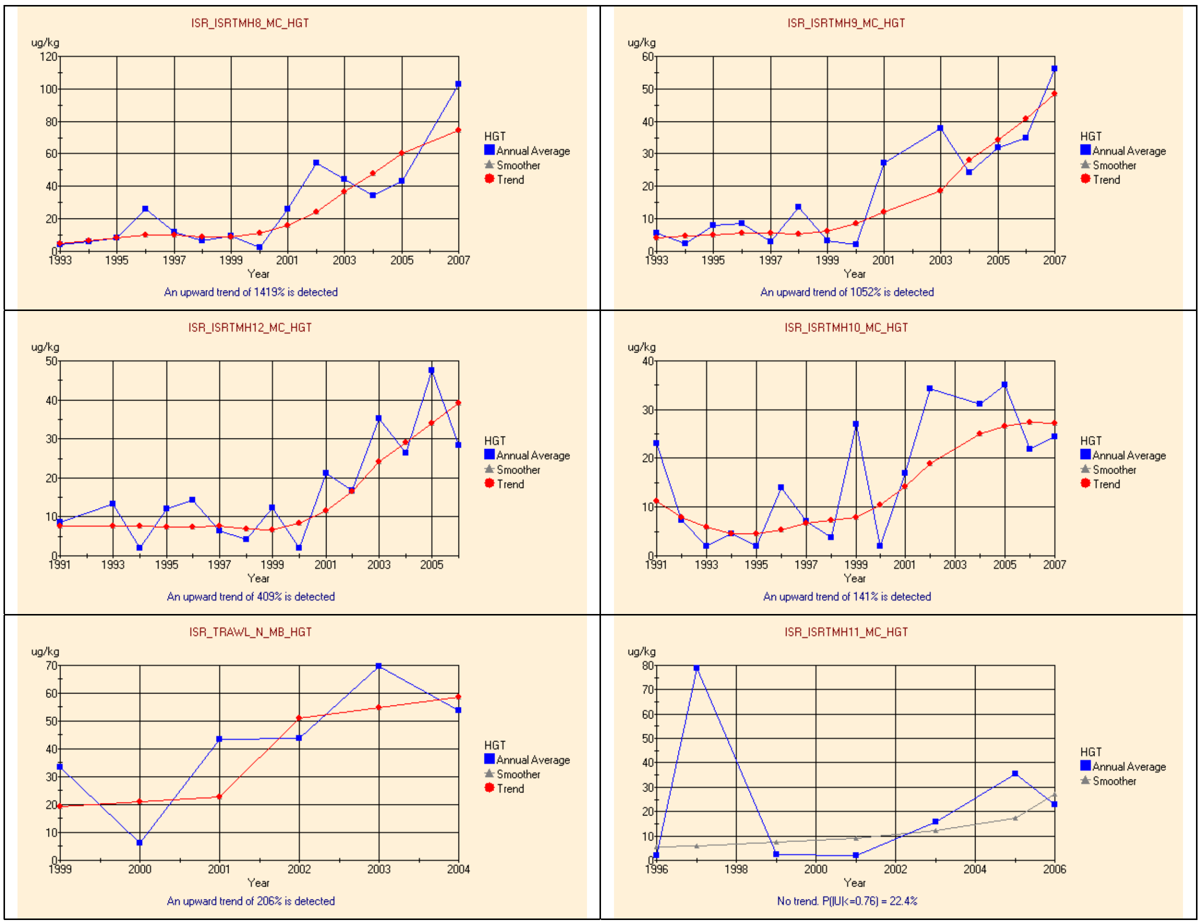


Figure 4.17: Graphical output from “Trend-Y-tector” software suite for total mercury mass fraction at stations in Haifa Bay, Israel.

Slovenia

Two stations are regularly monitored for trend monitoring of trace metals in biota along the Slovenian cost. The data show a serious and strict maintenance of the decided sampling strategy. Such approach is essential for a successful trend monitoring.

The within year sampling variance is very low and far below the threshold of 0,060. The acceptable z scores, z<<2, allow to assess trends with each observation given equal statistical weight and the number of sampled years (8) to perform a valuable assessment.

The results of the assessment indicate that a monotonic, downward trend (positive Mann-Kendall test) for CD mass fraction at station TM (Figure 4.16) was present. The smoother (lowess) indicate that probably a non-linear downward trends for CD mass fraction at station 24 was also present. The statistical test shows a very low probability of a false positive test. The values for total mercury mass fraction didn't show any trend and indicate just an oscillation of the values around $120 \cdot 10^{-9}$ on both stations.

