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CONTRIBUTIONS RECEIVED BY THE INVITED EXPERTS

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The attached papers represent the contribution from the invited experts who will attend the Consultation meeting on the identification of Mediterranean pollution emerging issues. They were used by the Secretariat for the preparation of the working document UNEP(OCA)/MED WG.168/Inf.2 and they are herewith included as they were received, for information.

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SOCIO-ECONOMIC TRENDS AND MARINE POLLUTION IN THE MEDITERRANEAN

by

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The Blue Plan scenarios, built in 1985, were not intended to provide in depth perspectives on the possible evolution of marine pollution, but rather focussed on the demographic, economic and environmental interactions on land. They essentially considered that, in the "good scenarios", the implementation of the Barcelona Convention Protocols would lead to a satisfactory situation in the sea. In the case of "bad scenarios", these Protocols would not be implemented and the situation in most parts of the Basin and particularly South and East, would simply get worth.

Since 1985, the Mediterranean scene has undergone some major changes. The consequences of the previous entry of Greece into the European Community have taken place. Spain has since joined completely the European integration process. The European Union has strengthened its environmental regulations. The communist block of Eastern Europe ahs collapsed, leading to profound re-organization of trade and transport, including oil from the Black Sea region. The succession of tensions in Algeria, in Libya and in the Near East have created added uncertainties, culminating with the disintegration of former Yugoslavia which leads to a totally new situation in the Adriatic. The most significant development however, which corresponds to a major recommendation of the Blue Plan, is probably the launching, in 1995 in Barcelona, of the Euro-Mediterranean Partnership supported by the MNEDA funding, which aims at establishing peace, stability and prosperity in the region. This partnership will also include the setting up of the region as a Free Trade Zone (FTZ) by the year 2010, through association of the European Union countries with their Mediterranean partners in the South and East of the Basin.

The region is currently subject to a number of heavy trends, which affect directly or indirectly the pollution of the sea, essentially in the coastal zone. These are likely to continue, whether or not the FTZ is established. However, it appears logical to look at these trends in the perspective of the establishment of the FTZ. This seems all the more appropriate that most prospective studies, including those of the Blue Plan, are taking the year 2025 as time horizon, and that even if the FTZ is delayed by a few years it will probably be in place before that time.

In this general perspective, the main variable, which seem likely to have a significant impact on marine pollution are the following: i) population growth, urbanization and industrialization in the coastal regions; ii) increase of international and domestic tourism in these regions; iii) development of road transport along the coast, iv) development of maritime traffic; v) further development of high yield irrigated agriculture in the coastal plains combined with marginal production in the highlands. Each one of these variables has its own dynamics but it is naturally their synergy which will matter in the end.

1. POPULATION AND URBANIZATION

It is difficult, and indeed arbitrary, to give a precise geographical definition of the "Mediterranean region". The demographic and urbanization processes likely to affect marine

pollution directly are however those which take place in the coastal regions and these can be defined - somewhat arbitrarily - by the territorial units NUT3 which touch the sea, for which appropriate statistics are available.

With this definition, Mediterranean coastal population totalled 96 million people in 1970, 145 million in 2000 and is likely to reach 176 million in 2025. Yet, the Mediterranean is a major dividing lien between an industrialized "North" with a low fertility rate - ranging from Spain to Greece - and a developing "south", with a still rather high fertility rate - ranging from Morocco to Turkey (although Albania has "southern characteristics", while Israel and also Cyprus are more "northern").

Coastal population growth has thus almost totally stopped in the North and is even likely to decline slightly in some countries like Italy. The total for the North, which amounted to about 58 million in 1970, has reached only 6 million in 2000 and will remain close to the same figure in 2025.

In spite of a recent very rapid decline in fertility rates in the South and East, population dynamics will still lead there to an important increase in coastal population, growing from 37 million in 1970 to 76 million in 2000 and to 108 million in 2025. Within such a time span and at this stage of the demographic transition, these figures will not be strongly affected by the economic conditions. The establishment of the FTZ is not likely therefore to have much impact on them in the period considered.

The impact of the FTZ will be more noticeable on the urbanization process and on the consumption patterns. Urbanization in the North has already taken place and can hardly go any further. The process of "littoralization" itself (concentration of people and activities on the coastal fringe) is showing its limits. In the South, to the contrary, urbanization will continue strongly in any event. The FTZ, if extended to cover agriculture, is bound to even increase this phenomenon further because of the shift in favour of export crops and of intensive modern irrigated agriculture, leading to increased migration of rural population from the hinterland. In the last decades, a trend has been noted for a more rapid development of the smaller towns. Between 1950 and 1995, the number of Mediterranean coastal towns of more than 10000 people has thus raised from 777 to 1449. This trend might however be reversed since free trade would rather favour concentration of people (and also industries) in the larger centres. Such a process would call for even more difficult situation in these large cities for domestic and industrial waste disposal and sewage treatment, thus affecting coastal waters.

This environmental situation will be also aggravated by the changes in consumption habits in all the cities of the South which will tend to follow the path observe din the North for domestic purchases and commercial practices, with establishment of supermarkets, increased packaging, etc..., eventually lading to more waste going to the sea.

Such an urban development in the South and East of the Basin might well take place in the absence of adequate norms and regulations, unless of course the FTZ were accompanied by the setting up and actual implementation of regional norms for waste and sewage disposal on the coast and nearby hinterland, in line with the Barcelona Convention.

2. TOURISM

Tourism is an essential economic sector for all Mediterranean countries. More than half of the international tourists visiting these countries - those tourists which contribute directly to the balance of payment - stay in fact on the sea side. In 1990, 72 million international tourists, out of a total of 141 million, concentrated in the Mediterranean coastal

regions, which represent only 12% of the total surface of the countries concerned. The somewhat paradoxical fact is that in a scenario of sustainable development, which implies a good protection of the environment in the coastal areas, the number of international tourists is the largest, and to this has to be added a considerably higher number of domestic tourists than in another scenario. Thus the total number of international tourists in the coastal regions could reach between 140 and 220 millions in 2025, whereas the number of domestic tourists, could raise from 62 million in 1950 to 93 million or to 143 million, the largest figures corresponding to a sustainable development hypothesis.

With the establishment of the FTZ, one could expect this strong development of both international and national tourism in the South and East, while the necessary precautions implied in the sustainable development scenario would not automatically be taken. The result could then be an aggravation of the amount of waste going to the sea, in particular plastics and other debris, together with destruction of wetlands for infrastructures like roads, airports, hotels and marinas and degradation of sea grass beds and marine life, particularly along those coastal of Northern Africa and Eastern Mediterranean which are not yet urbanized.

3. ROAD TRANSPORT

The increase of road transport by private cars is a direct consequence of unplanned urbanization and tourism development. Its effects on land have consequences on the coastal marien zone, particularly through siltation and erosion and chemical contamination. The setting up of the FTZ is likely to increase considerably the role of the automobile in the South and East, since the private car would be one on the first purchases to be made by those benefiting from increased economic activity and since there would be no limits to car imports, as well as a great urge to export from the producing countries in the North. Transport by trucks would also be increased between specialized production areas and the ports for industrial goods, raw materials and agricultural products, the resulting pollution depending on the observance of regulations on the proper maintenance of the transport vehicles and quality of fuel and on the adequate development of intermodal nodes.

4. MARITIME TRANSPORT

The experience of the last 15 years has shown the difficulty of forecasting the future situation in the case of oil, which will remain by far the largest product in Mediterranean maritime transport. The re-opening of the Iraq export lines in Turkey and Syria, the Sumed, the Suez Canal and the new traffic through Turkey from the Caucasus, the Caspian Sea and Central Asia will in any case considerably increase oil hazards in the Mediterranean. This might be aggravated by the use of outdated tankers which would no longer be accepted in North America or Northern Europe but still tolerated in the region. The Bosphorus route could become particularly critical since the Montreux Convention forces Turkey to let tankers pass through. The establishment of the FTZ can only reinforce these trends, although it should also lead to a much greater use of natural gas in the region, which incidentally would reduce carbon emissions. An other effect of the FTZ might be a re-concentration of oil refining in a limited number of sites.

The concomitant entailment or reduction of subventions to less profitable or marginal agriculture will limit efforts in soil conservation. This would particularly affect the slopes of the mountainous hinterland in the Maghreb and in the Near East and would lead to increased erosion, with heavier siltation, and to higher flood hazard, given the characteristics of the Mediterranean climate.

5. CONCLUSION

The experience of NAFTA shows the considerable side-effects of free trade on the environment. For instance, increased maize import in Mexico affects local production methods, with impacts on land and water use and on migration from rural areas. Concentration of cattle feeding in the Mississippi Basin leads to nitrogen pollution in the Gulf of Mexico, an example which might have some relevance for the Mediterranean.

Harmonization of production norms is so far taking place at national level, advancing only slowly at regional level and very little in the environmental field, where the necessary technology transfers are not yet taking place.

The situation in the Mediterranean is naturally different and probably more complex, in particular because of the presence of the sea as a transportation constraint. The setting up of the FTZ could lead some countries in the region to use obsolete (and polluting) technologies in order to compete with their neighbours. Delocalization of certain industries from the North could take place towards those counties with easier pollution norms. It takes time in any case to apply anti-pollution standards. The incitation to do so may come from outside, but in the South and East of the Mediterranean, foreign investment in favour of modern production techniques has so far been weak, except in Israel and Turkey and for oil and gas production. This can be changed by the multilateral FTZ, provided the political situation is stable in the region.

The individual governments of the region will in any ase have to make considerable efforts at their own level if the Mediterranean environment is to be suitably protected. For those in the South and East, this will be particularly difficult, considering that they will have less income from customs duties - up to 20% - since about 60% of their trade is with the European countries.

Concerning marine pollution, this may have consequences, in particular, on the proper installation and maintenance over time of treatment plants along the coastline by the Southern and Eastern countries since such actions will not be part of their commitments in the FTZ. This shows that the proper application of the Barcelona Convention Protocols will be of even greater importance. Generally speaking, if the FTZ comes formally into being in 2010, an appropriate transition period with certain exceptions for the protection of the environment for countries in the South and East, together with appropriate compensation facilities, will probably be required. In other words, while the short-term - for at least a decade - might not look very favourable for the Mediterranean environment in a free-trade system, the progressive instauration of environmental practices similar to those of the European Union could lead to a satisfactory picture in the longer term, hopefully before 2025.

MARINE ENVIRONMENTAL AND POLLUTION EMERGING ISSUES

by

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1. GENERAL

The following aspects will need urgent attention/discussion:

1) Develop methods and criteria to identify and evaluate ecological risks due to pollutants (and other causes that present hazards to the marine environment (see point 3)),

2) Revaluate disposal of wastes into the marine environment as an alternative option to disposal on land in order to release the pressure on land disposal (see point 3)

3) Decide, if the terms of references of MEDPOL should be enlarged from referring only to deterioration of the marine environment caused by pollution, but to extend to all types of deterioration of the marine environment and therefore including also the deterioration cause from unsustainable land use, unsustainable exploitation of natural marine resources. At present, there is no instiutiton that considers these deteriorations.

4) The relative importance of marine with respect to terrestrial of other potential environment issues is discussed below.

2. PRESUPPOSITION

The whole discussion could be focused on RISK ASSESSMENTS that are relevant to INTEGRATED COASTAL AND OCEAN MANAGEMENT.

RISK ASSESSMENT should concern total risks (BUDGET APPROACH) that are not necessary limited to the risks from marine sources. RISK ASSESSMENT must take into consideration that the AWARENESS OF RISKS varied extremely between persons (e. g. between the general public and experts). This means that also those risks have to be considered, that are perceived as great risks by the general public, but not as such by experts (e.g. marine contamination risks versus non-marine risks). This is due to the great differences in AWARENESS OF RISKS, which for the general public is mainly due to the biased presentation of risks by the mass media stimulated by persons like Cousteau "the Mediterranean is dying") etc.

For a realistic RISK ASSESSMENT of pollution caused to the marine ecosystem and from marine resources to the human population, the marine risks must be evaluated in the frame of the sum of all risks (BUDGET APPROACH).

3. DATA BASE AND ASSESSMENTS NEEDED FOR INTEGRATED COASTAL AND OCEAN MANAGEMENT (ICOM)

3.1 Health

These risks can be evaluated from TOLERABLE INTAKES established by WHO/FAO (see Table 1 for selected PROVISIONAL INTAKES).

3.1.1 Trace elements

Emerging issues: None

Insufficient attention: Comparative risk assessment: Terrestrial versus marine exposure for Hg, Cd, Pb, As. In order to assess the relative risk of TE intakes the total intakes both from marine and terrestrial sources have to be estimated. In particular:

a) High **natural methyl-Hg** concentrations near geochemical anomalies need further attention because of the inefficiency of legal limits does not protect critical populations at risk.

Note: consuming e. g.

0.5 ppm = 500 ug Methyl-Hg/1000 g FW;

The Provisional Weekly Tolerable Intake of 200 ug/person is reached with 4 meals/week !) that do not protect critical populations at risk consuming

1 meal of sea food/day = 7 meals/week),

but hinder economically fisheries, because higher than 0.5 ppm seafood cannot be sold, but could be eaten by persons consuming less than 4 meal a week that is the great majority of the population (Gesamp, 1985).

b) Risk evaluation of high total As concentrations in benthic fish, crustaceans and molluscs, considering that most As is in a non-toxic organic form (Gesamp, 1985; Maher *et al.* → **contains ref to marine organisms**). This may become an emerging issue, if the public attention will be arosen by reports on high As_Total concentrations.

3.1.2 Chl-HCs

Emerging issues: None

Insufficient attention: Necessity of risks up-date showing that most probably no risks exist because the use of Chl-HCs is banned in the Mediterranean and the issue does not need further attention.

3.1.3 Pathogenic organisms

Emerging issues: None

Insufficient attention: Risk assessment of exposure to contaminated seafood. Re-assessment of risk from bathing in contaminated seawater showing small risk in comparison with seafood consumption.

3.1.4 Marine toxins (originated in blooms etc.) in sea foods

Emerging issues: None

Insufficient attention: Risk assessment of exposure

3.1.5 Cancerogeous substances

Emerging issues: None

Insufficient attention: Risk assessment of exposure to contaminated seafoods: Only insignificant risk: (GESAMP, 1991).

3.2 Ecosystem risks

3.2.1 General Problems

Emerging issues:

Develop methods and criteria to evaluate ecological risks due to pollutants. WATER QUALITY CRITERIA are insufficient, because they are based on LD-50 etc. and do not take into consideration the often much more important intake of pollutants through the foodchain (Fig. 3).

ECOLOGICAL QUALITY CRITERIA could be developed from concentrations in biological indicator species in polluted ecosystems. It has been suggested to use SEDIMENT QUALITY CRITERIA (Chapman and Mann, 1999), but the analyses of sediments is difficult (what extraction method, what collateral data on the matrix are necessary?) and it is even more difficult to establish correlations between concentrations of chemical species extracted from sediment and effects on biota, let alone on ecosystems. Sediments are good qualitative indicators for past contamination.

On the other hand, the matrix of biological species can be easily identified taxonomically and the chemical analysis is easier because the matrixes are more uniform. The same taxonomic identification will supply data on the area of the habitat, on the trophic level, etc.. All useful parameters for the interpretation and assessment of the observed concentrations. The pollution concentrations in the biota will average the concentration over the species-characteristic area of the habitat and the trophic level will give information on biomagnification/biodiminution. The effect/concentration relation can be directly established by correlating effects (e. g. health of the specimens, frequency distribution of species, reproduction success, etc.) with pollutant concentration in the biota observed.

3.2.2 Supertrophication (blooms)

(I do not use the term EUTROPHICATION, because the term is overused and refers only to nutrients (see also Emers *et al.*, 1992).

Emerging issues: None

Insufficient attention: Re-evaluation of model concepts. In particular:

a) All inorganic and organic nutrient species of N and P in seawater and biota, and uptake and release of P and N must be taken into consideration in modelling

supertrophication. The present practice of considering only PO_4 and inorganic N species is insufficient for an adequate understanding.

Recent papers on the importance of organic P: Benitez-Nelson and Buessler (1999) measuring the activities of two cosmogenic radionuclides in dissolved inorganic, dissolved organic and total particulate phosphorus pools over a seasonal cycle (March to August 1997) resulted in P-turnover rates with half of several weeks. Monaghan and Ruttenberg dissolved organic phosphorus in the coastal ocean: Reassessment of available methods and seasonal phosphorus profiles from the Eel River Shelf. Unpublished data from the Gulf of Taranto also show the relative importance of organic P concentrations (Fig. 1). For N similar situations exist.

b) Fluxes should be considered and not only static variables such as concentrations.

Other problems:

- Evaluation of mixing of water masses on supertrophication. Stratification and reduced mixing seems to favor supertrophication.

Note of interest:- After installation of sewage treatment plants along the Italian Adriatic coast criticism was voiced, because some experts suggested that the sewage treatment would transform P bound in complex molecules into much more easily bio-available P compounds thus accelerating P uptake and hence cause supertrophication. Easy to conduct enrichment experiments with algae incubation the sewage before and after treatment could easily establish the effect of treatment, but I am not aware of any publication on this matter.

3.2.3 Oil and petroleum products

Emerging issues: None

Insufficient attention: Enforcement of existing legislation and navigation regulation are the mayor issue.

Note of interest: After, in the 70-ies, ships had been confiscated and the captains responsible for illegal discharge (that previously received a premium when arriving in port without bulkwater to discharge) put in prison, oil contamination along shipping routes and on beaches has been greatly reduced. I have not direct evidence, but MEDPOL data should show this.

Preventions of tanker accidents through enforcement of higher navigation standards (limiting severely "out-flagging" to nations that insufficiently exercise control on ship safety standards and crew professionalism, but this may be outside the possibilities of intervention of MEDPOL.

3.2.4 Radioactivity

Emerging issues: None

Insufficient attention: None

The high risk awareness of radiation hazard, the early diagnosis and the relatively easy detection of radiation, have made health protection from radiation one of the best understand. Because risks to humans exceed greatly the risk to organisms and ecosystems, the principle "if human population are protected also the environment is protect" guarantees

environmental protection (IAEA, UNSCEAR various publications). Methods of health physics are much more developed and sophisticated than other methods and radiation evaluation has and has in the past and will in future serve as models for human protection.

3.2.5 Climate change

Emerging issues: None

Insufficient attention: Too much attention! Temperature increase is well documented in the reduction of glaciers, but the rise of sea level is only a very slow process effective only in centuries (Fig. 2). The tolerance to sea level changes is great: see the indifference to "Acqua alta" (flooding) in Venice and the various suggestions not transformed in remedies. Also Dutch and North-Germans have lived for centuries on land below sea level. While there is no doubt that the concentrations green house gases have increased, the consequences are not clearly established and other much more urgent environmental problems need pressing attention.

4. SOURCES AND ORIGIN OF POLLUTION

4.1 Natural sources (Land-based and marine sources)

4.1.1 Hot spots

Emerging issues: none

Insufficient attention: Geochemical anomalies for Pb, Cd, As, Cu, etc. besides the already well identified Hg-anomalies should be investigated more thoroughly and their influence on natural contaminations of marine biota investigated. Inputs from Rivers need more attention

4.1.2 Diffuse sources

Emerging issues: None

Insufficient attention: None

4.2 Anthropogenic sources (Land-based and marine sources)

4.2.1 Hot spots

Emerging issues: none

Insufficient attention: Hot spots have not received sufficient attention and examining hot spots could supply important data on the effect of pollutants on biota and ecosystems. In particular, the origin and statistics on quality and quantity of land-based sources need more attention.

4.2.2 Diffuse sources

Emerging issues: none

Insufficient attention: More efforts must be made to obtain more complete and comprehensive data.

5. COASTAL AND OCEAN MANAGEMENT

5.1 Development of concepts on an effective ICOM

Emerging issues: Development of concepts for the estimation of risks from disposal into the sea versus other disposal options. E. g. Land disposal.

5.2 Sewage disposal and sludge disposal from sewage treatments and versus direct pipeline disposal

Some basic considerations: Even an optimal 99% sewage treatment, achieved only in well-functioning plants, corresponds only to a dilution of 1 in 100. After sewage treatment the sludge has to be disposed.

In many part of the Mediterranean (Andalusian coast, Italian Riviera, around Islands such as Malta, Cyprus, Balearic Islands, etc the continental shelf is very narrow on relatively deep and oligotrophic water can be easily reached. Note: A very good example is Sanremo, where direct sewage disposal, after primary treatment only, has been practiced for decades. Sanremo has dismissed reusing reclaimed sewage water for irrigation of its predominate flower culture, because of fear of heavy metal contamination.