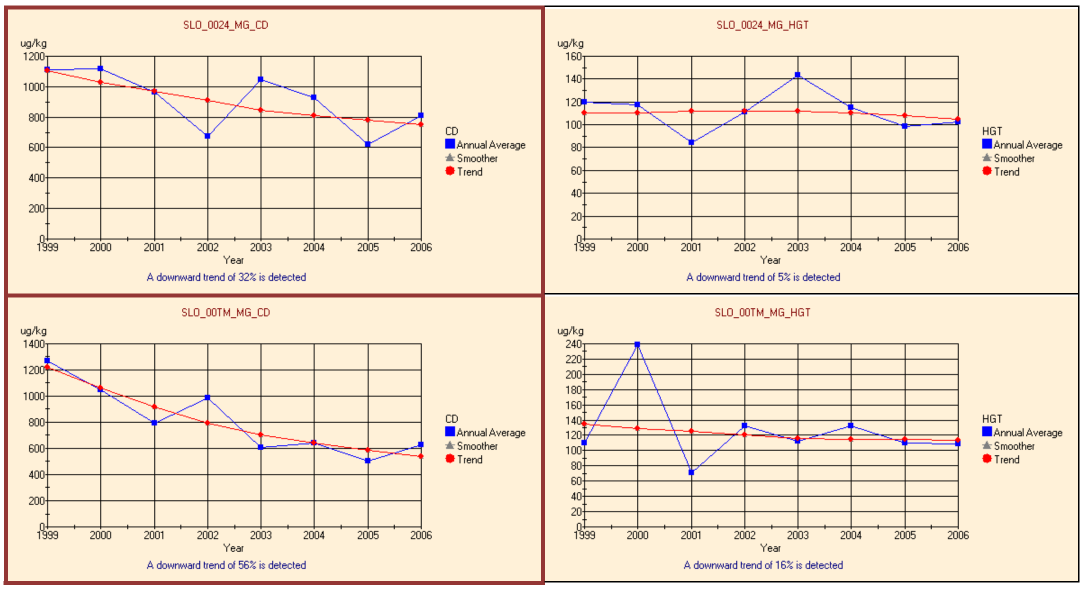


Figure 4.18: Trend evaluation results (from Trend-Y-tector suite) of cadmium and total mercury mass fraction in *Mytilus galloprovincialis* (MG) by year at stations 24 and TM in Slovenian coastal waters.

Tunisia

Data were submitted up to 2008 to the Secretariat. Five stations were regularly sampled. One station is in the lagoon of Bizerte, where two organisms were sampled, both bivalves, (*Mytilus galloprovincialis* and *Ruditapes decussatus*). In other stations only the last one was sampled.

The descriptive statistics show that the within year variance is very low, and far below the threshold of 0,060, indicating a good sampling and probably also analytical practice. The analytical variance cannot be determined because only one value with no replicates for CRM analysis were submitted, although it is not expected that the analytical practice can significantly influence the trend evaluation. As suggested for other countries, it would be valuable to analyse five replicates during the CRM analysis that in future with the QA exercises data can be used for a weighted trend assessment.

Part of the differences in values between the two submitted years can be explained with the differences in sampling months. The sampling month varies randomly with station and year showing that the pre-spawning period for the sampled species was not identified indicating that in future a better sampling strategy has to be formulated. A substantial downward trend for both cadmium and total mercury was observed on most of the stations.

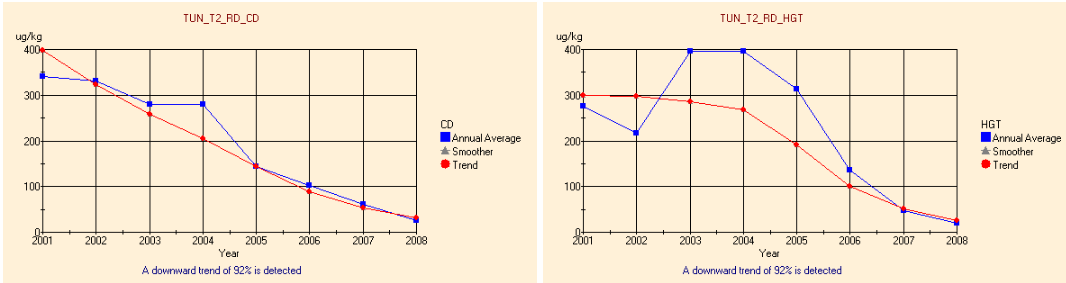


Figure 4.19. Trend evaluation results (from Trend-Y-tector suite) for cadmium and total mercury (HGT) mass fraction for *Ruditapes decussatus* samples collected at T2 station (Tunisia).