5.3 Land use

Emerging issues: should this issue be included in the terms of reference of MEDPOL?

Table 1

Provisional daily (PTDI) and weekly (PTWI) tolerable intakes of trace elements and chlorinated hydrocarbons (Moy 1997, WHO pers. com.)

Substance	PTDI ng for 60 kg body weight person	PTWI ng for 60 kg body weight person
Arsenic		900 000
Cadmium		420 000
Copper		210 000 000
Lead		1 500 000
Methylmercury		198 000
DDT_total	1 200 000	
aldrine	6 000	
Dieldrine	6 000	
PCBs	No limit proposed	

6. REFERENCES

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GESAMP (1991), Review of potentially harmful substances. Carcinogens: their significance as marine pollutants. *Rep.Stud.GESAMP*, (46):56 p.

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Percent organic P in the Gulf of Taranto 1968

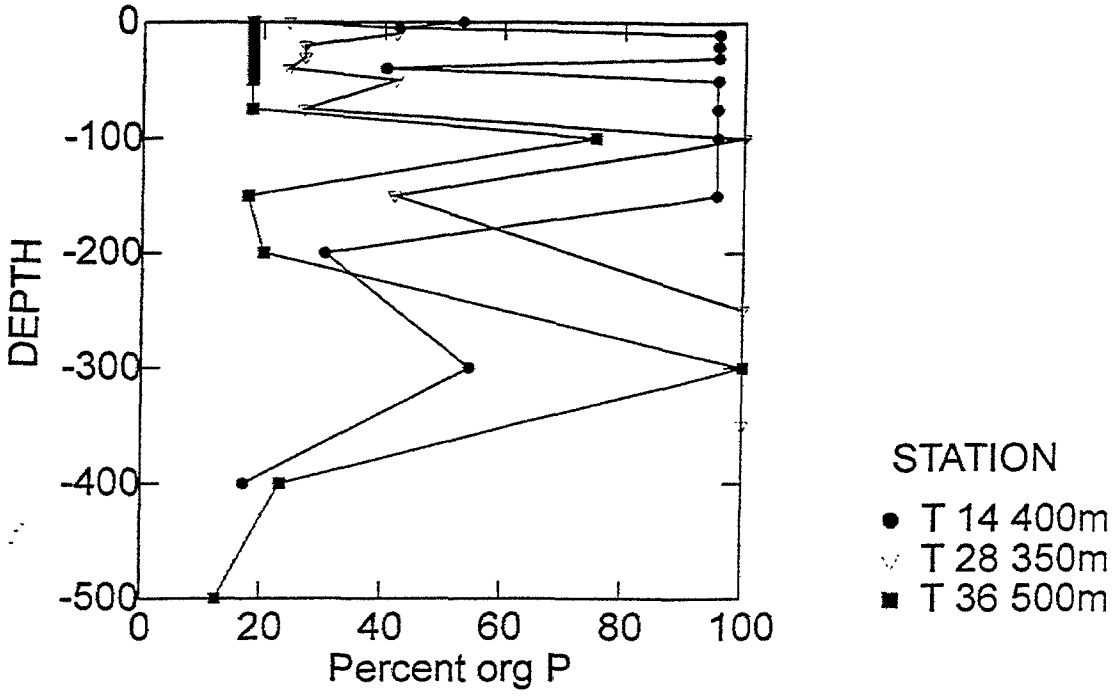
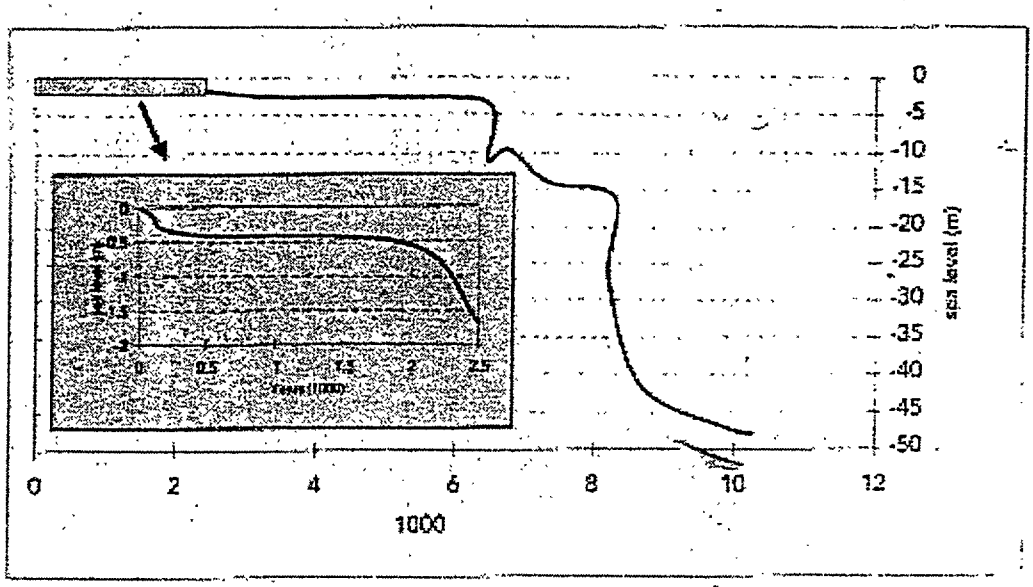


Fig. 1 Percent organic P in three stations (ENEA cruise "Gulf of Taranto, July 1968") Cerrati et. all. pers. com.

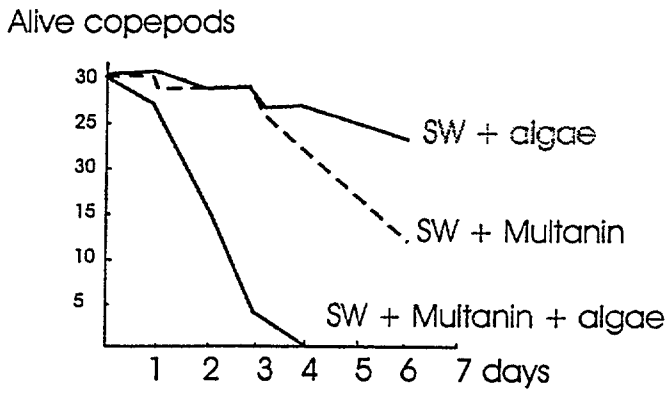
Figure 5.1 **Sea level rise in the Mediterranean region over the past 10 000 years**



Source: Pirazzoli, 1991.

the degree of development and eco-

Fig. 2 Historic sea water levels (in meters versus centuries!) in the Mediterranean (cited in EEA 1999)



Survival of E. acutifrons after addition of Multanin in seawater with and without food phytoplankton algae (Nassogne 1971 mod.)

Fig. 3 Survival of copepods after exposure to pesticides with and without food organisms (SW = seawater) (Nassogne, 1971)

MARINE ENVIRONMENTAL AND POLLUTION EMERGING ISSUES

by

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Environmental management has to face two main issues. One deals with contingent and specific emergencies, such as the impact of power plants, oil tankers, or urban settlements. These impacts are related to human activities over a vast scale. Another issue covers either underestimated or unpredictable events that might impair environmental functioning. Such events can be linked to one-species phenomena, such as the introduction of alien species (the cases of *Caulerpa taxifolia* and *Mnemiopsis leiydi* are paradigmatic), the decline of gorgonian populations, or of commercial sponges, or the bloom of gelatinous plankton or dinoflagellates.

The alterations evidently caused by human activities have been widely studied and monitored and legislation has been or is being issued to prevent their impact. The direct effect of large-scale human action has been immediately identified as harmful to environmental integrity and solving this problem is more a matter of economics and sociology than of environmental sciences.

The emerging issues in environmental understanding and management deal with the unexpected. The following examples are not intended to be exhaustive of what can be done, but show how many neglected topics might provide new insights into environmental functioning and, on the long term, into environmental management.

1. DATE MUSSEL FISHERIES: A STILL UNDEREVALUATED (AND DEVASTATING) EXAMPLE OF HUMAN PREDATION

Fisher *et al.* (1987) FAO monograph on the commercial species of the Mediterranean covered also the European date mussel, *Lithophaga lithophaga*, providing some figures about its production in Yugoslavia. Several studies on the impact of date mussel fisheries have shown that this activity is widespread in Croatia, Italy (Apulia, Campania, Sardinia), and possibly in Albania and Greece. The available information points out how this activity affects most of the countries of the northern shore of the Mediterranean Sea. Lack of information on other countries does not mean that they are unaffected. Date mussel fisheries are not organised over a vast scale. Fishermen act as isolate individuals and are not monitored, also because this activity is illegal in most countries. The reason for the prohibition of date mussel fisheries is linked to its environmental impact. No other human activity is as destructive as this. To extract the mussels, the fishermen dismantle the rocks and, while doing so, they completely eradicate the benthic communities, transforming highly diverse habitats into desolate barrens. A study by Fanelli *et al.* (1994) is now a little classic in this field, being extensively cited as documenting an appalling case of human impact (Dayton *et al.*, 1995; Naylor, 1995; Hall, 1999). There are several causes for the under-evaluation of the impact of this human activity:

- it is not caused by big firms or agencies, easily identifiable as the cause of environmental degradation;

- its effects are visible only by divers and are not detectable with physico-chemical monitoring;

- local populations consume date mussels and give little value to benthic communities (it is easy to convince people that cetaceans are important, it is more difficult to convince them to protect algae, sponges, cnidarians, bryozoans, and tunicates).

Besides unattended legislation prohibiting even the handling of *Lithophaga lithophaga*, there are no concerted actions to:

- document the impact of date mussel fisheries over a basin scale;
- estimate community recovery after the impact;
- plan measures to discourage both collection and demand of the mollusc.

It is strongly advised that such activities are promoted, with a generalised monitoring of rocky coastal communities. Some proposed cultivation as a way to make date mussels available without habitat destruction linked to collection. A possible (and unfortunately probable) scenario deriving from such a decision would be that the documents proving the provenance of a certain amount of date mussels from a cultivation firm would be used to justify the possession of animals coming from the sea. Mankind can survive even without date mussels!

2. THE ECOLOGY OF ROCKY COASTS

The beauties of the Mediterranean attract millions of tourists every year. Tourists increasingly look for high quality environments and eco-tourism is strongly encouraged. It is paradoxical that, in this framework, most research on marine communities focused either on fish populations or on soft bottom benthos, i. e. on communities of commercially exploited species. Coastal hard bottom benthic communities are invariably chosen for the institution of Marine Protected Areas, but there are no concerted actions to promote research in these environments. The economic impact of sea-based tourism in the Mediterranean area, however, is probably higher than that of fisheries. A basin-wide programme for the monitoring of coastal rocky shores might be set up by using the already existing MPAs as ecosensors of environmental quality (even fulfilling at least part of the tasks suggested in the former point) (Boero *et al.*, 1999). Monitoring should be bio-ecological, being based, for instance, on the estimation of community structure from standard quadrats according to predefined procedures (Fraschetti and Terlizzi, 1999). A minimal monitoring programme might require little efforts in data collection and moderate effort in data storage and analysis, having the potential of detecting habitat degradation or modification. A long term series of ecological observations from a basin wide network of hard bottom stations is a powerful tool for environmental management.

3. BIODIVERSITY

Biodiversity is a buzz-word, it is extensively used in all projects and plans and its protection is the core of world-scale concern for both governmental and non governmental organisations. The science of biodiversity recognition and identification, however, is disappearing. Taxonomy is endangered in most scientific communities (Maurer, 2000). This decline is now perceived as harmful by the most powerful funding agency: the National Science Foundation of the United States of America. The NSF has launched the Partnership for the Enhancement of Expertise in Taxonomy (PEET) with the target of rebuilding a breed of taxonomists in the USA. It is tenuous to plan the management of something that is not

recognisable. There is an urgent need for creating new opportunities for scientific careers in taxonomy. The first and only impulse in promoting such trends is the launching of projects financing these activities. A complete inventory of the biodiversity of the Mediterranean, with the identification of underexplored areas and understudied groups, is a prerequisite for serious dealing with any biodiversity issue.

4. CYCLES

Benthic pelagic coupling through biogeochemical cycles is a trendy approach to the understanding of the functioning of marine environments. In these last years, however, Mediterranean-based research has highlighted the need to understand also biological cycles as a way to disentangle ecological complexity. The cycle of coastal plankton, for instance, is the main process of the whole biosphere and evidence is more and more available about the importance of benthic resting stages of plankton in explaining plankton dynamics (Boero, 1994, Boero *et al.,* 1998, Marcus and Boero, 1998). The link of benthic resting stage banks with marine canyon circulation (Della Tommasa *et al.,* in press) and meiofauna predation (Pati *et al.,* 1999) are suggesting new scenarios for the understanding of plankton dynamics. Such studies are carried out only in the Mediterranean. The models have been proposed, there are also preliminary data supporting them. It is now time to test the models at a basin scale, providing a new way of looking at the functioning of marine communities.

5. GELATINOUS ZOOPLANKTON

On my way back from the CIESM meeting at Dubrovnik (May 1998) I saw a massive bloom of salps during the whole trip from Croatia to the harbour of Bari. Such bloom has been observed also by Greek scientists in the Aegean in the same period. A week later the salps were stranding along the Apulian coasts. Salps were estimated to be 10 per square meter, and this density was constant for almost seven hours of navigation. What is the impact of such a bloom on the phytoplankton communities of the basin? Is it influencing the functioning of the food webs? What happens of the dead salp bodies? Do they become mucilages and marine snow? Usually planktonologists study crustacean plankton and see gelatinous plankton as a nuisance, spoiling the copepods. Salps compete with copepods and probably re-direct the route of matter and energy through food webs if they are represented by billions of individuals. Nobody studies these phenomena because they are episodic and no carefully planned action can reasonably expect their occurrence. Jellyfish and ctenophore blooms are equally impressive. They have a big impact on planktonic and nektonic populations, sometimes influencing also fisheries and tourism. The impact of the blooms of *Pelagia* and *Mnemiopsis* do not require further explanation.

These phenomena, if and when considered, are studied only when they occur and so AFTER the environmental peculiarities that caused them. One is forced to study the symptom without having a chance to explore the cause.

Also in this case, a monitoring programme of gelatinous plankton, leading to long term series, is essential to draw information that will be useful to understand their causes, see the beginning of the blooms and relate them to particular environmental situations. Small species such as the Hydromedusae are often more impacting that bigger ones. They feed on fish larvae and on fish food, thus influencing the yield of fisheries.

After the golden years of *Pelagia*, no further funding has been made available for coordinated research on gelatinous plankton.

Crustaceans are much studied and represent the rule. Gelatinous zooplankton is greatly understudied and represent the exception. But are just these exceptions that cause big change. Regularity (crustacean plankton) explains stability. Irregularities (gelatinous plankton) explain change.

6. CONCLUDING REMARKS

I am perfectly aware that I have put forward some of my fields of interest as "emerging" issues in the study of marine environments and on the way they are affected by human activities. I am, of course, ready to admit that they are not the only ones. They are simply the ones I know better. All are supported by publications in highly impacting scientific journals and almost none is part of highly financed projects.

It is not necessary that UNEP actually funds these researches, it might be sufficient to send signals to local governments, asking for simple and concerted action, such as the one regarding the use of Marine Protected Areas as a network of ecosensors.

Innovative fields of research are usually underfunded due to lack of partners for international projects and to possible lack of appreciation by reviewers oriented towards more conventional and trendy topics. The paradoxical outcome of this situation is that the scientific community might be resistant to change. The renaissance of taxonomy due to PEET Projects is a top-down process, encouraged by the National Science Foundation. The financed project for the training of two Hydrozoan taxonomists is presently funding two PhD students with US money: one is Italian, the other is Brasilian. The US scientific community demonstrated little interest in this opportunity.

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MARINE ENVIRONMENTAL AND POLLUTION EMERGING ISSUES

by

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The overall context is that of providing scientific information in a form which makes it directly usable for management. The focus is to identify newly emerging pollution issues as well as those which did not receive sufficient attention in the past and are thus not yet resolved. These issues are to be first identified, then prioritised on the basis of their relative importance.

The issues must be related to marine pollution trends, assessment, effects and control. The risks to be considered are either direct with regard to environmental quality and human health or indirect as they affect socio-economic activities.

As requested y the organisers of the workshop the present note addresses mainly issues related to land and omits deliberately purely marine problems, such as fisheries, aquaculture, oil spills, marine biodiversity, while recognizing that it is often difficult to draw a lien between these two categories of problems.

This being said, the following is a list, in random order, of topics that could be discussed during the meeting, based, inter alia, on recent reviews of the state of the Mediterranean environment:

1. PRESSURES ON THE ENVIRONMENT

1.1 Waste and emissions inventories: review of methodologies used and extent of implementation;

1.2 Waste and emissions treatment practices: extent, efficacy (ex: quality of released wastewater, virus contamination, destination of sewage sludges, solid waste incineration, etc);

1.3 Water catchment approach to assess land use changes and inputs of pollutants and nutrients from agriculture, industry, households, etc. to the Mediterranean and to plan reduction of undesirable emissions; state of art of modelling these issues; quantitative estimates of water flows to the sea could also be made, as this seems to be a topic for which data are insufficient.

1.4 Trends in land use (including tourism) in selected coastal zones of the Northern and Southern rims of the Mediterranean and their impact on the environment, possible scenarios for sustainable development in these zones.

2. STATE AND IMPACTS ON THE ENVIRONMENT

2.1 Exposure assessments, absorbed doses (and possibly effects) in biota for selected organic micropollutants; special attention could be given to endocrine disrupters, such as TBT (an endocrine disrupter being defined as an exogenous substance that causes adverse

effects in an intact organism or its progeny, consequent to changes in endocrine function, a definition adopted at the Weybridge European workshop of 1996).

2.2 Revisiting biomarkers, focusing on Mediterranean organisms, taking account of recent developments in molecular biology.

2.3 Monitoring: this is of course an old topic. What is suggested is that it might be useful to review the whole subject in order to see what are the most significant and cost-effective indicators of environmental quality, of trends thereof, and of the efficacy of policy measures.

CONTRIBUTION TO THE IDENTIFICATION OF SOME MEDITERRANEAN POLLUTION EMERGING ISSUES

by

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1. TRACE METALS IN THE NATURAL WATERS

Natural water contain very low concentrations of ecotoxic metals and any contamination may present a severe hazard to the normal functioning of the natural aquatic ecosystem. Metals are not biodegradable and are involved in biogeochemical cycles by which they are concentrated from hydrosphere into sediment and biota, by very high distribution coefficients.

Trace metal species in waters are distributed between different physicochemical forms (i.e. simple inorganic species, organic, labile and inert complexes and metal ions adsorbed onto a variety of solid and colloidal particles). Variation in the chemical speciation of an element will affect its bioavailability. Thus, not only total concentration, but also metal speciation measurements are required to understand and predict the role and the fate of ecotoxic trace metals in aquatic systems. Dispersion problems of released metal pollution is also bound to starting chemical forms.

It is well known that each metal reacts specifically in aquatic environment although many of them are mainly associated with a particular kind of the reaction mechanism. Trace metals in the marine environment are practically distributed between abiotic and biotic compartments (compartments A1-A3 and B1-B-4 in Fig. 1). Relative abundance of trace metals in each compartment depends on their physico-chemical reactivity characteristics, consequent to their chemical nature and levels of achieved equilibrium and/or steady state.

Various anthropogenic sources can exert an influence upon the content of trace metals in the aquatic compartments, as follows: (i) direct input of metal containing pollutants; (ii) release of other reactive compounds affecting the redistribution of trace metals within chemical species and environmental compartments (i.e. organic ligands, surfactants, redox reagent, etc.), and indirectly by (iii) thermal pollution.

Specifically, a direct input of pollutants, denoted as (i) affects the content of trace metals throughout the entire marine system, while the other two examples (ii) and (iii) can exert a considerable influence on fluxes and redistribution of metal species as well as their quantities between the marine compartments. Increasing the remobilization of the already inactivated toxic trace metals through their bioavailability, hazardous influence on mankind are thus enhanced.

During the last decades development of new procedures for the determination of total trace metals concentrations and chemical forms of dissolved trace metals has become necessary.

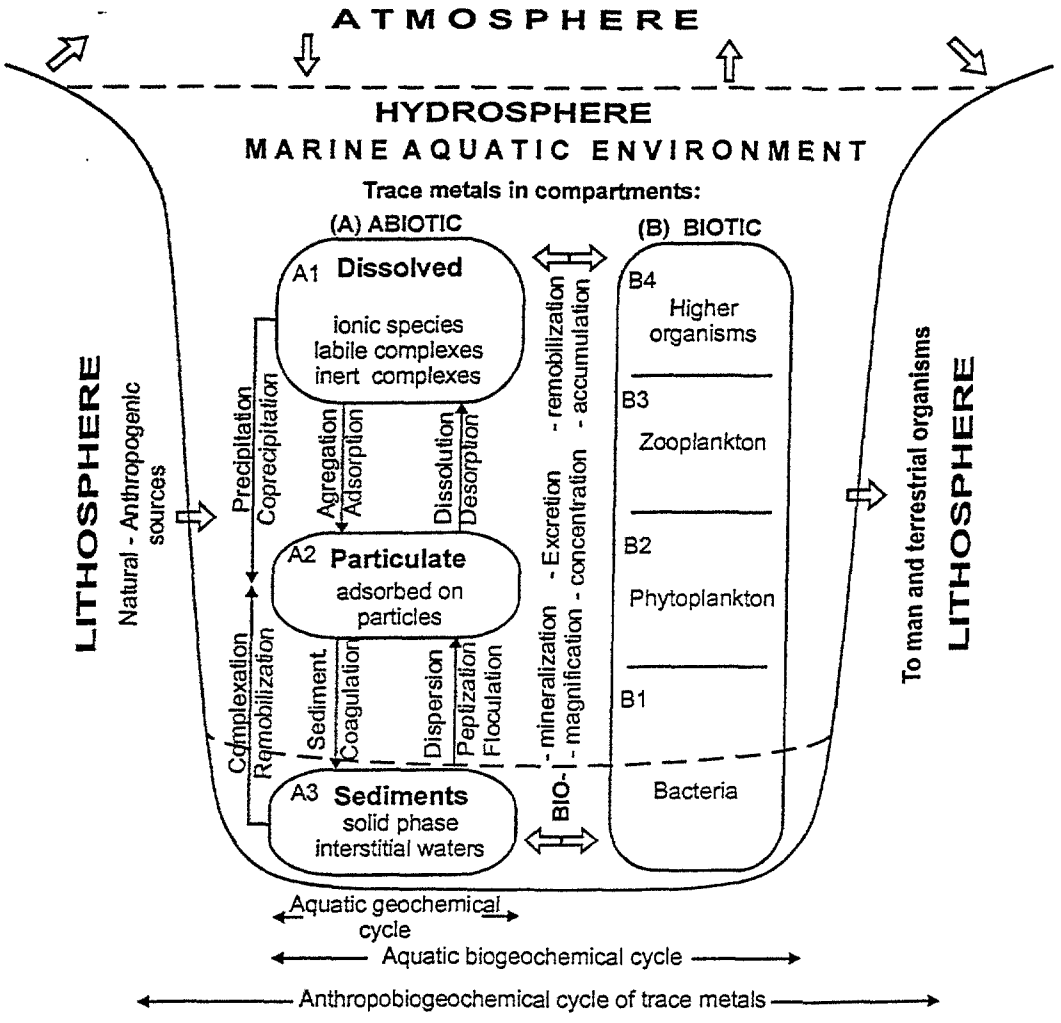

Fig. 1 Cycling of Trace Metals in the Environment

Special attention have to be paid to the actual characterization by proper analytical procedure. It is necessary because the complexity of the composition of the aquatic systems (fresh, saline and brackish waters), and the large number of possible artifacts in the trace metal analysis (i.e. contamination, losses by adsorption, change of speciation due to coagulation of colloids or microbial activity, etc.). Recent development of electrochemical techniques enables analysis of a large number of water samples with minimum perturbation of the composition of the sample. This is highly needed for reliable trace metal speciation of aquatic samples. Design of appropriate probes and experimental procedure is still a challenging task.

Prior to measurements, modeling and/or simulation of the chemical reactions essential for the determination of reactive and total metal concentration and metal complexing capacity (MCC) complex network of chemical and electrochemical equilibrium and reactions in the bulk of the sample solution as well as the possible influence of the measuring electrochemical procedure itself must be taken into consideration. Figure 2 shows how the metal whose concentration and/or speciation is to be determined, reacts with the other components in the solution. It also shows the distribution of the metal forms (i. e. speciation). In ASV measurements, portions of metal ΔM are subsequently added to the sample solution and left to equilibrate. "Titration" with electrons at the reduction potentials E_1

or E_2, results in the measurement of free and labile complexed, or total metal concentration with oxidation peak potential ε_1.

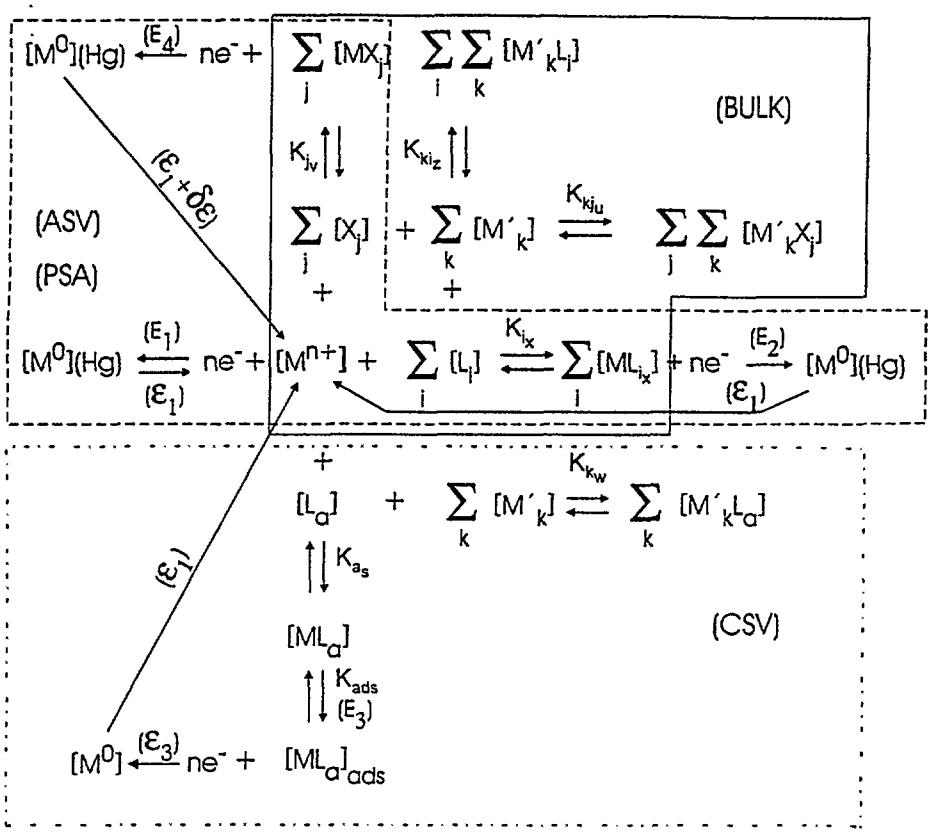

Fig. 2 The network of chemical equilibrium and electrochemical reactions in natural water samples: M - metal which complexing capacity is determined; M'_k - k other competition present cations; L_i - i ligands that form inert complexes; X_j - j ligands that form labile metal; L_a - added ligand; ne^- - number of electrons in the reaction; K_{xy} - corresponding stability constants; E_1, E_2, E_4 - reduction potentials; E_3 - adsorption potential; ε_1, $\varepsilon_1+\varepsilon$ -oxidation peak potentials; ε_3 - reduction peak potentials; Area surrounded by: solide line - represents reactions in the bulk of the sample solution, dash - takes part in anodic stripping voltammetry (ASV) and potentiometric stripping analysis (PSA), dash-dot - added because of cathodic stripping voltammetry (CSV) measurements.

For CSV, an additional ligand L_a has to be added to the solution. At the adsorption potential E_3, the intentionally formed metal ligand complex is accumulated at the surface of the working electrode. "Titration" with electrons results in a reduction process with a reduction peak potential ε_3. From the scheme it is evident that the stability constants of the metal complex formation are conditional ones and that they implicitly comprise the whole network of chemical reactions. The situation is still more complicated when, required by the measuring procedure, portions of metal $\Delta[M^{n+}]$ are added to the sample solution. The results of the consecutive measurements depend on the added metal distribution into the whole network, but in modeling , they are all implicitly included in the conditional stability constants.

Electrochemical analyses are very sensitive, specific and reproducible and at the same time allow simultaneous determinations of several elements even (at the levels) below 10^{-9} M. They are also capable of discriminating between mobile dissolved forms (i.e., free

metal ions and labile complexes with size smaller than a few nanometers) and colloidal/particulate trace metal forms. The former can be obtained by direct measurements in raw natural water while the latter can be obtained by measuring total metal concentrations in raw acidified samples. Moreover, electrochemical instrumentation has been computerized and the analytical procedure is completed automatically. Despite all these analytical and technical capabilities, most of the development reported until now deal with on-line automatic voltammetric analyzers for laboratory and/or field measurements.

Amongst the analytical tools available, the potentiality of electrochemical techniques for trace metals analysis and with significant advantages for dissolved trace metals speciation in natural water samples is obvious.

2. TRACE METALS AND ENHANCED RATE OF PHYTOPLANKTON GROWTH

Metal ions in natural waters include essential elements (such as Cu, Zn, Mn, Fe) which may also be toxic at higher concentrations, and non-essential elements, which are mostly toxic (such as Cd, Hg, Pb). Anthropogenic inputs have increased the concentrations of metal ions over the natural background in many rivers and lakes. Metal ions occur in natural waters in a variety of chemical forms, namely as free aqua ions, as complexes with inorganic and organic ligands, as particulate (or colloidal) phases or adsorbed on particulate (or colloidal) phases. These different chemical species have different reactivities and effects. Availability of metal ions to organisms, as well as toxic effects strongly depend on the chemical speciation. In many instances the effects have been shown to be related to the concentrations of free aqua ions.

In addition to major nutrients (nitrogen, phosphorus, and silicon), certain trace metals, including iron, zinc, manganese, cobalt, copper, molybdenum, and nickel are essential for phytoplankton growth and metabolism. Historically, oceanographers have focused their attention on "classical nutrients" controlling growth and species composition of marine phytoplankton communities. Recent experiments have demonstrated that minute (1-5 nM) additions of iron can markedly stimulate phytoplankton growth in many remote oceanic regions. These and other recent findings indicate that trace metals (mainly their species) play a far more important role in regulating the growth and ecology of marine phytoplankton than previously recognized.

The concern for the control of toxic metallic forms in the environment is reflected by the increasing number of legal regulations which insist upon the determination not only of total trace elements contents but also of chemical species. The European Commission has recognized the need to include such species in the list of dangerous substances to be monitored and some of them are already listed in EC Directives, e.g. on drinking water. Techniques used for the determination of metallic forms of elements generally involve many analytical steps such as extraction, separation and detection. These steps should be carried out in such a way that the speciation is unaltered during the analytical process.

Recently obtained data show that not only in the open ocean, but also in unpolluted rivers as well as closed marine and coastal areas, the concentrations of dissolved trace metals are considerably lower than previously referred to in the literature. The intention of future MEDPOL plans is to contribute to elucidation of the appropriate treatment of water samples considering the entire process from sampling of natural waters to the analytical treatment, including determination and final evaluation of obtained data. Field observations and theoretical and experimental laboratory work are devoted to establishing the governing mechanisms and the influence of various parameters on the fluxes and transformation of species of different trace metals and pollutants in the European continental and marine aquatic environment.

In order to achieve this goal, correlated approaches to the aquatic system will be used:

- development of new and application of existing specific electroanalytical methods (voltammetry, potentiometry, pseudopolarography) with adequate automated sampling techniques for reliable qualitative and quantitative determination of trace metals with respect to their distribution, various forms, as well as and the kinetics of transformation reactions. Improved sensors, sampling and analytical procedures will be developed in order to achieve a high level of specificity, sensitivity, reproducibility and reliability of data;

- field observations will comprise the "model" aquatic system in the Mediterranean region with the corresponding rivers and their estuaries and open ocean waters;

- comparison of data obtained from the analyses carried out under "classical" laboratory conditions and from "in situ" measurements will be elaborated.

In addition, I like to pick up your attention to the problems concerning:

- Remote sensing availability data for Mediterranean countries which are not highly developed

- Environment Impact Assessment (E.I.A.) procedure to evaluate the effect of major projects on the marine environment as it is dredging of the bottom and/or some large industrial construction in side of sea, as well as, the release of hoter/colder seawater treated by different biocides used as antifoulling agents.

- Special attention and control have to be paid to the enormous quantities of the seawater used in coastal thermal plants.

IDENTIFYING EMERGING POLLUTION PROBLEMS IN THE MEDITERRANEAN SEA

by

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The primary factor driving coastal marine pollution is the increase in populations that will be more affluent and hence use more energy and material resources. With improper management their wastes can enter the seas in unacceptable amounts. Certain characteristics of the discard will guide scientists in their investigations:

1. long residence times or persistence in the marine environment;
2. slow accumulation;
3. increasing flux with time; and
4. dissemination over wide areas.

The following polluting substances can be considered as the emerging in the Mediterranean Sea: plastics, plant nutrients, environmental estrogens, pathogens, alien species and algal toxins. In this paper, some suggestions regarding some of those issues are reported.

1. EUTROPHICATION

Perhaps the most studied marine pollution problem involves the consequences of the over-fertilisation of coastal surface waters. The entry of plant nutrients such as phosphates, nitrates and silicates leads to excessive biomass production in the waters and in the sediments. This is followed by a transfer of organic materials to the deeper waters where they can be oxidised by dissolved oxygen. Hypoxia and anoxia can then develop. Declines in fishery and shell-fishery yields, exotic and toxic algal blooms, alterations of community structure in coastal ecosystems and decreases in water quality are also attributed to the nutrient enrichments.

Understanding the course of eutrophication in a given water body requires a long-term commitment to a monitoring programme. The time frames of eutrophication involve periods of decades for significant and measureable chemical changes in the water column. Also the geographical extent of eutrophication can be extensive.

Programmes to assess the general problem of eutrophication require measurements to be made over a large areas and over a time-scale of decades. In order that relevant and essential data can be gathered in economically rational ways, novel methodologies are needed.

In Italy, for example, the criteria for classification of the trophic state of marine and coastal waters are stated in a new legislation (D.L. 11 May 99, n.152), related to the water protection by pollution in agreement to EC directives 91/271/CEE and 91/676/CEE.

The trophic state of the marine-coastal waters is characterised through a trophic index (TRIX) based on chlorophyll *a*, oxygen saturation, mineral nitrogen and total phosphorus.

Numerically, the TRIX index is scaled from 2 to 8, covering a range of 4 trophic states.

The parameters, to be included in this trophic index, are selected as directly related to eutrophication phenomena. The statistic elaboration of these parameters derived from the acquired experience in the decades programme in the Northern Adriatic Sea.

In particular, component parameters of the trophic index should:

a) be meaningful in terms of both, production and production dynamics;
b) encompass major causal factors;
c) be a routine measurements in most marine surveys.

Table 1

Definition of trophic index (TRIX)

Trophic index = $\{ Log_{10}(Ch\ a^{*}D\%O^{*}N^{*}P)+1,5 \} /1,2$
where
Ch *a* = Chlorophyll *a* (g/l)
D%O = Dissolved Oxygen as absolute deviation from saturation of 100%
N = N-(NO_3 + NO_2 + NH_4) (mg/m^3)
P = Total phosphorus (mg/m^3)

The first two parameters, chlorophyll *a* and dissolved oxygen, are a direct expression of productivity: chlorophyll *a* is a substitute parameter for autotrophic phytoplankton biomass and as such commonly measured; on the other hand, productive systems show noticeable variation in oxygen saturation, low productive systems normally do not. Hence, a D%O (absolute deviation of oxygen saturation from 100%) can be taken as an indicator for the production intensity of the system, encompassing both phases of active photosyntesis and phases of prevailing respiration.

Among the causative factors, total nitrogen and total phosphorus, expression of potential productivity, are the most representative parameters, but total nitrogen is often not routinely measured. Mineral components, instead, are usually measured and may be taken as substitute for the totals. The same would apply to total and dissolved mineral phosphorus, but substitution of mineral phosphorus for totals is more questionable. Silica, trace metals, and other production controlling factors, which could be supplementary indicators, are not routinely measured, and are in any case more difficult to incorporate into a trophic index.

2. EXOTIC ALGAL BLOOMS

Related to chemical and physical factors that cause eutrophication, perhaps, is the occurrence of exotic algal blooms, often called red tides. These massive growths of phytoplankton, often dinoflagellates, may contain highly toxic chemicals that can cause

illness, and even death, to marine organisms and humans. Some scientists argue that their frequency and geographic extent are increasing, possibly reflecting greater inputs of polluting chemicals with time. There have been four types of human illnesses associated with algal toxins so far identified:

PSP (paralytic shellfish poisoning) causes numbness and can result in human deaths;
DSP (diarrhetic shellfish poisoning) brings about diarrhoea and nausea;
NSP (neurotoxic shellfish poisoning) causes diarrhoea, vomiting, abdominal pain; and
ASP (amnesic shellfish poisoning), a novel illness, results in memory loss.

The toxins can enter the human food chain through the ingestion of phytoplankton by filter-feeding organisms, followed by their consumption by humans.

3. PLASTICS

Since the 1970s, studies have dealt with the problem of debris in the marine environment, mainly in terms of quantitative analysis and the effect on marine fauna. Most of the data concern floating debris or litter along the coast, particularly on beaches where it is abundant. Plastics account for the major part because of their poor degradability. The entanglement of marine species, particularly turtles but also mammals and birds, has been frequently described. Moreover, the thousands of tons of plastics in the sea constitute a considerable source of pollutants, notably polyethylene and polypropylene, which affect organisms. The aesthetic impact of larger debris is still another objectionable result. Finally, the repercussions on coastal economic activity, particularly fishing, have been demonstrated. The distribution of the debris is another impact factor. High concentrations are found near shipping lanes, around fishing areas and in oceanic current convergence zones. Conditions on the French beaches show the influence of currents on the distribution of debris.

Little information is available concerning larger debris on the continental shelf since considerable means are required for an undertaking of their study. In the survey dealing with the north-western Mediterranean Sea, the Bay of Biscay and Seine Bay, plastics were the most abundant type of debris, with an average of 80% in seine Bay and up to 95% for some stations in the Bay of Biscay. In the north-western Mediterranean Sea, plastics constituted most of the debris, at an average of about 77%, reaching a total amount of 3045 t for the shelf of N-W Mediterranean Sea. Considerable geographic variations were noted, with peak plastic abundances found in deposits off large cities (Marseille, Napoli, Genova and Barcelona, relating to the size of the cities). Moreover, debris may have been swept up along the coast because of the currents, as demonstrated from observation of debris of Italian origin along the French coast, especially between the border and the town Nice. Bags constituted more than 90% of the total plastic debris. In many areas the plastics are transported many thousands of kilometres from their site of entry.

In some areas such as the Bay of Palma (south Sardinia) and south of the Gulf of Fos, collection of kitchen items and shipboard maintenance products would tend to confirm the importance of ship traffic as a source of debris. The framers of the International Convention for the Prevention of Pollution from Ships (MARPOL), through its Annex V were most far-sighted in proposing a total prohibition of any discharge of plastic material to seawaters. Now it is up to sovereign nations to ascertain whether or not any disruptions to the ecosystems have taken place or are imminent. Monitoring programmes might utilise photographic studies, divers, trawls or submersibles. Trawl surveys appear to be the least expensive and perhaps can provide the statistically most satisfying results.

4. INTRODUCTION OF NON-INDIGENOUS ORGANISMS

Marine bio-invaders are organisms that have been introduced into a new marine ecosystem, and thrive within their new environment. In their home environments, these organisms live in balance with their predators, and are controlled by diseases and other ecosystem interactions. The invaders often thrive in their new ecosystem, where controls may not exist to keep populations in check.

These invading species (also known as aquatic nuisance, non-indigenous, exotic, or alien species) can cause complex changes within the structure and function of their new ecosystem. Impacts include restructuring established food webs, importing new diseases to the new surroundings, and competition with indigenous organisms for space and food.

Other ecological changes may occur when the invading organisms reproduce with native species, possibly altering the gene pool. This may lead to hybridisation and homogeneity, which reduces biodiversity, the primary element associated with an ecosystem's adaptability to natural or human-induced changes.

Introduction of new species can also directly impact society and human health. Invading organisms can replace harvested native species through competition or predation. New diseases, moving beyond their normal geographic range or brought by invading hosts, may eliminate native species. Pathogenic organisms can cause the build-up of toxins in wild-harvested fish and shellfish, raising serious human health concerns. These concerns then have to be addressed by society, typically resulting in large governmental spending.