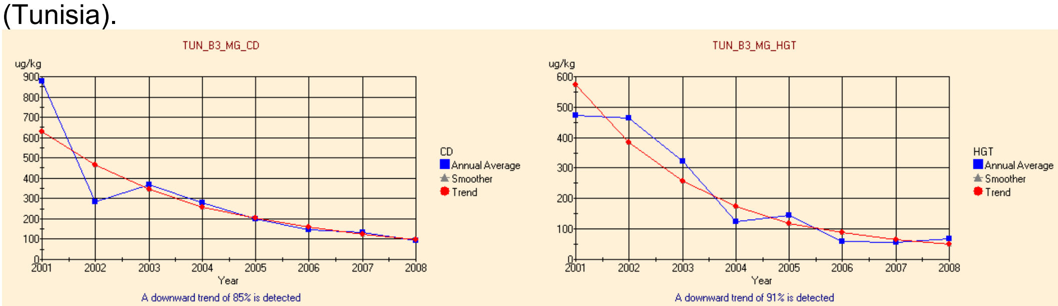


Figure 4.20. Trend evaluation results (from Trend-Y-tector suite) for cadmium and total mercury (HGT) mass fraction for *Ruditapes decussatus* and *Mytilus galloprovincialis* samples collected at B3 station (Tunisia).

Turkey

Turkey submitted data since 1998 for trace metals mass fraction in Mullus barbatus and verified all the data set in 2009 before the present analysis. The data now represents a valuable set of data of eleven years. The descriptive statistics show a variable within year variance which in some cases fairly exceeding the 0,060 threshold. In the beginning, a higher variability could be expected because during the first three years a single organism was analysed and later 5-10 samples with 4-5 pooled organisms. From the length vs. weight relationship it was noticed that the sampled population of fish was not always the same. In the first five years the relationship was homogenous and after 2003 a clear shift was observed indicating that probably a different fish population was sampled. On the other hand, the mass fraction of trace metals seems not to be dependent on fish size.

The analysis of the analytical variance and results of the QA exercise show an excellent laboratory practice and from the analytical point of view the trend evaluation has not to be down-weighted. In general, the detected trend is small or inexistent and presents only variations around a certain value for cadmium mass fraction (Figure 4.21.). For total mercury mass fraction a substantial change is observed in the accumulation of this trace metal in *Mullus barbatus*. This change coincides with the identified shift in the population metrics (length vs. weight) of *Mullus barbatus* in the area. A downward trend is observed when outliers are eliminated for cadmium mass fraction.

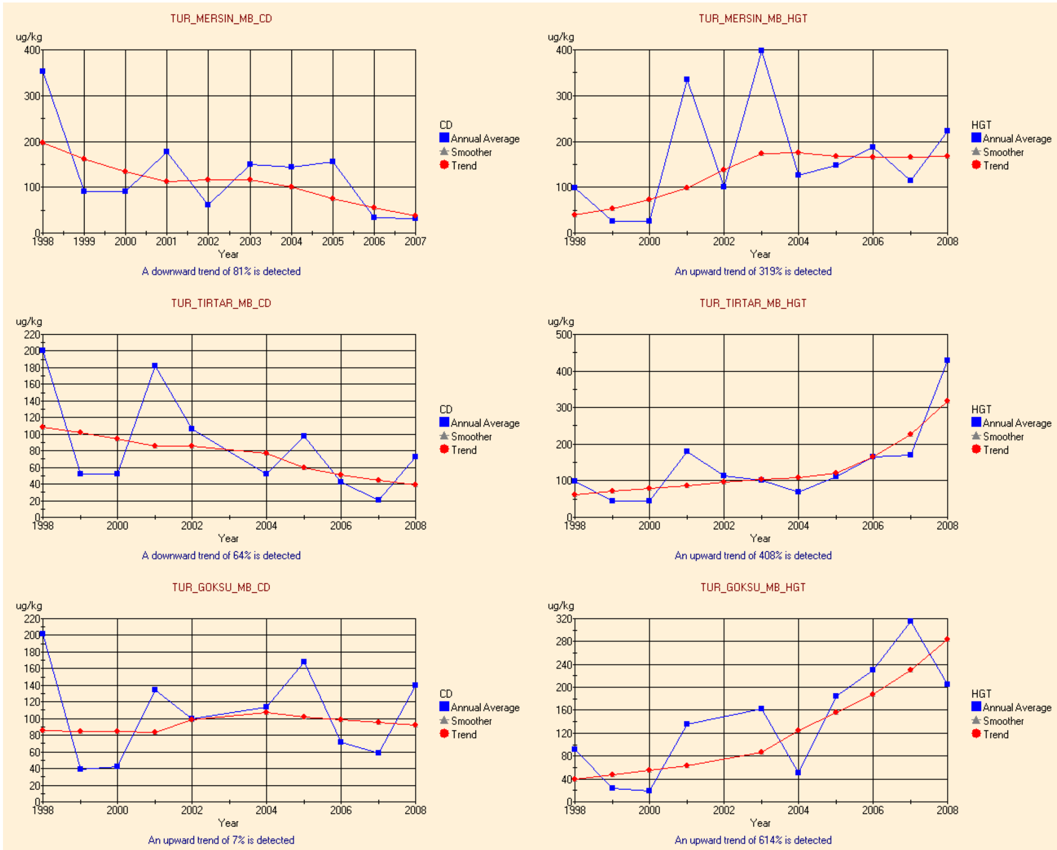


Figure 4.21: Trend evaluation results (from Trend-Y-tector suite) of cadmium and total mercury mass fraction in *Mullus barbatus* (MB) by year at Mersin, Tirtar and Goksu station in Turkey coastal waters, after outliers removal