A primary method of alien species introduction has been in the ballast water of shipping vessels. In order to maintain stability during transit along coasts and on the open ocean, ships fill their ballast tanks with sea water. Taken from coastal port areas, this water (and associated sediments) is home to multiple marine organisms. If they take hold in a guest port of the carrying ship, they can displace indigenous species, some of which may have commercial value, reduce species diversity and change the normal functioning of ecosystems. The ballast water pathway, rather than fouling organisms, appears today to be the more important vector. Most taxa that have a planktonic phase in their life-cycle can be found in the ballast waters. The possibility of survival of the transported organisms is probably higher where the chemical and physical characteristics of the receiving waters are similar to those of the site from which they were drawn.

As an example, of the 80 cargo vessels that entered Australian ports in a year, six were found to contain the cysts of the toxic dinoflagellates *Alexandrium cutinella* and *A. tamarense*. Blooms of these organisms are now occurring in places where they had not previously been found.

The South Africa/Australian worm *Desdemona ornata* was found in the Mediterranean Sea since the 1980s, as well as the Japanese red alga *Antithamnion nipponicum*. The American comb jelly *Mnemniopsis leidyi* was first introduced into Black Sea through ballast water in the 1970s. The comb jelly (an organism with similarities to a jelly fish) is a voracious predator on zooplankton and fish eggs and larvae and has been largely responsible for the collapse of the anchovy fishing industry in the Black Sea. In the 1990s this comb jelly has been discovered also in the Mediterranean Sea.

In the last decade, the International Maritime Organisation has been working through its Member States to tackle the problem. "Guidelines for preventing the introduction of unwanted organisms and pathogens from ships' ballast waters and sediment discharges" were initially adopted in 1991, updated in 1993 with the Resolution A.774(18) and in 1997 with the Resolution A.868(20) and IMO is now working towards adopting mandatory

regulations on the management of ballast water. The Guidelines recommends care in loading ballast water and where the non-discharge of ballast water is not possible, ballast water exchange in the open sea provides a means of limiting the introduction of unwanted species. Deep ocean water contains few organisms that are unlikely to adapt readily to a new coastal environment.

The problem of non-indigenous species introduced by ballast water in ships was also being recognised by broader environmental forums. The United Nations Conference on Environment and Development (UNCED), in Rio de Janeiro (1992), recognised the issue as a major international concern.

Invading organisms are also introduced through the culture of marine species, including fish, shellfish, and marine flora (seaweed). Through aquaculture, non-indigenous species can provide sources of recreation and inexpensive food for human communities. Conversely, these species, escaping from enclosed pens, or released - intentionally or not - into regional waters, can impact the coastal and marine ecosystem in ways previously mentioned.

Many organisms are inadvertently transported together with fish, shellfish or other animals imported for aquaculture purposes: for instance, the amphipod *Echinogammarus pungentoides* and the hydrozoan *Garveia franciscana* from the tropical Atlantic and Indian Pacific areas have appeared in the northern Adriatic lagoons, probably having arrived together with fish and crustaceans imported for aquaculture. The cnidarian *Haliplanella lineata* from the north-west Pacific was found in Corsican lagoons. The bryozoan *Tricellaria inopinata*, belonging to the Indian-Pacific fauna, has invaded the Venice lagoon. The isopod *Paracerceis sculpta*, whose genera are well-know along the American Atlantic and Pacific coasts, has been collected in the Venice lagoon and in the lake of Tunis. The sabellid polychaete of Indian Pacific origin *Desdemona ornata* has been found in brackish microhabitats on the Elba Island, in the coastal ponds of Tuscany and Sardinia, in the Venice lagoon and in the Ephesia Bay.

VIEWS ON THE PRESENT STATE OF POLLUTION OF THE MEDITERRANEAN AND EMERGING ISSUES[1]

by

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BACKGROUND

The Mediterranean Sea, the remains of the ancient Tethys, is a modern basin originated during the alpine formation by interaction of the two continents (Eurasia and Africa) and is still in continuous evolution. Opened to the west, it exchanges more than 10^6 m^3s^{-1} with the Atlantic Ocean. The Mediterranean proper also exchanges water with the Black Sea through the Dardanelles, the Sea of Marmara and the Bosphorus and with the Red Sea and the Indian Ocean through the Suez Canal.

The Mediterranean Sea
Dimensions: 3800 km E - W and 800 km N - S
Area: $2.5 \cdot 10^6$ km^2
Volume: $3.7 \cdot 10^6$ km^3
Average depth: 1500 m
Maximum depth: 5100 m, in the central Ionian

Between 30°N and 45°N, in the Subtropical Zone, the Mediterranean Sea, exposed to SW - NW winds, to strong insolation and to low precipitation, constitutes an evaporation basin with salinity above the oceanic mean. The hydraulic balance requires input of low-salinity water from the Atlantic Ocean and output to this ocean of high-salinity water. The dynamic equilibrium generates a general cyclonic circulation though the reverse also occurs in parts of the eastern basin.

Process	(m3/s)
Evaporation	95000
Precipitation	28000
Riverine discharges	14000
Net balance	-53000
Net inputs through	
Dardanels	6000
Gibraltar	54400
Sicilian channel	42000
Total inputs through	
Dardanels	12500
Gibraltar	1187500
Sicilian channel	1000000

The incoming oceanic surface water, nutrient-poor, is further depleted as it travels eastwards enhancing the poverty of the Eastern Mediterranean basin. However, the progressive enrichment towards the West, particularly of the intermediate and deep waters makes the Mediterranean a net nutrient contributor to the ocean with the outflow over the Gibraltar sill that may be traced all over the North Atlantic. The Mediterranean Outflow water also contributes with equivalent amounts of CO_2.

[1] Position paper presented at the **Consultation Meeting on the identification of Mediterranean pollution emerging issues** (Rome, 31 May - 01 June 2000)

Though the Mediterranean Sea has a mean productivity similar to the average of the global ocean, from an ecological standpoint, the strong stratification, the relatively narrow continental shelves and the scarcity of freshwater discharged along the coasts strongly limit the productive capacity making the Mediterranean an oligotrophic sea. The surface chlorophyll distribution integrated over the years shows similar values to those observed in the Atlantic Ocean at similar latitudes.

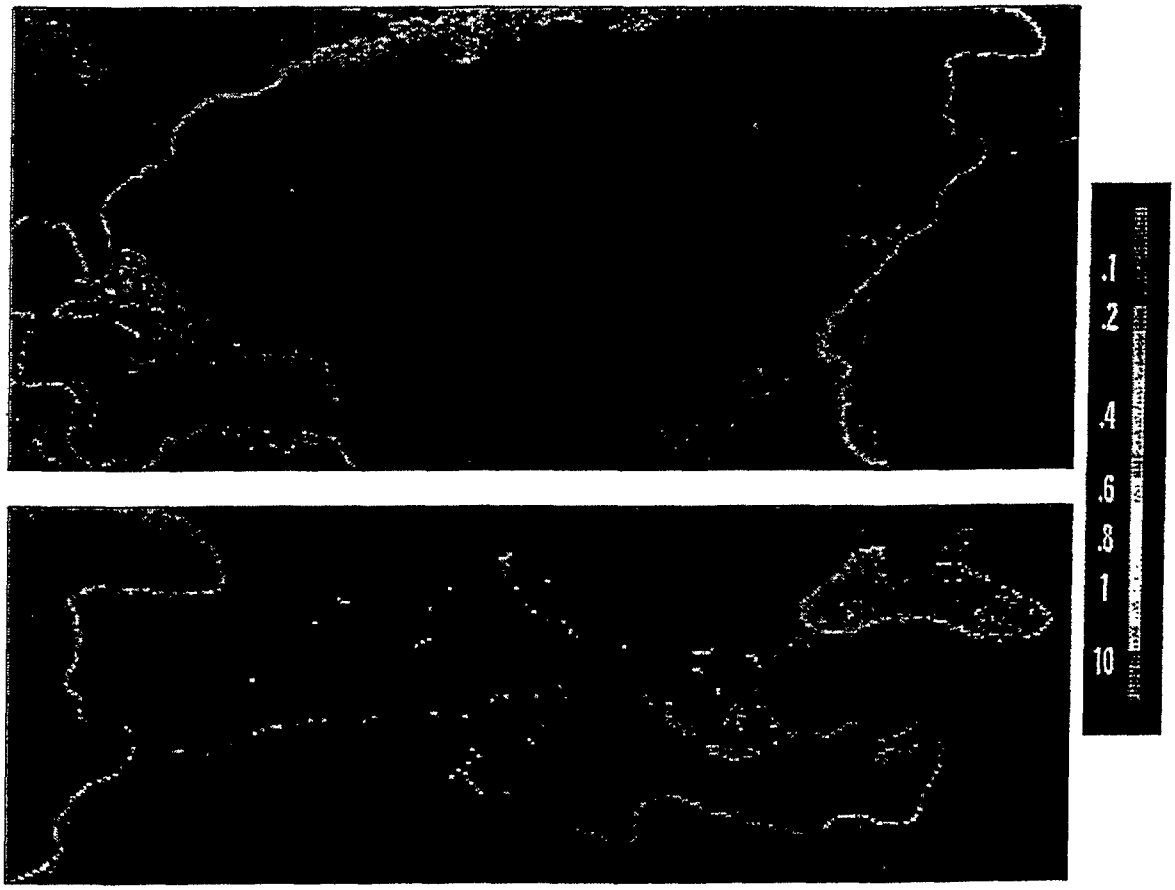

Fig. 1 Composite results of all Nimbus-7 Coastal Zone Color Scanner chlorophyll-a ($\mu g\ l^{-1}$) data acquired between November 1978 and June 1986. Rectangles indicate studied areas. Up, subtropical North Atlantic; down, Mediterranean Sea. (Provided by NASA/GSFC)

The geographic distribution of plankton coincides with the most important hydrodynamic features. The planktonic communities are directly linked to the fertilization processes, more intense in the open sea than in the coastal zones (away from the influence of land runoff).

The vertical distribution of plankton is bound to the thermal structure of the water column. Like most subtropical areas of the oceans, the Mediterranean Sea is strongly stratified. Except for a few particularly fertile areas, the phytoplankton is preferentially found below the thermocline, at the base of the euphotic zone, where it forms a deep chlorophyll maximum coincident with the nitracline that insures the minimum vertical flux of nutrients required for its maintenance. Production is relatively low in summer and winter but may be moderate in spring particularly in the northernmost offshore areas.

The Mediterranean estuarine systems (deltas) consist, mainly, in external buoyant plumes. Mostly due to the rapidly changing conditions (mixing/dispersion) these plumes, floating over nutrient-poor coastal seawater, are not very adequate for the development of dense phytoplankton communities. Nevertheless, some coastal zones are subject to strong trophic pressure due to the discharge of organic and inorganic nutrients. Examples are the North Adriatic, the Gulf of Elefsis and some highly populated enclosed bays with insufficient water renewal for the dilution of the mostly anthropogenic nutrients.

Occasionally, in these eutrophic zones, algal blooms may appear in a thin surface layer (generally with low-salinity water) due to high biomass production not immediately equilibrated by losses through dispersion or grazing. Settling of such large blooms onto shallow bottoms promotes the development of oxygen-consuming heterotrophic organisms (mostly bacteria) contributing to the formation of anoxia events with the result of fish killings and/or migration of benthic and demersal organisms.

When nutrients (N:P) are not in equilibrium (mostly in estuarine areas), the phytoplanktonic organisms may produce extra-cellular mucilaginous polysaccharides that may accumulate in places with restricted circulation causing ecological and esthetic problems.

The degradation of coastal zones may have several origins not always associated to the discharge of polluted waters. Excess fishing, aquaculture, construction of infrastructures (roads, railways, commercial or pleasure harbors, etc) are highly degrading activities for the marine environment.

1. ENVIRONMENTAL PERCEPTION

Emerging issues in the 60s and 70s were mainly the microbiological quality of bathing beaches and of shellfish growing areas, the toxicity of heavy metals (Hg, Cd, etc.) and of some persistent synthetic chemicals (DDTs, PCBs, etc.). Indeed, sewage, mostly untreated, was indiscriminately discharged all around the Mediterranean Sea heavily impacting popular bathing beaches and shellfish growing areas alike. Solid garbage of domestic, industrial and agricultural origin was being dumped at sea (from ships) or on coastal dumping sites from which it would find its way to the sea. Industrial wastes were directly discharged or dumped to the sea with heavy loads of potentially toxic elements (notably Hg) or synthetic substances. Oil pollution caused by careless ship operation, particularly with regard to tanker ballast waters, was *the* Mediterranean problem and indeed the situation was serious with regard to the stranding of tar balls on many beaches, particularly of the eastern basin. Construction of nuclear power plants was in vogue.

Loud voices (notably that of Com.. Jacques Cousteau) claimed for an urgent intervention to stop the Mediterranean from *dying*. Indeed important efforts were made to control some or all of these issues when the *Mediterranean Action Plan* was set up as a result of an effective governmental concerted action with the catalytic intervention of UNEP and various intergovernmental and international agencies (FAO, UNESCO, WHO, WMO, IAEA, CIESM, etc.). The Action Plan was put into operation in 1976 with its legal, technical and scientific components and, with various additions and modifications, has survived to this date.

2. EMERGING ISSUES

The perception of the environmental problems over the past forty years have undergone important changes in the views of the so-called *end-users* (society, media,

tourism operators, governmental and international agencies, environmental managers, NGOs, scientists, etc.). Most of the environmental problems perceived at that time were connected with non-marine activities (industry, energy, agriculture and urban development). Shipping, fishing, leisure boating, tourism, etc. were considered legitimate uses of the marine environment, a consideration that today may be challenged in view of the negative impacts they may have on the marine environment.

- Commercial fishing
- Coastal aquaculture
- Intensive tourism
- Individual diving
- Pleasure boating
- Watershed management
- Scientific research

Other environmental issues in the Mediterranean Sea that were overlooked or not known 30-40 years ago are:

- Coastal erosion
- Changes in river discharges
- Coastline alterations
- Beach *recovery*
- Toxic flagellates
- Jellyfish swarms
- Species invasion
- Species extinction

- Coastal eutrophication
- Hypoxia/anoxia
- Demographic explosion

- Algae blooms
- Coccolithophorid blooms
- Extra-cellular products
- Sea-level change
- Seawater warming
- Changes in circulation patterns
- Changes in salinity/evaporation

3. ACTIVITIES IMPACTING THE MARINE ENVIRONMENT

3.1 Commercial fishing

There was never a serious attempt at evaluating the impact or commercial fishing on the health of the marine environment. Fishing (and aquaculture) always was considered negatively affected by marine pollution, however, the CGPM was reluctant to take a clear position in this regard. Over-fishing is known to affect not only the yield of the commercial activity but also the wellbeing of other parts of the marine ecosystem. In addition, the heavy techniques employed by some fishing boats (trawling, long drifting nets, etc.) destroy many non-commercial organisms and habitats. A proper management of the fisheries should take account of the environmental costs. A particular issue to be considered is the highly damaging fishing of Mediterranean coral.

3.2 Coastal aquaculture

Though not as heavily as in the more productive northern seas, coastal aquaculture is expanding in the coastal areas and bays of the Mediterranean Sea. The high proportion of wastes produced by these activities and the use of antibiotics and other similar compounds to avoid pests and diseases create important disfunctions in the marine environment. GESAMP has made a review of the major impacts of aquaculture on the marine and coastal environment. Some of the impacts of this activity may act as a negative feedback mechanism. In particular, the appearance of toxic flagellates in shellfish growing areas may be the result of a selfcontagion through cysts being kept with pseudo-faeces in underlying sediments.

3.3 Intensive tourism

Tourism in the Mediterranean is paradigmatic. As a matter of fact, most of its shoreline hosts, at higher or lower intensity, activities related to tourism (urban development, marinas, changes in watershed ground cover, shipping, diving, etc.). Different models of tourism activities have been put into operation in the Mediterranean region and, at a later stage, exported to other regions of the Globe. The impact of tourism on the marine environment is multifaceted and has conditions for negative feedback since degradation of the environment (housing, boating, beach cleaning, sewage and waste disposal) takes place by the subjects of the activity.

3.4 Individual diving

Diving, like other aspects of leisure activities, has also a negative impact on the littoral environment, particularly when it is carried out intensively. Impacts are of low intensity but may affect some components of the ecosystem that are extremely relevant to the diving activity itself. It also may generate intense boat traffic in areas which should be protected because of their ecological or esthetic values.

3.5 Pleasure boating

In combination with the above activities (tourism, diving, etc.) leisure boats have proliferated in coastal areas of the Mediterranean Sea. Though they do not represent a numerous population living on board with important waste problems, they do impact the near-shore zone anchoring in critical habitats and contribute to significant pressure on the coastal system with connected activities (diving, solid waste, etc.). In addition, the marinas build around the Mediterranean shores for hosting these boats (sometimes not used for long periods of time) are heavily disrupting sediment dynamics and contribute to coastal erosion.

3.6 Watershed management

Various coastal problems are related to improper watershed management. This may happen by excessive water control (i.e. reducing the discharge of sediments to coastal areas) or by not having adequate control on the land cover and allowing large areas to be covered with concrete (urban development, commercial areas and large parking lots cause uncontrolled water floods in coastal areas).

3.7 Scientific research

Though never considered so far, scientific research may potentially affect the marine and coastal environment. In recent times, the number of drifting or steady buoys has increased as well as other expendable sensors or materials. Future developments in monitoring programs must consider this aspects carefully.

The following are some effects of the above activities:

Coastal erosion/Coastline alterations

When the sediment dynamics are altered either by natural or anthropogenic causes, coastal erosion may take place. Isostatic sea-level change may cause coastal erosion or coastal accretion. This natural process has been taking place in geological times and also at present. Due to deforestation and/or river damming many coastal zones, particularly in large deltas (Ebro, Rhone, Nile, etc.) undergo changes in water level relative to ground. The consequence is a reworking of the sand and fine sediment deposits that are reflected as coastal erosion. Building of marinas, sea-side roads or railroads, urban development often

causes coastal erosion which may turn against those who build them with destruction after unique storms.

Beach recovery

Some Mediterranean countries have undertaken intensive projects for beach recovery when sand is being lost to the deeper zones of the littoral. This activity consists in dredging mostly fossil beaches off the zone to be recovered and pumping this sand onto the beach until the desired beach profile is obtained. This action is not definitive and has to be repeated every 5 – 10 years. Important impacts may be generated by this activity, mostly to the ecosystem of the dredged area unless appropriate impact studies are carried out to minimize the damage caused. In addition, this activities should best be carried out in the cold season since the nutrients released from the washing of the dredged sediments may trigger undesirable plankton blooms.

Coastal eutrophication

This is still the most damaging process to the marine environment because of the eventually irreversible impacts made on the coastal ecosystem. The most conspicuous effect of eutrophication consists in the appearance of turbid waters, blooms of algae which may discolor the waters and eventually leading the underlying waters and sediments to hypoxia and/or anoxia. Extra-cellular products in the water column or on the benthic system may be generated in great amounts that may create difficulties for fishing activities and a negative perception from an aesthetic point of view. Eutrophic conditions normally appear in estuaries and other coastal zones receiving freshwater discharges (freshwater usually carries a high nutrient load). However, the addition of dissolved or particulate nutrients (inorganic or organic) to the freshwater of rivers or other out-falls, particularly from urban sewage or agricultural runoff exacerbates the otherwise normal processes and extends the eutrophic zones beyond the normal influence of freshwater plumes. The reduction in inorganic particulate matter carried out by rivers also contributes to the enhancement of eutrophication since inorganic sediments tend to dilute the organic matter therefore reducing to a great extent its oxygen consuming capacity. Only the reduction of the nutrient loads can mitigate the very negative effects of eutrophication and there is a high risk of these not being reversible. The high demographic growth rates in parts of the Mediterranean region, allow to think that the problems posed by this phenomenon will considerably grow in the years to come.

Toxic flagellates

With greater and greater frequency, various species of marine microorganisms producing toxins for mammals when they ingest shellfish and/or fish grown in affected waters have been occurring in coastal areas all around the world. In spite of great efforts to understand the origin and dynamics of the populations of these organisms there is no clear explanation for their ecological behavior. The possibility that these organisms bloom as a result of pollution is rather remote but the role of cultivated shellfish in the biological cycle of toxin-producing organisms has not been discarded and would classify this environmental issue as impact of aquaculture.

Jellyfish swarms

Like the above, various species of jellyfish (coelenterates) have been swarming along coastal areas of the Mediterranean Sea. Though their populations occur naturally in most areas of the world oceans, they constitute a real nuisance to users of the coastal environment because of their great numbers and the possibility for producing stings of diverse consideration to bathers. Like the above, no definite relationship has been found to

exist with pollution or any of the human activities. Nevertheless, they often constitute, in the end-user perception, an important environmental problem.

Species invasion

The transfer of organisms from one part of the ocean to another has been going on since the appearance of the first marine organisms the only barrier being the intolerance of some species to given climatic conditions. The Mediterranean Sea, open through Gibraltar, has been witnessing the free exchange of species since geological times. In recent times, the opening of the Suez Canal allowed the exchanges of species with the Red Sea and the Indian Ocean. A large number of species now in the eastern Mediterranean have been originated by this so-called Lessepsian migration. At present, the species invasion has taken a different nature because it is not being carried out by natural processes (water exchanges, swimming, etc.) but forced by shipping and other activities involving transport of seawater and/or live organisms in bulk. Though there are few examples of the local Mediterranean ecosystem being affected by this transport, the case of *Caulerpa taxifolia* clearly opens up an extremely relevant environmental problem.

Species extinction

A number of species have gone extinct and others have appeared in the course of evolution. This, however, has occurred along time scales in the order of millennia to eons. At present, however, due to exploitation or environmental damage, the process of species extinction has been enhanced considerably without their replacement by new species (except in the case of the above mentioned invaders). The increase in fishing, shipping, sewage discharges, etc. have caused the disappearance or near-disappearance of many species, particularly in the upper levels of the trophic chain. The decrease in bio-diversity is seen at the global level as a loss of the human heritage for future generations.

Climatic changes

A number of processes have been grouped under this heading, namely:

- Sea-level change
- Seawater warming
- Changes in salinity/evaporation
- Changes in circulation patterns

Natural variability is intrinsic to the functioning of the global system. However, due to anthropogenic activities, enhanced environment variability is postulated. The increase in production of radiation-sensitive gases, water basin management and other activities allow to predict rapid changes of some of the atmospheric and oceanic parameters controlling the climate. Of very unique intensity for the Mediterranean region are the changes in freshwater inputs that may substantially affect the internal functioning of the Mediterranean Sea. These changes may even have a global implication since the Mediterranean contributes significantly to the properties of the deep-sea water formed in the North Atlantic and exported to the global ocean.

4. ENVIRONMENTAL EDUCATION

As explained above, perception of the environmental problems is of extreme importance and this evolves with time. It is found very often that issues that are perceived as real problems by Society do not constitute a scientifically defined problem and vice-versa. The importance of scientifically assessed problems often does not match the perception

Society has of them. Very often the severity of the assessment applied to one place is not comparable to that used for other regions. This is very evident in the case of the Mediterranean Sea by no means more polluted than other regions of the globe or even Europe (North Sea, Baltic Sea, etc.).

It is therefore, of extreme importance to educate society with objective concepts and materials and to train educators in an objective way, using the scientific method for the generation of a General Perception of the environmental issues.

EMERGING POLLUTANT ISSUES IN THE MEDITERRANEAN SEA

by

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1. INTRODUCTION

Both contamination and pollution entail the perturbation of the natural state of the environment by anthropogenic activity. The two terms are distinguishable in terms of the severity of the effect, whereby pollution induces the loss of potential resources (Goldberg, 1992). Additionally, a clear cause-effect relationship must be established for a substance to be classified as a pollutant towards a particular organism.

The concept of marine pollution has undergone a continual evolution (de Mora, 2000). Firstly, the understanding of what constitutes a threat to has been broadened in scope to include organometals, endocrine disrupters, and non-chemical issues such as exotic biota from ship ballast waters and hulls. Secondly, the research process to investigate contaminants has changed. Biogeochemical practices have ensured that understanding the behaviour of contaminants in the marine environment requires a multidisciplinary strategy, which includes reliance on ecotoxicological studies. Thirdly, recognition of the deleterious effects of marine pollution has led to a variety of control strategies, both legal or technological in nature. Such an approach was once reactive to a pollution event, but is increasingly proactive in character. Marine pollution, perhaps once considered the domain of chemists and biologists, now impinges and relies on numerous other disciplines.

This paper presents a perspective on emerging pollutant issues, especially taking into account recent and ongoing developments in international agreements. Changing public perceptions often influence political will to introduce practical and legal control mechanisms. Thus, some pollutants "emerging" in the public eye have long been appreciated in scientific quarters, but the challenge remains to bring the issue to public attention in a comprehensible but honest way. Metal speciation is an example of this type emerging issue in that speciation influences environmental mobility and toxicity of metals, but most control strategies are based solely on consideration of total metal loading in effluent or at the impact site. In a similar way, persistent organic pollutants (POPs) have been included here as an emerging issue due to the ongoing negotiations led by UNEP to ban the use of most such substances. IMO is currently negotiating a means to ban the use of tributyltin (TBT) as a marine antifoulant, and thus, potential replacement biocides are of topical interest. Finally, considerable attention lately has been focused on The Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA). The challenges here are not only to determine what key chemical contaminants should be investigated, but also whether tracers can be found to help understand both spatial and temporal discharge patterns.

2. MARINE ANTIFOULANTS

Recognising its deleterious effects on marine ecosystems and the environment, many countries have restricted the use of TBT-containing formulations as marine antifoulants. This action has spurred the development and use of a wide range of alternative biocides, which have to be toxic to be effective. The application of TBT-containing paints will be prohibited

globally once the IMO succeeds in negotiating an appropriate international instrument. Thus, the variety and extent of use of replacement products are set to expand. Environmental guardianship demands that these alternative compounds are rigorously screened prior to use. However, prior experience, notably with TBT, has demonstrated that this is difficult to achieve and that such compounds easily undergo transboundary transport.

The special case of TBT is considered separately. However, a list of key biocides that merits attention can be complied based on toxicity criteria together with present and projected usage patterns. Core biocide compounds includes diuron, irgarol 1051, dichlofluanid, chlorothalonil, Seanine-211, and zinc pyrithione.

The following project design could easily serve as a model for a wide range of environmental investigations.

1. *Collection and compilation relating to antifouling paint and biocide booster usage*
   Information about antifouling paint and biocide booster usage is difficult to compile. This in parts stems from the fact that countries do not require nor maintain such a type of database and that the companies themselves view this as commercially sensitive information.

2. *Development of analytical techniques*
   Techniques are available for the analysis of key antifoulants. Best results are obtained with liquid chromatography – mass spectrometry (LC-MS), however, gas chromatographic procedures are available for most analytes. Zinc pyrithione represents a special case for which the analysis is non-routine requiring considerable care and attention.

3. *Environmental surveys*
   Environmental surveys of biocide distribution have often revealed interesting features. The presence of biocides has been detected in countries where the compounds concerned had never been permitted. Tributyltin (TBT) has been measured in marinas opened after the imposition of the ban on usage of TBT on small vessels. Such results prompt speculation on illegal usage and visiting yachts (i.e. a transboundary issue) as potential sources.

4. *Experiments in Environmental Chemistry*
   Basic chemical information about the compounds is required, for instance: solubility, water-octanol partition coefficients, and adsorption characteristics onto suspended particulate material All loss pathways need to be identified and quantified. This comprises both chemical (i.e. hydrolysis, photodegradation) and biological degradation pathways, together with sedimentation and hydrodynamic export.

5. *Ecotoxicological investigation*
   Very useful information about the toxicity of antifouling formulations and biocide boosters can be obtained based on some relatively simple experiments. With respect to toxicity of biocides to phytoplankton, small-scale experiments can be set up to measure the decrease in growth based on chlorophyll a following exposure to individual antifoulants and biocides.

6. *Integration of results and risk assessment*
   The final objectives of such studies would be to use existing models to predict biocide concentrations in the marine environment and undertake risk assessment, particularly for hot spots and key locations of economic (bioresources, tourist activities, etc.) importance.

3. TRIBUTYLTIN (TBT)

Tributyltin (TBT) and other organotin compounds are widely used as broad-spectrum biocides, in particular in antifouling marine paints (de Mora, 1996). These compounds have triggered a number of serious adverse effects in the marine ecosystem, particularly noteworthy being imposex in gastropods and shell deformations in oysters. The effect of organotins compounds in the aquatic environment continues to preoccupy environmentalists, industrialists, legislators and researchers. Negotiations are currently underway within IMO to institute a global ban of TBT on all marine vessels.

Recent evidence suggests that residences times in parts of the Mediterranean Sea can be as long as 8 years (Michel and Averty, 1999). Such a finding was surprising and justifies verification at other deep-water sites. Considering the very long half-life of the products, even with no further input once a world-wide ban is imposed, it may take another 150 years for natural processes to remove the material from sediments. Ongoing monitoring is required to oversee and verify environmental restoration. In this context, imposex surveys can complement chemical measurements.

A recent literature survey (Belfroid *et al.*, 2000) showed that for the majority of countries, including many countries with high seafood consumption, no data on organotin levels in seafood exist. For these countries, the claim that organotin compounds in seafood pose a negligible risk to humans has no scientific basis. More attention to this gap in knowledge is needed and TBT levels should be regularly monitored in seafood for human consumption. Such concerns are highlighted by the occurrence of TBT in human livers (Kannan and Falandysz, 1997).

4. TRACE ELEMENT SPECIATION

Speciation analysis is the analytical activity of identifying and measuring the quantities of one or more individual chemical forms in a sample (e.g., species of metals and metalloids, including organometallic compounds and different oxidation states). The *speciation* of an element clearly governs its geochemical and biochemical behaviour, manifest in terms of environmental mobility and bioavailability, respectively, due to differing characteristics such as charge, solubility and diffusion coefficient. Thus, simply determining the total amount of a trace element in a sample, without distinguishing the various species present, is no longer adequate to meet pressing environmental, regulatory and economic needs for understanding mobility, bioavailability, storage, retention and toxicity.

An increasing number of recent publications have dealt with the study of chemical speciation of trace elements, notably for arsenic, chromium, mercury, tin and platinum. The evolution of this awareness is, however, quite paradoxical. Although dramatic events or economic burdens alerted the public about toxic forms of elements (e.g., the high toxicity of methylmercury identified in Minamata, Japan, in the 1950s, or the high mortality of oysters in the Arcachon Bay, France, in the 1980s due to organotin contamination), regulations still, in most cases, consider only the total element levels. This is in many cases not sufficient for an accurate risk evaluation (e.g., for environmental contamination, food quality, health risks).

The distinction between toxic and non-toxic forms of the trace element is a matter of some concern. Differences may depend upon the oxidation state. Cr(VI) ions are considered far more toxic than Cr(III) because Cr(VI) penetrates immediately into a cell where it is reduced and becomes potentially carcinogenic. Alternatively for organometals, methylated forms of arsenic are far less toxic than As(V) and As(III). Methylmercury and mercury vapour are highly toxic as they are bioavailable, whereas ingested metallic mercury is not. Tributyltin compounds are endocrine disrupters, which is not the case of inorganic tin compounds.

The difference in toxicity and carcinogenicity between inorganic and organic species is well known to the expert community, but should be better documented. The toxic species are the inorganic As(V) and As(III). In fish products, the average concentration of arsenic is relatively high, but only a small percentage is present as inorganic species, with the main species being the non-toxic arsenobetaine (Sorensen, 1991; Francesconi and Edmonds, 1993). The lack of toxicity data for organoarsenic compounds, such as the arseno-sugars, does not allow for any risk assessment for these species. Simple and validated analytical methods are needed as well as certified reference materials and even calibrants.

Four decades after the first alarming reports on the so-called Minamata disease, a disease resulting from the neurotoxicity activity of methylmercury, the presence of methylmercury in fish and shellfish is still a major environmental problem in many estuaries and coastal areas. High mercury levels in fish and shellfish cause health risks to human communities. As the major threat comes from methylmercury, which is quickly taken up but slowly excreted by living organisms, biotic and abiotic methylation of mercury need to be quantified and our understanding of environmental factors controlling bioaccumulation of methylmercury in various species and ecosystems should be improved. The detection of very high mercury concentrations in certain pelagic fish from the Mediterranean has raised special interest in the cycle of this metal in the Mediterranean (Cossa *et al.*, 1997). The Mediterranean geochemical mercury anomaly, that is the presence of cinnabar deposits, supposedly accounts for these observations. However, a close examination of the data shows no evidence that this "anomaly" has led to higher ambient mercury levels outside the immediate coastal zone in the vicinity of ore deposits. Conversely, measurements in fish show higher mercury concentrations in offshore specimens than in those from coastal areas. Aston and Fowler (1985) concluded that "It seems clear that until more data are available on natural mercury levels (both inorganic and especially organic) in the Mediterranean ecosystem, and on the food chain relationships of the different chemical forms of this metal, the origin of the unusually high mercury concentrations in large pelagic fish such as tuna will remain an enigma".

5. PERSISTENT ORGANIC POLLUTANTS

Persistent Organic Pollutants (POPs), are a set of 12 compounds, according to the decision 18/32 adopted by the UNEP Governing Council in May 1995: PCBs, dioxins, furans, aldrin, dieldrin, DDT, endrin, chlordane, hexachlorobenzene, mirex, toxaphene and heptachlor.

These compounds are of natural or anthropogenic origin and resist photolytic, chemical and biological degradation. They have a low solubility in water but a high solubility in lipids with a high tendency to bioaccumulate in fatty tissues of living organisms. Their concentrations increase in the food chain and can reach rather high levels (Villeneuve *et al.*, 1985). Being semi-volatile, these compounds can be found in remote places far away from their application or manufacture areas resulting in wide-spread distributions all over the planet, including areas where they have been never used (Elder and Villeneuve, 1977; Villeneuve *et al.*, 1989).

The use of pesticides has been banned in many countries, the most important remaining one is DDT (but toxaphene was also used in huge quantities in tropical areas, such as Central and South Americas) for the control of malaria. In some countries such as Mexico, Mozambique or Madagascar, the malaria, spread by mosquitoes, is still a problem for the populations and there is now a background of DDT in all bivalve samples collected on the coastal areas (Villeneuve *et al.*, 1999). PCBs appears to be still produced in some countries, the major sources of waste PCBs originate from old, and not well maintained,

electrical transformers. Chlordane, heptachlor and mirex are still used against ants and termites. HCB is mainly a by-product of the chlorine industry (Fowler *et al.*, 1985).

In many countries incineration of wastes could be a major source (dependent on the chlorine content of the waste) of dioxins as neither furans nor dioxins are produced commercially, and have no known use. They are only by-products resulting from the production of other chemicals. These dioxins will be, then, found in dairy products, mainly milk, cheese and butter, as in France, where many incineration plants were not adapted to the proper destruction of these compounds. The solid residues from the incineration plants, used for building roads, are also a source of dioxins. From these residues, dioxin can, then, contaminate the underground water supplies. Being very toxic, dioxin is the compound to follow up very carefully in the next future. Furans are a major contaminant of PCBs and, so, can be found in all PCBs containing oils used for electric transformers.

6. URBAN SEWAGE POLLUTANTS AND TRACERS

6.1 Surfactants

Surfactants are organic compounds used to emulsify and solubilize oils, greases and other substances. In agriculture, their primary use is in pesticide spray formulations which lowers the potential for adverse environmental impacts from pesticides by reducing application rates. However, studies with alkylphenol ethoxylates surfactants (the nonylphenol ethoxylates (NPEO)), have indicated that when these compounds are degraded by bacteria, products may form are more toxic to aquatic organisms than many pesticides (Holmes and Kingsbury, 1980). Consequently, surfactants and related products are being identified as a marine environmental and pollution emerging issues which should be taken into consideration in the Mediterranean region.

Usage of nonionic surfactants increased remarkably in the last decade in Europe with alkylphenol ethoxylates (APEO) and alkylethoxylates (AEO) constituting 80 % of this market (Clunie, 1992). Although in household laundry products, APEO are being replacing for the less toxic and persistent AEO, APEO are still currently used in some industrial applications, such as textile and tannery industries. These endocrine-disrupting alkyl phenols have been recently included in a growing list of environmental chemicals with detrimental effects on endocrine, reproductive, and immune systems in humans, wildlife and fish.

Among the anionic surfactants, the linear alkylbenzene sulfonates (LASs) have been widely used as surfactants in the manufacture of detergents since the mid-1960s (Myers, 1992). Despite of their low toxicity and high biodegradability in freshwater, their degradation in the marine environment is slower and depends on the specific environmental conditions (Terzic *et al.*, 1992). Moreover, some LAS residues, e.g. linear alkylbenzenes (LABs) sorb to particles and reach the sediments of marine coastal areas. Other aromatic sulfonates without long alkyl side chains (naphthalene disulfonates (NDS) and sulfonated stilbenes (SSTB) which are used as intermediates in detergent formulations are reported to be more persistent than the LASs (Castillo *et al.*, 1999). These chemicals have a potentially high mobility in an aquatic environment, and therefore, their fate and behaviour after release into the environment need to be understood.

The most widely used cationic surfactant in the 80's was ditallowdimethylammonium chloride (DTDMAC) but owing to its physicochemical properties and its nonbiodegradability in anoxic environments, was replaced in Europe since 1991 by the more biodegradable "ester quats" surfactants, e.g., the diethyletherdimethylammonium chloride (DEEDMAC) (Fernandez *et al.*, 1996).

6.2 Tracers

A series of hydrophobic components usually found as impurities in commercial detergents has also been proposed as urban sewage markers. These comprise LABs which are the residues of synthetic starting materials for LAS industrial production (Ishiwatari *et al.,* 1983; Eganhouse *et al.,* 1983), trialkylamines (TAMs) which were identified in the widely used cationic surfactant DMDTAC (Valls *et al.,* 1989a). Although LABs and TAMs do not pose adverse effects to many marine species (Glendhill *et al.,* 1991), these hydrophobic compounds are more persistent than their ionic counterparts and tend to accumulate in sediments and in marine biota (Valls *et al.,* 1989b; Serrazanetti *et al.,* 1994). Additional indices based on the occurrence of fecal steroids (e.g. coprostanol/coprostanone) have also been established for tracing urban pollution (Grimalt *et al.,* 1990) and has been widely used to trace faecal pollution in coastal areas (Venkatesan and Kaplan, 1990).

This large variety of organic compounds associated with urban-domestic activities and pesticide spray formulations are introduced into coastal areas. Quick apart from concerns due to their potential toxicity, they can be used for tracing the spatial distribution and deposition of land-based pollutants in coastal zones. A recent survey has shown that conventional sewage treatment can be ineffective in the removal of some surfactant-derived metabolites, and in particular, the highly toxic nonylphenol ethoxylates (Lee and Peart, 1998). Additional studies have reported the occurrence of domestic surfactant markers in deep-sea sediments indicating advective bottom transport of urban sewage to remote places (Chalaux *et al.,* 1992).

At present, surfactants have been poorly studied in the Mediterranean Sea and often restricted to the vicinities of urban sewage outfalls, e.g. Barcelona (LASs, LABs, TAMs, NPE: Valls *et al.,* 1989a; 1989b, 1990; Fernandez *et al.,* 1991), coastal enclosure of Venice (NPE: Marcomini *et al.,* 1990) and Ebro river in Spain (naftalene monosulphonates: Pocurull *et al.,* 1999). Without such measurements, the validity of the conclusions from baseline aquatic risk assessment with regard to the hazard of these compounds are hardly possible.

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RESEARCH NEEDS FOR THE RAPID ASSESSMENT OF MARINE POLLUTION (RAMP) IN THE MEDITERRANEAN REGION

by

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1. INTRODUCTION

Throughout Europe (and indeed the rest of the World), there is a growing need to provide environmental managers with effective tools with which to make scientifically-sound assessments of anthropogenic impacts on coastal marine ecosystems. A diverse array of procedures already exists for detecting the damaging effects of pollutants. These include, ecological surveys for identifying changes in the abundance and diversity of species comprising communities; chemical and biomonitoring techniques for determining the concentrations and bioavailability of contaminants released by human activities, and biochemical, physiological and behavioural biomarkers that provide early-warning of exposure to, and in some cases, adverse effects of pollution. When these procedures are used in combination in well-designed survey programmes, they can help to identify which pollutants are responsible for marine environmental degradation.

However, the procedures outlined above have a number of practical drawbacks. They are expensive to perform, must be carried out by highly trained scientists and often necessitate the use of technologically-advanced equipment. In many countries, the availability of qualified personnel and sophisticated analytical facilities is extremely limited. Resources are simply not available to routinely undertake detailed investigations along thousands of kilometers of coastline. These constraints point to the need to develop a more pragmatic approach that can provide the basis for prioritising among study sites. Research is urgently required which will yield a suite of cost-effective, easy to use, ecotoxicological methods that can be applied in the rapid assessment of marine pollution.