Conclusions on the trend analysis data

The present evaluation shows that the trend monitoring of trace metals in biota can be used to assess a change with time in the environmental levels of chemical contaminants when longer data series were provided by countries with long-term monitoring programmes. This can be used as one important tool for the assessment of the effectiveness of control measures taken at the pollution hot spots and also for the assessment of state of marine environment.

Some problems were still identified, mainly dealing with the lack of maintaining the declared sampling strategy, even if substantially reduced if compared with the 2005 evaluation. The weakest part of the programme is still the data transfer and manipulation. In order to overcome these problems, countries are encouraged to prepare a detailed programme manual including clear objectives and the description of a detailed methodological approach aiming to successfully maintain the programme over time (positioning, sampling, methods, and data elaboration, exchange and presentation).

From the trend monitoring point of view, the best sampling strategy always aims at attaining the best information on the sampling variance and with that a valuable determination of the underlying trend, keeping that in mind it is good to avoid pooling whenever possible. The suggested strategy for smaller organisms, mainly molluscs, that are not always sufficient for all analyses, is to use 5 samples with 15 pooled specimens. If one sampled organism, mainly fish, provides enough sample for all analyses, the use of 15 to 25 (preferred) samples is suggested if the underlying variances are not know. The sample should be collected in a length stratified manner: divide the size distribution in three or five classes (log scale and depending on size: MG -1 cm; MB - 2 cm.) and sample the central one; sample always the same size class.

The statistical suite used (Trend-Y-tector) developed for the OSPAR countries by the Netherlands National Institute for Coastal and Marine management (RIKZ) is easy to use and can be used as a trend evaluation tool.

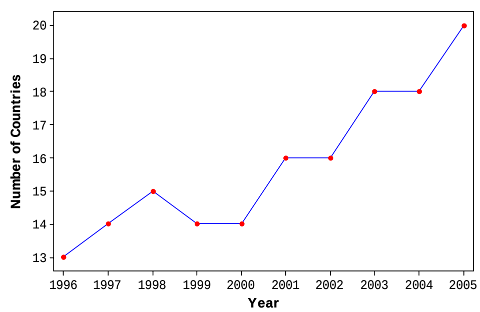
5. Compliance monitoring - health related

This type of monitoring is addressed to coastal recreational water quality activities that are mainly linked to bathing waters and shellfish growing waters, where cultivation of shellfish is practiced. The joint interim criteria for bathing waters and shellfish growing waters adopted at the Fourth Ordinary meeting of the Contracting Parties (Genoa, 1985) were based on the maximum acceptable concentration of only one indicator organism (faecal coliforms).

Following the implementation of the LBS Protocol, and the introduction of National Monitoring Agreements, compliance monitoring for coastal recreational waters and shellfish growing waters was launched in 1985. Only a limited number of countries submitted monitoring results for sanitary compliance monitoring within their National Monitoring Agreements, during the period 1985-1995. In 1996 the "Assessment of the state of Microbiological pollution of the Mediterranean sea" was prepared. That document attempted to consolidate and update all previous information on the state of microbiological pollution of the Mediterranean sea with particular reference to coastal recreational and shellfish areas through the inclusion of monitoring and research data, drawn from national MED POL monitoring programmes, MED POL research projects, EC annual reports on bathing waters, and other national and international sources. A major concern was observed when comparing data from EU countries with those from Mediterranean non-EU countries. In fact, the indicators were not only different but even the EU values were stricter than those of the rest of the countries.

In May 2007, an updated report on the assessment of microbial pollution in the Mediterranean was prepared in an effort to provide the most recent information on the subject and also to compare the results of the 1996 report with the data from the past decade. A considerable number of countries ranging from thirteen in 1996 to twenty in 2005 have implemented monitoring programmes and have submitted the data for bathing waters compliance. The number of participating countries has grown from 13 to 20 in 2005 with a slight downturn between 1998 and 1999, the overall number of sampling points has risen steadily indicating that more extensive areas of the Mediterranean are being monitored (Figure 5.4.).