2. BACKGROUND

Through recent research efforts a novel strategy for the rapid assessment of marine pollution (RAMP) has been developed that involves suites of very simple, comparatively inexpensive chemical and biological markers that can be applied in aquatic environments (Depledge and Readman, 1999). Immunoassay-based tests provide a rapid and highly selective means of measuring specific chemical compounds. They involve using antibodies that have been raised to specific types of chemical pollutants. Inexpensive test kits have been designed so that the intensity of a colour reaction diminishes when the antibody and chemical combine. Thus, the intensity of the colour provides an estimate of the concentration of the pollutant in a sample. Chemical immunoassays can be performed for a fraction of the cost of conventional analyses.

With regard to the detection of biological effects, the biomarker approach has been adopted. Biomarkers are defined as "biochemical, cellular, physiological or behavioural variations that can be measured in tissue or body fluid samples, or at the level of whole organisms, that provide evidence of exposure to and/or effects of, one or more chemical

pollutants (Depledge, 1994). The biomarker approach was developed originally to chart the exposure of organisms to contaminants. For example, exposure to organophosphate and carbamate pesticides is signalled by the inhibition of an enzyme (cholinesterase) that is involved in transmission of nerve impulses. More recently, biomarkers of adverse biological effects have begun to be characterised, for example, measures of lysosomal dysfunction and reduced immunocompetence of blood cells.

Biomarker techniques need to be simplified as far as is possible and general measures of toxicity need to be used in conjunction with specific markers. For example, monitoring the heart rate of clams and crabs provides a simple indication of metabolic status (is the animal well-fed or starved ? Is its health impaired ?), whilst metal-binding protein induction indicates that exposure to trace metals has occurred. The two markers viewed together indicate exposure and adverse effect. Toxicity is also reflected by the onset of cellular pathology (disease) that can be detected using the neutral red lysosomal assay. This involves incubating blood cells from molluscs or crustaceans with a red dye. The dye becomes incorporated within vesicles (lysosomes) within the cells. The time taken for the dye to leak out of the lysosomes reflects the health of the cells (and the organism from which they were taken); the shorter the time, the more stressed the organism.

More recently, biomarkers have been used to detect and monitor ecologically significant effects such as changes in growth rate and reproductive success.

3. RAMP PILOT PROGRAMMES

A RAMP pilot programme, funded by the UK Department for International Development, has been in operation in Brasil for over 3 years. During this period, Brasilian scientists in Rio de Janeiro, Sao Paolo and Salvador have undergone training in RAMP procedures. They have now acquired the expertise to survey sites along 8000 km of the Brasilian coastline with a view to setting priorities for in-depth investigations at sites of concern, using more sophisticated techniques. The RAMP concept and procedures have also attracted the attention of several other countries. For example, in September, 1999, the Intergovernmental Oceanographic Commission funded a workshop in San Jose, Costa Rica to train personnel from Costa Rica, Puerto Rica, Colombia, El Salvador, Honduras, Cuba, Panama, Ecuador, Guyana, Mexico, Trinidad and Tobago. Another RAMP pilot project will be initiated in the autumn of 2000 in Cape Town, South Africa and the Vietnamese authorities have arranged a preliminary workshop in June, 2000 to prepare a RAMP programme.

4. RESEARCH AND DEVELOPMENT NEEDS

Techniques such as cholinesterase inhibition, lysosomal assays and cardiac activity measurements are designed to investigate pollutant effects on individuals as a basis for providing early warning of potential population and community-level disturbances. Recent evidence demonstrates beyond doubt that chemical data alone does not provide enough information for sound environmental management. Similarly, biological changes that cannot be clearly related to specific pollutants are of limited value. This is why the RAMP concept involves integrating the use of chemical and biological markers. It relies on a weight of evidence approach. If there is no evidence of chemical contamination or of adverse biological changes in organisms following assessment using RAMP procedures then a site will be designated as having a low priority for further investigation. In contrast, if immunoassays indicate the presence of contaminants and that biomarker responses are abnormal, then a site will be given a high priority for more detailed investigation using more sophisticated procedures. This approach provides an effective means of maximising resource use.

To enhance the robustness of the RAMP approach much more research is required to develop and evaluate both current and new procedures. Methods need to be intercalibrated and standard protocols established. Methods also need to take account of regional needs. Specific examples of rapid assessment procedures that require further scientific development are simple tests for sediment toxicity, nutrient enrichment and microbial pathogens. There is also a need to determine how current tests, designed for use with specific organisms, can be modified and applied to a broader range of organisms.

The Mediterranean Sea offers, at a regional level, a unique opportunity to carry out research on the RAMP approach. The very extensive coastline of the region is impacted by a diverse array of chemical pollutants. It is also home to a wide variety of marine organisms, many of which are commercially important. Expertise in marine environmental science in research centres throughout the region provide the opportunity to compare RAMP methods against more elaborate and expensive procedures so that RAMP methods can be properly validated and limitations identified. Clearly, MED POL support to carry out the research necessary to develop the RAMP approach to a level where it can be of value to environmental managers will greatly assist efforts to effectively address pollution issues in the Mediterranean Region.

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CAN THE MEDITERRANEAN SEA BE POLLUTED?

by

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The sea is the final stage of the water cycle under human control before natural evaporation and the climate takes over. The disposal of sewage to sea, either directly or as a result of drainage from rivers, has caused concern for three main reasons.

a) its effects on bathing beaches and other recreational areas.
b) its impact on the sea environment and its ecosystems
c) the concentration of polluting substances in the food chain of animals and humans.

Efforts towards the prevention of pollution of the Mediterranean Sea have lead to the taking of important international steps. One of the principal objectives is to protect both human health and the environment by maintaining the quality of coastal waters especially which are used as bathing water. Principles of the Directive (76/160/EEC) concerning the quality of bathing water of the council of European Communities in December 1975 were adopted by most of countries. Although there are considerable controversies on the standards of this directive, they can be solved by reviewing the EU directive standards in the current epidemiological and especially in viral scientific research. Blue flag awards for clean beaches campaign, initiated by Foundation For Environmental Education in Europe and rewarding the efforts of those that meet the standards of the Blue Flag Charter have been taken up and put into practice by many countries.

However, efforts to prevent the pollution of the Mediterranean Sea may take longer periods than anticipated to reach the desired goals. Some "minor details" may hinder these efforts. Specifying these "underestimated details" may enhance the efficiency of the future endeavors towards the prevention of pollution in the Mediterranean:

- Obtaining the support and the participation of the community: This may include cultural differences of the related countries. In languages of some Mediterranean communities "sea" mostly reminds people greatness, infinity and unlimitedness. Such associations have an important impact on the attitudes of the people. However how human activities affect a sea area depends very much on the sea's ability to dilute, disperse and assimilate pollutants and other influences. Therefore, an efficient risk communication approach is needed. The message that "the sea can be polluted" and the problems that may be caused by this pollution must be given to people of every level of education. Through this, active participation of well-informed and conscious public can be obtained.

- The fact that pollution of the sea is not solely a matter of concern for the people living on the coastal areas but for the health of all people in that country should be emphasized. A systematic and continuous education programs and approach to prevent sea pollution must be implemented. (An international multilingual popular radiobroadcasting can effectively support these activities)

- Approaches towards risk assessment and risk communications must be supported.

- Related countries have to support and promote research on the subject by the universities. An infrastructure must be created to realize international multi-central researches on the subject.

- All related countries must be stimulated to prepare and apply a baseline survey regarding coastal pollution. For many coastal areas, the extent of environmental problems has not been fully understood. Detailed quality and status assessment is a first step to take effective preventive measures.

- Economic barriers that may hinder the participation of non-EU member country trainees to international education program should be lifted. The fees charged from non-EU member state participants should be lowered to the EU-member country trainees' level. This will help to create effective risk communication.

- The qualification and curricula of personnel who takes part in the monitoring and prevention of the sea pollution must be reviewed and international minimal standards on the subject must be determined.

- Methods of early detection of sea pollution have to be developed. High-level academic analysis may not always be effective. Therefore, standard material, method and equipment for on-site seawater analysis must be developed and field personnel have to be trained to perform such analysis.

- Coordination of departments/ministries within a country; Protection of marine environment requires combination of both land and sea-based activities. In many countries these activities are related with several governmental bodies like Ministries of Health, Environment, Agriculture, Housing and Public Works, Municipalities and Governorates. Distribution of authority and responsibility among different departments/bodies are making attempts towards the prevention of pollution difficult. In every country a single official body must be designated as the competent authority. This authority is essential to identify bathing water for sampling and monitoring and to ensure that the waters comply with the standards set by International technical bodies.

- Forming a unity in technical terms and concepts: International organizations and committees are usually inclined to use a special diplomatic language and technical jargons. It will be quite useful to compile an appropriate glossary in which the meanings of these terms are precisely given in the language of related countries.

- Compilation of simple and easily comprehensible technical guides: it will be highly helpful if such guides are compiled so that they are easily reproducible and are cheap and if their translations to the languages of the related countries are facilitated.

- Strengthening of nongovernmental organizations, which will provide technical advice to municipalities, to prevent contamination of bathing waters and beaches by discharge of sewage of coastal cities. Every municipality constructs and maintains effective treatment facilities to prevent risk of infection by serious diseases, fecal and other offensive materials. Municipalities wishing to take technical advice may be asked to pay amounts, which they cannot afford. Strengthening nongovernmental organizations, which can provide advice on these subjects and at the same time creating a platform that will facilitate international cooperation among these organizations, can be an alternative. A system must be developed to exchange related information between countries.

- Exaggerated campaigns related to coastal pollution should be avoided that may ruin confidence between countries. It is possible that economic and touristic competition may exist among related countries. However, attempts to prevent marine pollution must not be

confused with such a competition. There is a sincere requirement of immediate public warning if, for any reason, a beach becomes unsafe or is grossly polluted. Local authorities must inform the public of any health concern that could arise as a result of bathing. Yet, exploiting such circumstances in an exaggerated manner in order to take precedence in economic and touristic competition over other countries may later hinder cooperation among the related countries. This has an important role in strengthening international cooperation and in full implementation of existing conventions.

There is need for rationalistic approaches that will reconcile the national and international priorities. In the determination of those criteria the impact on human health, economic results of the threatening resources, vulnerability of marine ecosystem or lost due to irreversible damage, global importance of habitat under threat should be taken into account.

- Development of reliable international reference laboratories: It is necessary that a reference laboratory of international standard be set up in every related country and a system that will be enable continuous data flow between them. Compilation of a technical guide for the standardization of methods of analysis is essential. International accreditation rules must be determined for such marine pollution laboratories.

- Motivation of research projects for the prevention of marine pollution. Related countries should support and stimulate universities and academic institutions towards implementing such research projects. Appropriate infrastructure must be created that will enable multi-central research activities.

- An international intervention plan must be developed for acute substantial pollution events.

- Development of acute pollution guideline levels. Priority must be given to the determination of measures in such cases as earthquakes, water floods in costal areas, and accidents that may lead to petrol or chemical spills.

- In addition to criteria for the monitoring of marine pollution, standards should be set for the observation of improvement. Improvements may not be detectable many years. So, this may lead to negligence of some priorities towards the prevention of marine pollution. Such assessments and their international declaration can help to enhance the willingness of countries to take the burden of expenses.

- Review/revision and standardization of the guiding principles for acute pollution events prevention, preparedness and response.

- Development of environmental safety performance indicators.

- International cooperation should be enhanced in problems of mutual pollution. Such issues include eutrophication problems in some areas with related effects such algal blooms, impacts of contamination by organic micro-pollutants on fauna.

- Related countries must be published an annual report on bathing water quality. However the data in these reports should be presented so that they can be compared on the country basis. It is essential that a system of reporting and statistical evaluation of sea pollution be proposed and developed. Inter-country reporting differences must be eliminated and standardized.

- Environmental impact assessment standards and guides should be compiled. Every industrial plant to be constructed on the coastal line must have its, environmental impact

assessment be performed. Possibilities of providing technical and economic support on this issue to those countries that are in need should be investigated. It may not be sufficient to employ only emission and discharge criteria in the assessment of coastal areas. Carrying capacity of special sea and coastal areas has to be taken as the basis of receptive areas.

- Related regulations of the countries should comparatively be published and differences among them must be determined. Differences that may prevent international cooperation should be eliminated.

- Projects to diminish the pressure of urbanization, tourism, and recreational activities, on coastal and marine ecosystem should be supported.

- Short and long-term economic consequences of marine pollution must be identified and studies should be performed on suggestions of solution by motivating countries to meet the monetary coast of prevention of marine pollution.

MARINE ENVIRONMENT AND POLLUTION: EMERGING ISSUES IN THE MEDITERRANEAN

by

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1. ECOLOGICAL SUSTAINABILITY OF THE MEDITERRANEAN: FUTURE CHALLENGES OF MED POL

The Mediterranean is subjected to various pressures, either natural or induced by deliberate human actions. In regions exposed to minor pollution, the marine environment can withstand such pressures without collapsing, while heavily polluted areas might be irreversibly disrupted. Comprehensive knowledge of different sub-regions' response to ecological pressures should be central to future activities of MED POL.

The Mediterranean is a deep, virtually tide-less sea, with a number of basins below 3000m. The eastern and western regions are separated by the relatively shallow straits between Sicily and Tunisia, and have significant differences in fauna and flora. The Aegean and Adriatic are semi-enclosed extensions from the Mediterranean basin. Evaporation is 3 folds the input from precipitation; and the deficit is compensated for by the inflow from the Atlantic at Gibraltar.

The main centers of population and industry are located north of the western Mediterranean and around the head of the Adriatic; they receive most of the 120 million tourists that inflate coastal population in the summer season. By contrast, the North African coast is mostly arid with less urban and industrial development. Accordingly, pressures on marine environment vary due the wide diversity of human and development activities of the Mediterranean states.

Few coastal areas suffers from oil pollution and beaches in the affected regions are irritatingly contaminated with specks of tarry oils; deballasting, tankers-cleaning operations, offshore oil extraction and refinery wastes contribute to oil pollution. Adverse effects on fishery, tourism and public health are mostly noted in the Gulf of Naples, Cagliari, the Bay of Izmir and the Sea of Marmara, in Turkey and the Abo Kir Bay in Alexandria, Egypt.

Several coastal cities still discharge untreated or partially treated sewage to the sea. The priority hot spots are along the Egyptian, Spanish, Italian and Israeli coasts. Other anthropogenic inputs to the Mediterranean include organic loads (BOD), nutrients, and salt discharges from rivers and coastal settlements. The pesticide pollution is derived entirely from drainage areas of the rivers. Inputs of heavy metals and PCBs are derived from the rivers of Rhone and Po, the Saronikos Gulf in Greece, and the oufalls of Mex and Abo Kir in Alexandria. In recent years, phosphorus input to the Mediterranean has increased due to intensive use of detergents and fertilizers.

Despite the existence of some locations where conservative pollutants accumulate in relatively high concentrations, neither the water nor the organisms in the Mediterranean appear to be seriously contaminated and pollution levels are generally comparable to those in the Atlantic. Preliminary evidence indicates that PCBs and radionuclides are subject to "demagnification" in the Mediterranean. While microplankton usually accumulate persistent pollutants, contamination of higher tropic levels is actually reduced. This is attributed to

sinking of the heavily polluted faecal pellets to the seabed and their subsequent removal from the pelagic food chain. Threats to the wintering bird flocks are attributed to reclamation of coastal wetlands and shallows, destroying irreplaceable feeding grounds, and the gradual depletion of the fish stocks upon which the birds depend for food. The adverse consequence is mostly noticed in the east Mediterranean States.

2. EMERGING ENVIRONMENTAL ISSUES IN THE MEDITERRANEAN

As the MED POL programme seeks to establish a bridging between priority pollution issues and practical real-time remedial actions, the following guiding principles are recommended for developing a functional plan of action for the future:

Selectivity in addressing issues with the understanding that solving all environmental problems of the Mediterranean is beyond the available human and financial resources of MED POL, a strategic rather than a wide-ranging approach should therefore, be adopted where selected interventions can achieve the greatest impact;

Target-oriented activities which focus on achieving programme objectives, with built-in flexibility to permit changes when needed, and periodic assessment of performance to steer activities toward their intended destinations;

Building on the synergy between people, development and coastal environment to attain ecological sustainability and rational use of the Mediterranean resources;

Future activities should not only emphasize achieving the goals of sustainable ecology in harmony with economic development and resources conservation. The goals should be achieved in a cost-effective manner with maximum reliance on endogenous capabilities and with due account of the special economic, social and political conditions of the individual countries; and

There is a need to strengthen organizational and administrative mechanisms in the Mediterranean States, to enable implementing non-structural activities in harmony with physical structures.

3. EMERGING PRIORITY ISSUES (MEDIUM-TERM)

3.1 Assessing the Impact of Global Warming on the Mediterranean Ecosystem

Global warming is causing a gradual rise in sea level. Low-lying coastal areas in the Mediterranean would be inundated, certain small islands in the basin may be submerged, and the severity of coastal storm damage would increase. The predicted climatic changes is bound to occur at a much faster rate than historical changes, and it is unlikely that vegetation would have time to adapt smoothly. The higher temperatures and greater supply of carbon dioxide would stimulate the growth of some plants. Weather patterns would become more extreme, with more frequent droughts, early frosts, cold periods, storms, etc.

The fishing industry would be disrupted by shifts in the boundary between land and sea, the loss of breeding grounds in wetlands and estuaries, and the alterations in species composition due to these changes and the rise in sea temperatures. Water would become an increasing constraint in agricultural areas.

Changes in climate and vegetation, along with population movements, would stretch the adaptation of species up to and beyond their natural limits. The loss of densely settled

coastal lowlands and islands would set in motion migration both internally and to other countries. 'Ecological refugees' would increase in numbers. There would be major needs for new infrastructure - housing, transport, water supplies, health care, education, etc.

Appropriate interventions should be directed to combating the anticipated problems within the context of a strategic cross-sectoral approach that meets national needs and sets out implementable action plans.

3.2 Assessing Impacts of Priority Hot-spots on Marine ecology and water quality

Adverse impacts of pollution from priority hot spots are manifested in damage to fish, wildlife, human health and serious deterioration of water quality. The main risk of pollution in open waters is from oil slicks owing to accidents to tankers, or the clandestine dumping of hazardous waste at sea. The worst effects of such pollution are experienced when it reaches coastal waters. Raw sewage, industrial waste, and agro-chemicals severely foul the coastal waters in the hot-spot areas, and the costs are borne by fishermen, tourism, industry and the community at large.

Reefs and beaches are being degraded as a result of extensive dynamiting, pollution and the excavation of sand for construction purposes in the hot-spot areas. Reefs often serve as coastal protection, are popular with tourists and divers, and are important in the food cycle of fish.

Beaches near hot-spot locations are increasingly at risk from pollution and physical destruction from wave action and quarrying with consequent losses to amenity and tourism. Algae bloom - particularly Red Tides- has started to become a problem to tourism adjacent to hot spots with intensive industrial and human activities.

Well-formulated action plans should be developed to avert further deterioration in the priority hot spot regions, and to avoid excessive remedial costs to future generations. The precautionary principle requires anticipating problems before they arise rather than to react to them when they become obvious. The formidable technical and political problems must be surmounted to enable integration of EIA in all developmental activities. The MED POL should promote use of EIA as an effective tool to control activities that degrade the marine environment, to protect the regenerative capacity of the ecosystems, and to prevent developments that are detrimental to human health.

3.3 Assessing Transboundary Pollution Problems

Transfer of contaminants in shipping from nation to nation and harbor to harbor is a serious regional issue. Although discharges and spills have received the most attention, the economic and ecological costs of transferring nuisance species in ballast can cost billions of dollars and significant ecological damage to biodiversity results when preventive measures are not taken. Land-based pollution can in many instances spread beyond the boarders of the country of origin.

Social issues which affect decisions concerning transboundary pollution include: (1) differences in the nature and degree of demographic pressure on the resources; (2) vulnerability of local communities to external-introduced threats; and (3) diversity of rules governing property rights and access to natural resources.

Demographic pressures increase competition over resources and hasten depletion. They stem from population growth in coastal and riparian areas and may be intensified by in-migration. In some instances, transferred migrant and refugee populations add to the pressures created by internal migration to the coasts. The most vulnerable are women and

indigenous groups. Indigenous groups along the coast have the least access to social services and are the ones most affected by resources depletion. Gender concerns are important in coastal towns where women play key roles in maintaining homesteads, soil and water conservation, and processing fish and marine products.

Conserving Biodiversity of the Mediterranean Basin

The Mediterranean, and the reefs and wetlands on its fringes, are rich in biodiversity, much of which is unexplored and little understood. Of more direct interest is the role of marine organisms, especially in reefs and wetlands, in the life cycle of fish, the potential value of sea plants and creatures as medicines, and their role in tourism and leisure, and in assimilating waste products. The seabed is a major source of oil and natural gas, and potentially of minerals. Some of the sea's minor products (seaweed, shells, and live tropical fish) are of considerable local economic importance.

Combating Nutrient Over-enrichment and POPs

Nutrient over-enrichment of coastal waters accompanying increased nitrogen and phosphorous discharges from sewage, livestock, and fertilizer is a rising problem in the Mediterranean basin. Devastating algae blooms and toxic algae already afflict some areas where industry, and agriculture are concentrated. These blooms interfere with ecosystem productivity, composition, and function. Another more subtle but significant transboundary pollution issue of persistent organic pollutants, or POPs is anticipated to evolve in the coming few years. POPs involve release of trace organics, which are usually carried by air and water current and compound the accumulation of chemicals shown to impact wildlife, fish and the humans who consume them. These chemicals have intergenerational health effects, undermining the development of the human brain as well as behavioral, endocrine, neurological, and reproductive systems in the developing fetus.

3.4 Long-term Priority

Strengthening Institutional Mechanisms for Coastal Management

The escalation of on-site and land-based pollution and degradation of watersheds and wetland habitat, deforestation, and ineffective agricultural policies, cause appreciable deterioration of marine water quality and irreversible damage to aquatic life. The apparent poor management of coastal regions and lack of commitment to infrastructure investments impede multi-country and multi-sectoral management of shared water resources. Upgrading institutional mechanisms within the context of an integrated coastal management system should be addressed, particularly in the hot-spot regions.

Enhancing People's Participation

While recognizing the importance of the economic, political and social factors for achieving sustainable and environmentally sound development in the Mediterranean basin, active participation of the people through voluntary, self-reliant organizations of their choice is equally important.

People's participation is a complex and long-standing process that requires fundamental changes in social attitudes and individual behaviour. The efforts and resources needed to achieve active participation of the people are considerable, but the ensuing people-motivated and collective actions are necessary for attaining ecologically sustained development of the Mediterranean coastal regions. In the long-term, MED POL may identify active groups, and intended beneficiaries, assist in setting priorities at the national level, and provide technical advice to promote participatory activities.

3.5 Issues to be coordinated with other UN competent Agencies

Identifying Immunotoic Chemicals in the Coastal Environment

Special attention should be placed on toxic chemicals and their effects on host resistance to infectious diseases in coastal communities of the Mediterranean. Exposure to immunotoic chemicals may modify the response of individuals and populations to the changing epidemiological and environmental context of infectious disease. The relationship between environmental change and infectious diseasing attracts attention in the region since a link was proposed between climatic changes and the reemergence of infectious diseases. However, little attention has been given to the potential for chemical contamination and exposure to toxic chemicals, which affect population response to endemic infectious disease.

The emergence of immunotoic chemicals requires concerted research for assessing the nature and extent of toxic exposures in populations beset by endemic infectious disease. Such assessments will help the affected States to maximize investments in both health and environmental protection.

Promoting Selection of Environment Friendly Replacement Alternatives

While replacing hazardous chemicals represents an obvious solution to pollution problems, care has to be taken to ensure that the replacement is not itself damaging. Mercurial slimicides were replaced by pentchlorophenol, which later proved to accumulate in marine organisms. Copper was replaced by tributyltin in antifouling paints, which turned to be even more damaging to commercial shellfisheries. DDT was withdrawn from use due to its damaging effect on populations of predatory birds; however its replacement by organophosphorous insecticides proved to be detrimental to human death. These examples draw attention to the need for thorough assessment of the potential long-term health and environmental impacts of replacement alternatives.

3.6 Issues that require further attention in the future

Promoting Real-life surveys and Field studies

Marine ecosystem has inherent wide, erratic, natural fluctuation caused by climatic or biological events. They can be on a scale comparable to the effects of the most severe pollution damage, sometimes, as in the case of the loss of dominant herbivores, producing exactly the same kind of change or, causing even greater and more widespread change.

To get credible assessment of pollution damage, particularly from diffuse inputs, it is necessary to acquire a profound knowledge of ecosystem structure and the unique performance in specific coastal zones. A concentration on the more controlled situation in the laboratory is no solution to this problem. The laboratory studies commonly lack realism and give misleading results or, at best, yield results, which can be applied to a real-life situation only with great difficulty.

It is also necessary to institute area-specific safe limits of effluent discharges in various coastal regions of the Mediterranean. The response of marine ecosystems to stress and the environmental cost of alternative methods of waste disposal should be carefully considered when developing effluent limits for various localities.

The hazard posed by a particular pollutant depends on its persistence, toxicity, and bioaccumulation potential. However, the actual impact it has once it is released into the environment depends also on its behavior in the receiving water. A specific pollutant may be localized or widely distributed depending on its ability to remain in the water column or

sequestering in sediments. Therefore, assessment studies must consider variations in local circumstances. Future marine pollution research should consider the following:

- Measuring the concentration of contaminants in the water column, sediments, and marine organisms;

- Studying the degradation or modification of these contaminants once they reach the sea;

- Discovering their transmission through food webs; and

- Measuring their effects through toxicity tests of varying degrees of refinement and sophistication and studying the physiological, developmental, or behavioral responses of organisms exposed to them.

HEALTH IMPACTS OF CLIMATE CHANGE AND OF STRATOSPHERIC OZONE DEPLETION

by

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Human environmental impacts now include unprecedented changes at global level in the atmosphere and the stratosphere. Climatologists project that greenhouse gas accumulation in the lower atmosphere will change the world's climate and have apparently already begun to do so. Depletion of stratospheric ozone has occurred in recent decades. The relationship between the two phenomena is complex and new knowledge is emerging. Authoritative international reviews have concluded that these global environmental changes will affect human health, mostly in adverse ways. At global level, some of the ongoing changes in patterns of human disease are compatible with the advent of climate change. However, further research is needed to clarify these and future relationships.

Climate change is likely to have wide-ranging and potentially serious health consequences, including various risks to the health of Mediterranean populations. Some health impacts will result from direct-acting effects (e.g. heatwave-related deaths, and ultraviolet-induced skin cancer); other will result from disturbances to complex physical and ecological processes (e.g. changes in patterns of infectious disease, in freshwater supplies, and in agricultural yields). Effects on human population health are likely to become evident within the coming decade. It is therefore important to enhance capacity for the detection of the early health impacts of climate change and stratospheric ozone depletion. This can only be achieved by supporting research, monitoring and assessment activities.

Authoritative international reviews have concluded that climate change will affect human health, mostly in adverse wasy (McMichael *et al.*, 1996).

The major types of impact of climate change and stratospheric ozone depletion on human health:

TEMPERATURE AND WEATHER CHANGES

		Direct
Exposure to thermal extremes	:	Altered rates of heat- and cold- related illness and death
Altered frequency and/or intensity of other extreme weather events	:	Deaths, injuries, psychological disorders; damage to public health infrastructure

Indirect

DISTURBANCES OF ECOLOGICAL SYSTEMS		
Effects of range and activity of vectors and infective parasites	:	Changes in geographic ranges and incidence of vector-borne diseases
Altered local ecology of waterborne and foodborne infective agents	:	Changed incidence of diarrhoeal and other infectious diseases
Altered food (especially crop) productivity, due to changes in climate, weather events, and associated pests and diseases	:	Malnutrition and hunger, and consequent impairment of child growth and development
Sea level rise, with population displacement and damage to infrastructure	:	Increased risk of infectious disease, psychological disorders
Levels and biological impacts of air pollution, including pollens and spores	:	Asthma and allergic disorders; other acute and chronic respiratory disorders and deaths
Social, economic and demographic dislocations due to effects on economy, infrastructure, and resource supply	:	Wide range of public health consequences: mental health and nutritional impairment, infectious diseases, civil strife
STRATOSPHERIC OZONE DEPLETION		
	:	Skin cancers, cataracts, and perhaps immune suppression; indirect impacts via impaired productivity of agricultural and aquatic systems

A major problem assessing future health impacts is the lack of research on most questions related to weather, climate and health. Indeed, climate change impacts have been identified as a research priority for environment and health in Europe by the European Science Foundation (EC/ESF/WHO-ECEH, 1998).

The health impact assessment of global climate change has three distinctive features: (I) the large spatial scale; (ii) the timing and the potentially long temporal scale; and (iii) the level of complexity in the systems being studied. Further, health impact assessments must accommodate multiple uncertainties that compound across antecedent environmental and social changes. Some health impacts of global climate change can be estimated by reasonable 'extrapolation' of relatively simple cause-effect models. For example, a change in ambient temperature is expected to change the number of temperature-related deaths. However, this may not be appropriate if the health risk concerned is linked to an ecological process. Infectious diseases are the most obvious example of a category of health problems with complex ecologically based dynamics. Climate change impacts on population health will reflect the conditions of the ecological and social environments in which humans live. Our health is profoundly affected by various natural systems such as the ecology of pests and pathogens, food supplies, water supplies, climatic conditions and weather patterns. In

addition, climate change will not affect human health in isolation, but will do so simultaneously with other ecological and demographic changes.

There is a need to consider how these global change processes will affect the health of Mediterranean populations, how to minimize adverse health impacts, how to improve monitoring and research, and how to facilitate all such actions through Mediterranean-wide coordination, sharing of information, and cooperation in wider international efforts.

The 1992 United Nations Conference on Environment and Development (UNCED) recognized, in Agenda 21, that the unavoidable uncertainties attached to forecasting the potentially serious impacts of global environmental change do not justify a wait-and-see approach. Rather, in such circumstances there is a strong case for prudent and precautionary action. This "precautionary principle" is manifestly relevant to global climate change and stratospheric ozone depletion because of the possible occurrence of irreversible changes in the world's environment and climate systems and because of the potentially serious nature of the associated health outcomes.

The detection and attribution of early impacts of climate change on human population health is a priority. Some of the impacts resulting from the direct-acting effects are likely to become evident within the coming decades. For example, an increase in heatwave-related deaths and an increase in ultraviolet-induced skin cancer in some populations may occur soon or already are occurring.

There is good evidence that anthropogenic climate change is already having an effect on plant growth and distribution. There is also good evidence of climate-related changes in the distribution and behaviour of animal species both within Europe and elsewhere (BirdLife International/WWF, 1997).

The time frame of the emergence of health impacts of climate change would depend on several factors:

- The "incubation" period (delay between environmental event and onset of ill-health), which ranges from almost zero (storm-induced injury for example), to weeks or months (vector-borne infections); to years and to decades (UV-related malignancies);

- factors influencing "detectability", given that a change really does occur. The extent and quality of information and variability in the background or pre-existing level of disease must be considered. The time of first detectability of health impacts of climate change will depend on two primary determinants:

  (a) the sensitivity of response (i.e. how steep is the rate of increase);
  (b) whether there is a threshold that results in a "step function".

It is likely that the first detectable changes will be in the geographic range (latitude and altitude) of certain vector-borne infectious diseases and/or in the seasonality of these diseases. For example, summer-time food-borne infections (e.g. salmonellosis) may show longer-lasting annual peaks.

If extreme weather events become more frequent (e.g. heatwaves, floods, droughts) then detectability will refer principally to whether the frequency of such events or "exposures" has increased. If such events become more, or less, severe, then it would be possible to detect changes in the magnitude of health impacts associated with such events.

Any changes in levels of nutrition and hunger will be difficult to attribute to climate change *per se*. There are many, complex, influences on food production. Temporal trends in production policies, soil degradation, variety of genotypes and phenotypes, along with trends in transport, storage, distribution and marketing, ensure that it remains difficult to discern any influence of climate change upon food production.

Failure to reduce fossil fuel combustion (as the principal means of reducing greenhouse gas emissions) will results directly in a continuing (and increasing) avoidable burden of mortality and disease from exposure to local air pollution.

Climate change is likely to entail serious implications for human health in many countries in Europe. Vulnerable populations need to be identified and adaptive actions must be taken. For example, countries in southern Europe are vulnerable to increased local transmission of malaria. Beyond Europe, impacts on food and water supplies and sea level rise could be catastrophic. Climate change may, therefore, exacerbate current problems in peri-European regions (North Africa, Western Asia, etc.) and indirectly lead to population displacement.

The management of risks to health requires that several steps are taken: awareness that the problem exists; an understanding of what causes the problem; capacity to deal with the cause; a sense of values that the problem is important; and political will. We now need to redefine as unacceptable many of the personal and industrial practices that contribute to burden of greenhouse gases and thereby pose risks to the health of present and future generations.

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LARGE SCALE PHENOMENA AFFECTING THE FUNCTIONING OF THE MEDITERRANEAN SEA AND THE DISTRIBUTION OF POLLUTANTS WITHIN THE BASIN

by

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1. INTRODUCTION

The aim of this meeting according to the invitation letter, is to discuss **marine environmental and pollution emerging issues** in the Mediterranean with a view, as I understand it, to prioritize them in order to better focus the funding of the research projects (activities) within the MEDPOL framework and keep track of the major scientific issues regarding the Mediterranean Sea, as well. This meeting comes as a follow up to a recommendation of the MAP Focal points meeting held in Athens in September 1999.

The scientific issues which are of importance to the Mediterranean are certainly numerous and many of them are relevant to pollution issues as well. In this short note we took the option of presenting only two such themes because we believe they are very important ones (not necessarily the most important ones...) but mainly in the hope of opening up a broad discussion and an exchange of views. These are a) the abrupt climatic change which occurred in the Eastern Mediterranean Sea in the early 90'and its consequences on the currents and the ecosystem (the so-called Eastern Mediterranean Transient) and b) the atmospheric deposition and impact of pollutants, key elements and nutrients on the open Mediterranean Sea. Both issues share a number of common characteristics :

- They are both of basin or sub-basin scale and have an important transboundary dimension.
- They have both been the object of CIESM workshops where they have been discussed in detail and relevant reports (CIESM publications) are (or will be soon) available.
- The scientific issues related to these two themes have been the object of proposals submitted to the EU (EMERALD and ADIOS respectively) for funding and they have received letters of support from UNEP/MAP.

2. THE EASTERN MEDITERRANEAN TRANSIENT

During the last decade, the circulation and water properties in the Eastern Mediterranean (EMED) have undergone dramatic changes. A shift in the location of the deep water formation site from the Adriatic to the Aegean occurred, which completely changed the deep conveyor belt of the EMED as well as the properties of its deep waters. The volume of deep waters produced in the Aegean by 1995, was equivalent to a supply at a rate of 10^6 m^3/s over 7 full years; the Adriatic previously took more than twenty years to produce such an amount! This event has been named the Eastern Mediterranean Transient (EMT). The existing data of the Mediterranean Sea, which go back to 1910, show that no event of a similar nature or magnitude had occurred during the last 100 years.

The addition of the dense Aegean waters led to uplifting of the pre-existing waters. This effect brought the nutricline closer to the euphotic zone, making nutrients potentially more readily available to the ecosystem. Whether this effect will (or has) trigger(ed) an increased biological production is still an open question. There are, nevertheless, indications of significant changes in primary and secondary production in various areas of the Eastern Mediterranean. Furthermore, there are indications of far reaching effects of the EMT up to the Straits of Sicily and even into the Western Mediterranean.

Several hypotheses have been suggested to explain the occurrence of the EMT, such as internal redistribution of salt in the EMED, changes in the atmospheric forcing, reduced rainfall over a number of years followed by severe winters, etc. Another suggestion links the event to the North Atlantic Oscillation (NAO). Although these hypotheses shed light on the causes of the EMT, a consistent theory of this is still lacking.

The EMT must be considered as the most significant event ever observed in the atmosphere-ocean climate system of the Mediterranean. Such or similar events with global influence on the climate are known to have occurred in the past (evidenced from ice core and other proxy data) with a strong link to the conveyor belt and the deep water formation sites of the North Atlantic (Dickson *et al.*, 1988). Nevertheless, because of the dimensions of the Atlantic and other parts of the global ocean, such events occur on far larger time scales (compared to decadal time scales in the Mediterranean) and probably need also a much more persistent period of atmospheric anomaly to trigger them. One should thus consider the EMT as a "miniature" example of abrupt climatic variability in the coupling of the ocean-atmosphere system. At the same time, the limited area of the EMED enables adequate monitoring of the evolution of the EMT in time.

The understanding of the causes of the EMT and the study of its evolution and fate not only are of great importance for the Mediterranean system, but also offer a unique opportunity to gain insight into the mechanisms involved in a much more general way. It is a unique opportunity to measure a fast evolving process at basin scale.

In my capacity as Chairman of the CIESM Committee of Physical Oceanography, I organized, as mentioned above, a CIESM workshop *("The Eastern Mediterranean Climatic Transient : its origin, evolution and impact on the ecosystem")* in Trieste, Italy, from 29/3 to 1/4/2000. Here are a few lines from the summary report of the meeting (which is still under preparation).

The workshop was convened to specifically examine questions related to the abrupt climatic change in the Eastern Mediterranean known as the Eastern Mediterranean Transient (EMT). The aim was to determine what is known and understood as well what needs further investigation and clarification. The workshop also reviewed examples of similar effects of climatic changes or trends on the ecosystem of other areas such as the Atlantic and considered the potential influence of the EMT on the Western Mediterranean.

The topics which the group discussed included:

- the causes and origins of the EMT. Are these causes of local origin or are they related to larger scale atmospheric variability (ex. NAO) ?
- how sensitive is the Mediterranean system ? Are similar transients to be expected in the future ?
- the evolution and fate of the EMT ; how long do we expect the EMT to affect the EMED before it fades away ?
- how much will the WMED be affected by this transient ?

- what are the known and expected effects of the EMT on the ecosystem ? Are there indications that these effects could influence not only primary and secondary production but fisheries as well ?

The evolution of the EMT:

An increasing number of information now exist about the evolution of the transient and its effects on the thermohaline circulation of the Eastern Mediterranean. Important individual aspects of the transient as for example the temporal evolution in the Aegean, changes in the local and global salt budgets, changes in the circulation and the uplifting of mid-depth waters have been investigated separately, but a comprehensive analysis of all existing data and a consistent interpretation is still missing. Additionally, some of the analyses and most of the recently collected data are still unpublished and therefore not available to the public. During the plenary discussion following the various presentations it was therefore suggested that in order to structure the further discussion, to identify open questions and to gather the observational evidence collected to date by various groups a list with the sequence of events leading to the transient should be created.

The causes and origins of the EMT:

The well documented changes in meteorological forcing over the Eastern Mediterranean, and particularly the Aegean sea, include three cold winters in the early months of 1987, 1992 and 1993. It was noted also that from 1988 onwards the winter wind fields over the Aegean and the western Mediterranean changed and stronger northerlies prevailed for all the years 1988-1993. It is probable that there were also changes in net Evaporation-Precipitation, in particular several dry years appeared during this period. All of these changes may have been partly responsible for the formation of Aegean deep waters. Other possible contributions included long term trends in Evaporation-Precipitation and the historical damming of the Nile and Danube rivers, and perhaps changes in salt exchange with the Western Mediterranean. But the relative importance of anomalies in meteorological parameters as wind speed and direction, air temperature and precipitation in triggering the EMT was judged differently. Conflicting hypotheses either attribute the origins of the EMT to anomalous cold winters only or postulate a necessary preconditioning of the Aegean through increasing salinities prior to these cold winters. The role of the salt increase in the eastern half of the Eastern Mediterranean in relation to the EMT remained controversial throughout the discussion. No consensus could be reached on the importance of the observed salt increase in the Cretan Sea to start the EMT. Conflicting hypotheses viewed this salt increase as a result of the deep water production in the Cretan Sea and the resulting increased exchange rate between the Cretan Sea and the Levantine and not a prerequisite. It was suggested to investigate these problems using specially designed model simulations. The value of modelling in unraveling the causes of the eastern Mediterranean changes would be that the various possible contributions mentioned above can be tested in isolation for their effects. Some contributions may be much more important than others. The most important prerequisite for this task however are reliable models which can produce the properties and circulation prior to 1987.

Currently two modelling efforts have attempted to reproduce the changes caused by the EMT, using different models and different forcing anomalies. There was some discussion of the relative value of comparing the salt budgets in these models with observations. Observations demonstrate clearly the importance of redistribution of salt and successful model simulations should reproduced water properties and final salt distributions very similar to those observed. However similar salt re-distributions might be achieved in several different ways within a model, all leading to similar end states. It was therefore agreed that the next step should be to try to use models to reproduce the sequence of events present in the

observations rather than just focussing only on the final end state (eg. as observed in 1995 by Meteor).