Figure 5.1. Number of countries submitting data (1996-2005)



The overall number of bathing waters in the Mediterranean conforming to and the number exceeding the national standards between the years 1996 and 2005 are presented in Table 5.1. Whilst there has been a very slight overall increase (92.3% - 92.8%) in the percentage of bathing waters complying with national legislation the improvement has not been consistent over the years. Quality of those areas where monitoring takes place appears to have steadily increased until 2003 and then a slight worsening of quality are seen in 2004. A slight improvement is seen between 2004 and 2005. It should be noted that data only refers to waters that are officially monitored and there may be a number of bathing areas which are used for recreation that are not monitored.

Table 5.1. Summary of bathing water monitoring data per year complying and non-complying with the national legislation (1996 – 2005)

YEAR	Bathing waters CONFORMING	Bathing waters NOT CONFORMING	CONFORMING%	NOT CONFORMING%
1996	8747	734	92.3	7.7
1997	9036	769	92.2	7.8
1998	9390	619	93.8	6.2
1999	8873	534	94.3	5.7
2000	8818	620	93.4	6.6
2001	9617	593	94.2	5.8
2002	9745	608	94.1	5.9
2003	9887	549	94.5	5.3
2004	9803	834	92.2	7.8
2005	10842	839	92.8	7.2

The positive trend for bathing water is also noticed in the number of sampling points, where samples were collected for analysis. In fact, following a minor decrease in 1999-2000, the number of sampling points was increased from 9,500 to 11,600 sampling points per year. The results confirm that every year more and more countries with an increasing number of sampling points implemented monitoring programmes.

Although there is no real trend evident during the sampling period it can be seen that, 50% of the countries submitting data for 2005 achieved over 90% compliance with national standards for bathing water quality. Around 93% of bathing waters conform to the legislation, and compared with the findings of the past assessment, it shows that the general situation remains unchanged, even with the increase of sampling stations and number of data. There is still a lot to be done for achieving a compliance percentage of about 97-99%, which will provide better degree of safety to the bathers. However, a better look at the national compliance data shows that in some countries including those of the EU, the data conforming to the legislation are in the range of 98-100%, indicating that the compliance percentage in the remaining countries is much less than 98-100% and therefore more efforts have to be made by those countries.

In view of the relative importance of microbial pollution of coastal areas and according to the new operational document for the MED POL Phase IV period (2006-2013), several attempts have been made to follow new criteria and standards for the Mediterranean countries. It should be noted that in the last years, due to recent advances in the field of epidemiological studies correlating bathing water quality and health effects, the World Health Organization published in 2003 the “Guidelines for safe recreational water environments” and the European Commission launched in 2006 the updated Directive “concerning the management of bathing waters quality”, which is based on the WHO guidelines. Both regulations are based on a common indicator, faecal streptococci, and since more Mediterranean countries joined the European Union, and have to apply stringent legislation, and a number of non-EU countries decided to adopt or follow the European directives, to avoid duplication of efforts by these countries, all countries can monitor for the common indicator.

There is still much to be done in terms of improving bathing water quality in the Mediterranean, particularly in the south and eastern part of the region. It is likely that bathing water quality will need to be further improved as legislation is tightened. The EC bathing water Directive for example has been revised and will require higher standards of quality. It will be difficult for improvements to be made if there is not a better understanding of the sources of pollution, and in particular the balance between point source and diffuse sources. Identification of sources of indicator organisms forms an important part of water quality management allowing targeted risk management and remediation to improve water quality and protect public health. Improvements will also need continuous training courses and intercalibration exercise in microbiological methods (including data quality assurance and updating of the relevant procedures for the implementation of the legislation). In addition, capacity building assistance should be provided for sampling methods, microbiological methods of seawater analysis, good laboratory practice and the assessment and control of health risks deriving from swimming, or from consuming of shellfish.

6. <u>The development of Marine Pollution Indicators</u>

6.1. Introduction

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 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). Furthermore, the Contracting parties 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.

In the European Union, the 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. 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).

Similarly, the Marine Framework Strategy Directive (MFSD) of the EU 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.

For the development of criteria and methodological standards to assist the implementation of the Marine Strategy Framework Directive, Task Groups (TGs) were organised by ICES and JRC to DG ENV. The MSFD identifies 11 descriptors of Good Environmental Status (GES) and TGs have been established for all but the Descriptor 7. MED POL participated as observer in TG5, TG8, TG9 and TG10, and provided information of the relative activities, data collection, methodologies and assessments. The work of the TGs is in progress.

Qualitative descriptors for determining good environmental status (MSFD-Annex I)

(1) Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.
(2) Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems.
(3) Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.
(4) All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.

(5) Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.
(6) Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.
(7) Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.
(8) Concentrations of contaminants are at levels not giving rise to pollution effects.
(9) Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards.
(10) Properties and quantities of marine litter do not cause harm to the coastal and marine environment.
(11) Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

6.2. Chemical Indicators

Indicators related to the MEDPOL strategy for monitoring eutrophication (T, S, pH, DO, Transparency, Orthophospate, Silicate, Total N, Total P, Nitrate, Nitrite, Ammonium and chlorophyll-a) appear to be in a moe advanced stage since they are the most ‘measured’ parameters in most monitoring programmes of Mediterranean countries.. Monitoring of heavy metals in biota and bacterial levels in bathing waters are also very well developed whereas the monitoring of Chlorinated Organic compoundsand 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/or there are inherent difficulties in their quantification (as in the case of Chlorinated Organic compounds).

6.3. Biological effects indicators

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. 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. 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).

For an integrated biomarker data management an Expert System, has been developed at Di.S.A.V. (University of Piemonte Orientale) in the framework of the BEEP (Biological Effects of Environmental Pollutants) EU programme. The function of the Expert System is to rank the level of the pollutant-induced stress syndrome by integrating the data obtained from:

a) Early warning biomarkers: i.e. sensitive biomarkers of stress, or of exposure, revealing the effects of pollutants at the molecular and/or cellular level.
b) Biomarkers of stress, suitable to reveal the development of the stress syndrome at the tissue/organ level: i.e. histological biomarkers, but also biochemical biomarkers such as the GST (Glutathione Trasnferase) test recently developed (i.e. evaluation of the GST released from the cells and present in molluscan haemolymph).
c) Biomarkers of stress at the organism level: i.e. biomarkers able to show that the stress syndrome has decresed the mussel’s capacity of survival and/or growth and reproduction

(such as stress on stress response, scope for growth, gonad and gamete alterations, survival index).

A good interpretation of the development of the stress syndrome by the expert system depends on the possibility to utilize biomarkers of stress able to integrate the toxic effects of pollutants over the caging period. Among these, are those biomarkers that show a trend characterized by a continuous increase or decrease in the value of the selected parameter (such as lysosomal membrane stability, lysosomal lipofuscin accumulation, lysosomal neutral lipid accumulation , micronuclei frequency) in relation to an increase in toxicity. Moreover, the expert system takes into account possible interferences among the different biomarkers.
In the framework of MED POL Phase IV, it was decided to apply a 2-tier approach, using caged molluscs:

- the first tier would include a single biomarker, namely, lysosomal membrane stability, and mortality.
- The second tier would include a whole set of biomarkers including lipofuscin accumulation, neutral lipid accumulation, micronuclei frequencies, oxidative stress, metallothionein content, acetyl cholinesterase activity, peroxisome proliferation, lysosome to cytoplasm ratio, and stress on stress.

6.4. 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. A large number of concepts and numerical techniques have been developed for the proper interpretation of data. Recently, considering the importance of Ecological Indicators towards the implementation of the Water Framework Directive of the EU, 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 EU Member States 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).

Considering that the EU-Mediterranean countries are moving towards a comparable methodology to assess the quality of the environment in their transitional and coastal waters, a Workshop was organised on 12 October 2009 by MED POL to review the progress made in the framework of MED GIG Phase I, in order to develop a harmonized core set of ecological indicators for the quality of the marine environment to be used for the assessment of the state of the Mediterranean coastal marine environment, in the framework of UNEP/MAP.

In the preliminary draft conclusions of the meeting, it was recognized that Chlorophyll-a can be used as a phytoplankton biomass (as well as eutrophication level) indicator using annual means of monthly collected data.

For angiosperms, the use of roots density and depth lower limit of the Posidonia oceanica meadows is an indicator of the state of the marine environment supported by several data in many Mediterranean countries. However, most of these data are in scientific literature and are not regularly reported as result of national monitoring programmes. SPA/RAC is also developing a monitoring programme for vegetation species in the framework of its Marine Vegetation Action Plan. For some coastal areas of the Mediterranean (eastern Med – Israel, Lebanon, Syria, and western Med – south-eastern Spain and Morocco), where Posidonia is not found, the angiosperm Cymodocea could be used for the same purpose. It was considered that this indicator could be used immediately.

For macroalgae, the indicators tested in the framework of MED GIG seem to be well developed. However, although scientific groups are working on macroalgae in many Mediterranean countries, such data are not usually collected in the framework of national monitoring programmes. The maturity of this indicator has to be checked.

The indicator on the macroinvertebrates is a robust method using 1-2 samples per year and can give good indication on the state of the marine coastal environment (on the soft bottom ecosystems). It is based on species and abundance lists prepared by expert taxonomists. The need of expert taxonomists seems to be the major problem for the indicator's use, since the number of such experts is relatively small in most Mediterranean countries..

Conclusions Marine Pollution Indicators

According to the conclusions of the Report on the state of the art of Marine Pollution Indicators in Mediterranean countries (UNEP(DEPI)/MED WG. 316/Inf.11, 13 June 2007), 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.

7. Towards an harmonized integrated marine monitoring programme in the Mediterranean Region

The Contracting Parties to the Barcelona Convention, at their 15th Meeting in Algeria (2008) adopted the MED POL Phase IV Operational Programme, which called for the development of a holistic approach for the monitoring and the assessment of human impacts on the marine and coastal environment. The philosophy underlying the holistic approach is that all monitoring activities are integrated in a single, well-defined aim – that of achieving a particular level of environmental quality in a specified ecosystem. Within the MED POL Programme, this means that uniform practices had to be adopted across all types of monitoring activities and data management. Several facets have to be standardized: indicators, methodologies for sample collection and chemical measurements, interpretation of results and assessment of pollution. All these tasks have to be undertaken within a harmonized quality management scheme, with a view to integrating results into a common, regional database and using the scientific data to improve protection of the marine environment.

In the 15th Meeting of the Contracting Parties (Algeria, 2008) it was also decided to progressively apply the ecosystem approach to the management of human activities that may affect the Mediterranean marine and coastal environment (Decision IG 17/6 in Annex II). The road map for the gradual application of the approach consisted of the following broad steps.

i) Definition of an ecological Vision for the Mediterranean.
ii) Setting of common Mediterranean strategic goals.
iii) Identification of important ecosystem properties and assessment of ecological status and pressures*.
iv) Development of a set of ecological objectives corresponding to the Vision and strategic goals.
v) Derivation of operational objectives with indicators and target levels.
vi) **Revision of existing monitoring programmes for ongoing assessment and regular updating of targets**.
vii) Development and review of relevant action plans and programmes.

The 15th Meeting of the Contracting Parties decided that ecological vision for the Mediterranean is “A healthy Mediterranean with marine and coastal ecosystems that are productive and biologically diverse for the benefit of present and future generations”. The Meeting also decided on the following strategic goals for marine and coastal areas.

- To protect, allow recovery and, where practicable, restore the structure and function of marine and coastal ecosystems thus also protecting biodiversity, in order to achieve and maintain good ecological status and allow for their sustainable use.
- To reduce pollution in the marine and coastal environment so as to minimize impacts on and risks to human and/or ecosystem health and/or uses of the sea and the coasts.
- To prevent, reduce and manage the vulnerability of the sea and the coasts to risk induced by human activities and natural events.

Also, the Contracting Parties have decided to strengthen cooperation and seek synergies with initiatives pursuing similar environmental objectives, including the European Union’s Directives (Water Framework Directive (WFD) and Marine Framework Strategy Directive (MFSD), with a view to achieving a shared vision of a healthy Mediterranean with marine and coastal ecosystems that are productive and biologically diverse for the benefit of present and future generations.

The European Union, through its MSFD is also promoting the cooperation with the Regional Conventions and specifically with Barcelona Convention. In the MSFD it is stated that:

"The Directive should contribute to the fulfillment of the obligations and important commitments of the Community and the Member States under several relevant international agreements relating to the protection of the marine environment from pollution: …. the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean, approved by Council Decision 77/585/EEC (5), and its amendments from 1995, approved by Council Decision 1999/802/EC (6), as well as its Protocol for the Protection of the Mediterranean Sea Against Pollution from Land-Based Sources, approved by Council Decision 83/101/EEC (7), and its amendments from 1996, approved by Council Decision 1999/801/EC."

The MSFD also states that:

"Third countries with waters in the same marine region or sub-region as a Member State should be invited to participate in the process laid down in this Directive, thereby facilitating achievement of good environmental status in the marine region or sub-region concerned." (MSFD 2008/56/EC).

As a result of the above, it is clear that in the Mediterranean Region there is a political will and the possibility to harmonize strategies for the protection of the sea, including those for monitoring and the assessment of the environmental state and pollution trends.

However, there are currently some differences in the targets of the monitoring programmes between the different actors in the Mediterranean Region:

According to Article 12 of the Barcelona Convention all Contracting Parties shall establish monitoring programmes and designate the competent authorities responsible for pollution monitoring. In addition, Article 8 of the Land–Based Sources Protocol stipulates that these monitoring programmes should aim:

a) "Systematically to assess, as far as possible, the levels of pollution along their coasts, in particular with regard to the sectors of activity and categories of substances listed in Annex I, and periodically to provide information in this respect; and
b) To evaluate the effectiveness of action plans, programmes and measures implemented under this Protocol to eliminate to the fullest possible extent pollution of the marine environment".

The monitoring activities in MED POL Phase III and IV were designed in consideration of the above, and with the following specific objectives:

- to determine temporal trends of some selected contaminants in the coastal waters and specifically in hot-spot areas in order to assess the effectiveness of policy measures and actions taken ;
- to undertake periodical assessments of the state of the environment in hot spots and general coastal areas (needed to provide information for decision makers on the basic environmental status of the areas which are under anthropogenic pressures), and
- to control pollution by means of compliance to national / international regulatory limits.

Concerning the trend-monitoring component, its specific aim was to detect site-specific temporal trends of selected contaminants basically at the designated hot spot sites in the coastal marine environment. The aim is eventually to monitor the effectiveness of control measures taken at pollution hot spots with long-term data of several decades or more.

As the Barcelona Convention monitoring strategy aimed at the generation of data on the state of marine environment and pollution trends at pollution hot spots, the monitoring activity of most Mediterranean countries was basically directed to coastal areas at the vicinity of land-based pollution sources thus leading to large geographical gaps in the coverage of the Mediterranean coastal waters.

On the other hand, the EU monitoring strategy aims at the assessment of the state of coastal, transitional and marine waters, based on specific indicators, having as ultimate goal the preservation of a “Good Environmental Statues” of all European waters. As a result,
“Each Member State shall, in respect of each marine region or subregion concerned, develop a marine strategy for its marine waters in accordance with the plan of action”.

“Member States sharing a marine region or subregion shall cooperate to ensure that, within each marine region or subregion, the measures required to achieve the objectives of this Directive, in particular the different elements of the marine strategies … are coherent and coordinated across the marine region or subregion concerned”

The plan of action of the MSFD includes the preparation by 15 July 2012 by all Member States of an initial assessment of the current environmental status based on 11 Descriptors, establishment of the Good Environmental Status of waters concerned and the establishment of environmental targets and associated indicators. By 15 July 2014 Member States have to establish and implement monitoring programmes for on going assessment and regular updating of the targets. Finally by 2015 at latest the Member States have to develop programmes of measures designed to achieve or maintain good environmental status. The programmes have to enter in operation by 2016, at latest.

This approach demands for an adequate geographical coverage of the water bodies as well as the designation of thresholds between the different status, especially the designation of the threshold between “Good” and “Moderate” status.

There are therefore differences in the goals between the Barcelona Convention and the EU Directives:

Barcelona Convention concept asks for the reduction of pollution from land based pollution sources and as a result the MED POL monitoring programme sampling stations are mainly located at the vicinity of pollution hot spots,

The EU Directives aim at the improvement of the environmental quality (Good Environmental Status) of the sea and as a result monitoring effort is located in all transitional, coastal and marine water bodies of the countries.

However, the adoption of the Ecosystem Approach for the management of human activities by the Barcelona Contracting Parties, and the requirements of the LBS Protocol (Article 8) “…to evaluate the effectiveness of action plans, programmes and measures implemented…” provides the political background to adapt the MED POL Monitoring Strategy, in order to extend the monitoring programme of the Mediterranean countries to all coastal water bodies (and not only the pollution hot spots), and to adapt the data generation strategies in order to use indicators for assessing their environmental statues, in agreement with the MSFD.

Of course, the number and location of sampling sites, the indicators to be used for the assessment of the Environmental Status in the Mediterranean, the threshold values for the designation of the “Status”, as well as the necessary parameters to be measured to “feed” the indicators, have to be discussed by the countries with the assistance of competent experts in the framework of MED POL. However, it seems necessary to progress towards that direction in order to implement the “harmonization” of monitoring efforts in the Mediterranean region. However, it has to be remembered the indicators development concerns the environmental targets associated with them and their link to existing regional and national policies in the Region.

It has to be underlined that obtaining results from monitoring is a tool, not an end in itself. Data interpretation at various levels is essential, with outputs related to the creation of an accessible database, the dissemination of information about pollution and pollution control in the Mediterranean region, and policy advice to the Meeting of the Contracting Parties.

The main concept for the development of the new marine monitoring strategy should be based on the monitoring of representative water bodies, including pollution hot spot areas, in order to assess the quality of the marine coastal ecosystem.

The following issues should be considered in the revision of the monitoring strategy of the Mediterranean countries in the framework of MED POL.

- Hot spots will continue to be monitored at representative stations
- New monitoring stations may be introduced in order to adequately cover all coastal water bodies in the country
- Each country has to decide on its water bodies and the number of representative sampling stations
- The parameters to be monitored and the sampling frequency has to be discussed again and necessary changes have to be introduced to the MED POL monitoring programme according to regional and international priorities
- The use of indicators to be agreed upon has to be applied for the continuous assessment of the environmental status of the Mediterranean coastal and marine water bodies
- Common methodologies have to be developed in the Mediterranean for the identification of indicators. The work already done in the framework of the EU Directives will be taken into consideration
- Assessment criteria have to be developed for the Mediterranean, in order to distinguish between the stages of Environmental Statues, from pristine to polluted.. The progress made on this issue in the EU and other Regional Conventions (like OSPAR and HELCOM) will be taken into consideration.

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