Keeping to the spirit of using models to isolate different effects one important experiment should be to apply the known changes in winds and the known cold winters to a model but without explicitly changing E-P and without introducing any other preconditioning changes prior to 1987. If this experiment can reasonably reproduce the sequence of events from 1987 onwards it will suggest that E-P and river runoff changes might have played a less important in preconditioning the new eastern deep waters. This is a sensible approach because to date the E-P forcing is the most poorly known of the meteorological forcings. After more in-depth analysis of meteorological time series including new data sets for the E-P forcing a set of forcing scenarios should be put together and should be the basis for the future modelling studies. In order to inter-compare the forecasting skills of different models a common way of presenting results either on sections of through budgets should be developed.

An open issue has been the mechanism by which the Aegean increased the production rate and where the huge amounts of water produced were stored. It was suggested that for comparison with experimental data, rates of deep water formation on the northern shelf should be computed from the model runs. A question that should be addressed in model runs with realistic forcing is the stability of the thermohaline circulation of the Eastern Mediterranean as a whole. What makes the winter 91 so unique compared to a similarly cold winter in 87? This is related to the question why the transient has only been observed one time over an observation period of 100 years, while meteorological anomalies of similar magnitude have existed in the past.

Salt budgets of the Eastern Mediterranean indicate a larger salt content in the present situation compared to the past. The salt increase is in the order of 5-6 10^{13} kg and can only partly be attributed directly to changes in the freshwater flux. One hypothesis suggests that a salinity increase in the inflowing Modified Atlantic Water (MAW) through the Strait of Sicily could be responsible for the salt content increase. This would indicate a connection of the EMT with the Western Mediterranean, but the data base for the analysis is small and associated with large errors. In a differing hypothesis it was suggested that disturbances either of the freshwater budget (E-P-R) of the basin or the water formation mechanism would cause an imbalance of the exchange of water masses and salt through the Strait of Sicily and could upset the salt budget, at least temporarily. A simple 2 layer box model of the basin indicated that either a 10% increase in E-P or a 10% decrease in the water formation rate could lead to a net influx of salt at Sicily of around 4 10^{12} kg/yr. This is reasonably consistent with the required salt inflow over 10 years to explain the observed increase in salt content. In the model case in which the salt influx is achieved without any change in E-P, it is accompanied by a 10% drop in the volume exchange at Gibraltar. Such a change would be very hard to detect in observations. Following this hypothesis the changed salt content of the eastern Mediterranean observed in 1995 could have been easily supplied through Sicily but could simply be a response to changing water formation conditions inside the eastern basin, rather than to causes in the Western Mediterranean. Both hypothesis however would agree on a salt import from the Western Mediterranean to the Eastern Mediterranean and this should be checked in future analysis.

Relation of the EMT to larger scale atmospheric anomalies:

Correlation analysis has shown that the Mediterranean atmospheric anomalies display a connection with Indian monsoon in summer and with the North Atlantic oscillation (NOA) in winter. The existing analyses have been performed on de-trended time series, the influence of a long scale trend therefore has not been explored yet, neither has the onset of the EMT been related to the large scale atmospheric anomalies. In the discussion the need

for more meteorological analysis was expressed and the necessity to establish the relation of EMT and these large scale anomalies was stated. Focus in the meteorological analysis should be given to changes in the freshwater balance over the Mediterranean which to data are poorly known. Concern was expressed that if disturbances in the fresh water flux play an important role in the triggering of the EMT and thus provide a destabilizing factor for the thermohaline circulation, the magnitude of these anomalies should be known in order to judge the potential for future hazards due to continued increasing use of freshwater in the countries surrounding the Mediterranean.

Influences of the EMT on the ecosystem:

It was felt that a direct assessment of changes in the ecosystem related to the EMT was difficult given the complexity of the system and the lack of data. The group regretted the scantiness of biological time series in the Mediterranean being available to monitor changes. Scarce evidence of ecosystem changes exist as the appearance of larger copepod species in the Ionian or abundance and species changes in the Ierapetra gyre. Problems in the analysis of existing data sets were seen in the necessity to distinguish between advective changes in species versus reaction to changes in the environment and the treatment of the high mesoscale activity. The role of viruses and bacteria and marine microbiology in general would need to be considered as well. Overall it was felt that a modelling approach would be more promising to assess ecosystem changes and might even help providing guidelines in the interpretation of biological data sets.

Following the discussion about biological data the following recommendations have been given.

- Design a series of process oriented modelling studies to assess the importance of horizontal advection versus vertical mixing/upwelling on nutrient supply in the euphotic zone.
- Combine existing data sets to identify depth of nutricline and euphotic zone for various parts of the Eastern Mediterranean.
- Try to calculate the total nutrient content of the Eastern Mediterranean and its variability (regional/temporal).
- Changes in (N/P) ratio needs to be identified. The data suggest radical changes in (N/P) ratio in Thyrrhenian Sea.
- Establish times series at critical locations for biochemical monitoring: Southern Adriatic, Cretan Sea, Northern Levantine, (Rhodes, Cilician basin), Sicily Channel.
- It would be desirable to implement new technology to moorings as in-situ sampling of nutrients and chl-a
- Put sediment traps at several locations (use models to spot locations).
- Identify role on eddies on nutrient supply.
- Investigate invasive species and their role on the ecosystem.
- Study Seawifs chl-a data to learn about patchiness of the biological production.
- Carry out simplified coupled physical biogeochemical modelling study to understand interannual nutrient evolution (PZN model).
- Explore the connection (intensity, event sequence) on nutrient accumulation at near-surface levels on the biological production.
- Install continuous surface measurements (nutrient, chl-a) by ferries.

Influence of climatic changes on the ecosystem:

A relationship between a climate index and changes in the ecosystem might be difficult to find and is probably of indirect nature. One of the more important indices for the European region the North Atlantic Oscillation (NOA) is basically a winter index and only

species for which winter is an important season are likely to show a correlation. Similar analysis carried out in the North Sea and North Atlantic provide guidelines how such an influence between climate changes and ecosystem changes could be detected. A specific issue named in the discussion was the relationship between atmospheric blocking and changes in the ecosystem. Since atmospheric blocking is related to stratification changes in spring it could effect the ecosystem severely during a time when the most important changes in biology are to be expected. This relationship should be investigated in future analysis.

3. THE ATMOSPHERIC DEPOSITION AND IMPACT OF POLLUTANTS, KEY ELEMENTS AND NUTRIENTS ON THE OPEN MEDITERRANEAN SEA

As it has been largely demonstrated in the most recent literature reviews in the field, it has now become evident that the atmosphere is not only a significant but in some cases the dominant pathway by which both natural and pollutant substances are transported from continents to both coastal and open seas. These substances include mineral dust, plant residues, heavy metals, radionuclides, nitrogen species from combustion processes and fertilizers, pesticides, and a wide range of synthetic organic compounds from industrial and domestic sources. Some of these substances, such as lead, mercury and some chlorinated hydrocarbons, when carried into oceans by atmosphere are potentially harmful to marine biological systems. Others, such as nitrogen species, phosphorus and iron, are nutrients and may enhance marine productivity. For some substances (e.g. C, Al, Cd, Pb, Hg, some REE, artificial radionuclides), atmospheric flux has an important impact on their oceanic chemical cycles. Atmospheric inputs may thus exert many different effects on the marine environment, and it is necessary to understand the magnitude, timing and geographical distribution of the atmospheric fluxes of these compounds to both coastal and open seas.

Regarding the response of marine systems to atmospheric inputs, there are two further considerations to take into account, representing two facets of the same problem. First, and of societal relevance, is the fact that the effects of human activities on the oceans is one of the areas of greatest public interest. Intense human activities in regions surrounding semi-enclosed seas, such as the Mediterranean, always produce, in the long term, a strong environmental impact in the form of coastal and marine degradation and a heightened risk of more serious damage. The Mediterranean is a clear example of a sea at risk as a result of its geography, its very long civilization, its present permanent coastal population and the very intensive seasonal flow of tourism. Urbanization, disposal of industrial and domestic wastes, intensive agriculture and animal husbandry, soil degradation, desertification and forest fires are in fact only a few of the many factors which have exerted pressures on the Mediterranean environment that now put its integrity at stake. However, the scale of the problem has not been fully quantified or understood. In order to improve this situation, detailed quality and status assessment are required. Establishing a baseline of quality in terms of input loads, contamination levels and biological status and effects would be a useful starting point of improvement.

The second facet of the problem is scientific. The present-day temporal and geographic variation in open ocean chemistry is, so far, largely due to natural oceanic processes rather than human activities. But for early detection, prediction, and potential mitigation of human impacts it is however essential to distinguish these human influences from the natural background variations, which is only possible if natural variability is thoroughly characterised and understood in terms of the governing processes. It is presently difficult to identify any impact of anthropogenic inputs of nitrogen and metals to the open ocean via the atmosphere, although such inputs are known to occur and could potentially affect primary productivity. For example, dust deposition onto the nutrient-limited Mediterranean basin ($2.3\ 10^6$ km^2) is one of the greatest in the contemporary ocean (20-50 10^6 tons yr $^{-1}$). There have been several hypotheses suggesting that this large input is

responsible for biogeochemical effects, although no concerted scientific program aimed at directly elucidating these effects has yet been set up. Indeed, as mentioned in the latest documents published by the European Environmental Agency (1999) or by UNEP/MAP (1996) most efforts deployed so far were limited to the coastal zone and still presented a fragmented approach.

The following questions, which partly take up the list of recommended actions defined during a dedicated CIESM Workshop (CIESM, 1997), are among the most important deriving from the present knowledge of atmospheric deposition in the Mediterranean:

- What are, at the scale of the entire basin, the levels and variations of anthropogenic inputs from the atmosphere as compared to natural ones?
- To which extend does atmospheric deposition impact on the biogeochemistry of the Mediterranean Sea?
- Does atmospheric deposition induce significant productivity changes that could, in turn, accelerate the propagation of pollutants and key elements to the deep environment?
- Is atmospheric deposition the major pathway of pollutants and key elements to the deep Mediterranean environment?
- Are there already any detectable effects of pollution in the deep Mediterranean environment and particularly in the deep benthic fauna?

MANAGEMENT OF THE COASTAL AND MARINE ENVIRONMENTS BY MEANS OF OPERATIONAL SYSTEMS

by

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FORWARD

The critical analysis of the results obtained up to now from the main Conventions and the progress of the science and technology suggest some important changes in the commonly used approach for:

- monitoring the marine and coastal environment,
- identify the pollution risks,
- suggest management option.

Monitoring: the concepts of periodical monitoring should be reviewed on the based of the necessity to control the marine and coastal environment on a daily base in order to avoid any short term impact of adverse events.

Identification of risks: the technological progress allow a continuous monitoring of physical, chemical, biological parameters, metals, etc. An analysis is necessary of the available tools, in order to design a more effective monitoring system.

Management tools: operational oceanography is now providing new services for the forecast of the marine environment and of the path of the contaminants. These services can help the decision makers in their evaluation process at short and medium term.

1. INTRODUCTION

The main Conventions provide periodical assessments of the state of the marine and coastal environments. Data are collected at national level in selected locations with temporal samplings which allow to define the long-term variability of the environments.

In general, only some sub-sets of data are released to the international Conventions. These produce periodic reports which are used for the improvements of the environmental regulation at international level.

However, this approach is only partially useful for a basin-wide, long-term strategy. Local or regional events of concern can be under-estimated by a data aggregation process, and could be considered of minor importance ('only' a hot spot) for the entire "Convention community". The intrinsic nature of the marine environment and the non-linear relationships among the processes in the ecosystem require a continuous monitoring and the development of operation tools and services as base for decision making processes, as well as for dissemination of data and information. The management of the marine and coastal ecosystem is a daily activity which requires a strengthening of the collaboration, common strategies for monitoring, data and information exchange in near real time, common tools for the assessment of the environmental condition and the forecast of its evolution in short-medium term.

The scientific and technological progress is providing the tools for the implementation of a new approach in the management of the Mediterranean marine and coastal resources for an enhancement of the quality of the life of the Mediterranean people. System analysis, optimisation, numerical models, graphical presentation, multi-disciplinary data bases, remote sensing, on-line monitoring and computer technology can help the Mediterranean community *to develop comparable and compatible techniques, validate methodologies and measurements, organise regular scientific reviews, develop options for corrective measures, agree on formats and storage, and communicate the information gathered to potential users* (Agenda 21, Ch. 17).

It must be understood that the objectives of the environmental protection could vary from one region to another, depending on the different users' needs and on the priorities defined at local/regional level. It must also be recognised that the data and information must be available with a short delay in order to implement a basin-wide 'operational management system', which can be based on:

a) optimisation of the sampling strategies for the several objectives of operational systems and their multi-faceted applications;

b) definition of a minimum number of parameters to be routinely (operationally) collected;

c) implementation of analytical/numerical tools for data and information production and exchange in near-real time.

2. SAMPLING STRATEGIES

In establishing an observational programme some fundamental design questions must be posed. In particular: should the monitoring of all parameters be done and then address each single objective of the broad environmental protection concept? or sub-sample in terms of area, distribution, parameters, indicators? The monitoring programme must be focused on the requirements of the selected clients which will use the data. The main clients (in this case) are the environmental authorities and policy makers, but also the scientific community is interested. The data collected during a monitoring activity must satisfy some requirements which can be synthesised as:

- specific : a too broad monitoring system will never satisfy the objectives,
- measurable: quality data are necessary for any assessment,
- attainable: the specific objectives must be reached,
- consistent: with the objectives
- comprehensive: once having defined the environmental problem, and the monitoring objectives, nothing should be lost.

3. COST EFFECTIVE MONITORING TECHNOLOGIES

Sensors have been developed during the last decade. They can provide data on temperature, salinity, oxygen, chlorophyll, nutrients, metals. New technological developments are possible now, for the implementation of multiparametric, cost effective monitoring system based on ships of opportunity, moored buoys, coastal stations. Although physical, chemical and biological data could be included in the operational acquisition system, the technology for the different parameters acquisition is at a different stage of development. In principle, it is possible to acquire physical, chemical and biological data in

the upper layer (few hundred meters), however, instrument suitability varies very greatly, and cost effectiveness suggest to limit the data collection to few parameters.

4. DATA DERIVED PRODUCTS

Data analysis can provide an assessment of the state and trends of the environment by using historical and newly acquired data. Furthermore, numerical models can provide other indirect information and a short (days) to medium (month) term forecast of the marine and coastal ecosystem. The temporal scale is, of course, depending on the spatial scale, i.e. the area for which the forecast is required. The use of numerical models involve more complex post-processing work for the purpose of identifying causes of environmental changes and relationships among the physical, chemical and biological processes. They can be used as effective tools for the management of the environment.

5. DATA AND INFORMATION MANAGEMENT

The understanding of environmental changes requires the establishment of effective mechanisms for the request and return of data as well as for the quality assurance documentation (good information practice). The communication technology now in place permits the creation and maintenance of distributed data bases, which can develop system more 'client oriented' and develop a closer working relationship with both data suppliers and 'clients'. The data management system must provide information on:

- precision of instruments
- calibration of instruments
- *in situ* sampling methodology
- intercalibration / intercomparison
- data quality check methodologies

In practice, the quality of data is based on concepts which comprises the quality assurance of fieldwork, the quality control of the data and their proper sue. More in general it is necessary to develop a system able to provide, in near-real time data, derived products, model outputs. In other terms it is necessary to develop an "Information System" which will provide not only data and information, but also the tool for the interpretation of them (by means i.e. of spatial and temporal maps).

NEEDS FOR QUALITY CONTROL PROGRAMMES FOR ENVIRONMENTAL ANALYSIS IN THE MEDITERRANEAN AREA

by

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1. INTRODUCTION

Accordingly to the increase of the public concern for environmental problems, environmental studies have become one of the main research lines in the past years. They cover a broad range of disciplines, e.g. analytical chemistry, geology and biology, and include several aims such as monitoring (routine analyses), research (studies of environmental pathways), modelling etc. Chemical analyses are in many cases the basis of these studies and hence have an enormous economic impact. Many analytical methods have been developed for the determination of contaminants in air samples (fumes, steams, fogs, etc.), water samples (freshwater, seawater, rainwater, etc.), solid samples (wastes, soils, sediments, plants, fish tissue, etc.), and biological fluid samples (blood, serum, urine, etc.). However, these methods should have at least three main charactheristics to be suitably employed in environmental analysis: (i) they should be able to determine contaminants down to the extremely low environmental concentrations: often g/kg levels, sometimes ng/kg and even pg/kg levels; (ii) they should be able to determine the analytes of concern in presence of a wide variety of interferents; and, (iii) they should be characterized by good precision and accuracy, avoiding mistakes that would lead to wrong experimental results and consequent wrong environmental considerations followed by wrong political decisions in terms of environmental management, health care, etc.

In few words, analytical methods and, in particular, analytical techniques, should be characterized by high sensitivity, high selectivity and high precision and accuracy. Unfortunately, many of these methods are far from being under control. In general, a lack of quality control in chemical analysis leads to economic losses due to repetition of analysis, destruction of goods wrongly considered of bad quality, doubts on government decision, etc. In case of environmental analysis a lack of quality control means not only economic losses but also, and above all, risks for environment and for public health.

The cost of the analytical chemist "getting it wrong" can be enormous in all areas and leads to loos of confidence in the validity of analytical results. In our modern society, quality in the analytical laboratory is a must which have to be proven to meet the needs of the customers and attract their confidence (and all others who make use of the results), and represent value for money. In this respect, international organisations such as the ISO and the CEN have set up quality standards which are being considered in accreditation systems. However, there is often a confusion over the meaning of quality control (designed to provide a quality product) , quality assurance (designed to ensure that the quality control activities are being properly implemented), and quality system (set of procedures involving the organisational structure, responsibilities, and resources for implementing quality management). Whereas the concept of quality control and quality assurance is well understood by modern laboratories (either commercial or with national responsibilities) which are often accredited in various analytical sectors, there is an enormous gap in the transfer of knowledge to smaller laboratories. One reason is that e.g. regional laboratories have less access to the international literature and do not have the resource to implement a quality system. Analytical chemists e.g. from Southern EU countries do not master the English

language which represents an additional difficulty to access the literature on QA/QC which is in most cases in English. Finally, and above all, there are no or very few initiatives in these countries to train analytical chemists with respect to quality in the analytical laboratory and to support the laboratories with appropriate quality control tools for the evaluation and the improvement of the analytical performances.

A correct implementation of quality assurance guidelines includes procedures for the control of the quality of measurements and procedures to evaluate their quality .

Keeping under control the measurements means not only to control blanks, calibrants and technical instrumentation but also to improve the capability of the laboratory staff, to adopt, where existing, Standard Operation Procedures and in general to adopt good laboratory practice consisting in a correct sample storage, treatment and analysis trying to reduce the very common contamination and losses of analytes problems.

The evaluation of the quality of measurements implies the use of independent methods of analysis, the statistical treatment of data, the maintanance of long term documentation and, above all, the participation in intercomparison exercises (also called collaborative studies, round robin tests, interlaboratory studies, etc.) and the use of reference materials (RMs) and/or certified reference materials (CRMs) depending on the final aim.

2. REFERENCE MATERIALS

According to ISO, a reference material is defined as a material or substance, one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of measurement method or for assigning values to materials. A certified reference material is defined as a reference material, one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation that is issued by a certifying body. The fundamental difference between RMs (also known as "Laboratory Reference Materials") and CRMs (also known as "Standard Reference Materials") is that some parameters in CRMs are known with great accuracy.

However, these definitions sometimes led to misinterpretation and then to an uncorrect use of these materials. In case of chemical analysis, and environmental analysis in particular, a modified definition has been proposed by R. Morabito in the frame of EC workshops:

A reference material (also known as "Laboratory reference material" or "Laboratory control material") is defined as a material, one or more properties are sufficiently well established to be used in an interlaboratory exercise for the evaluation of the comparability of data provided by the laboratories, or in the establishment of a quality control chart to evaluate the long term reproducibility of the laboratory.

A certified reference material (also known as "standard reference material") is defined as a reference material, one or more properties are certified, with a stated uncertainity, by a technically valid procedure, which are traceable to a stated reference and accompanied by a certificate or other documentation that is issued by an accredited body, to be used for the evaluation of the accuracy of the method(s) used by the laboratory.

In these definitions, RMs are to be used solely for interlaboratory studies (including proficiency testing) and reproducibility evaluation (e.g. quality control charts), while CRMs are to be used exclusively for the evaluation of accuracy; in very rare and specific cases

CRMs can be used for calibration purposes. It should be stressed that the CRM definition implies that the issuing body should be accredited; at present, there is still no well-established rules in this respect and general requirements for the competence of reference materials producers are still in discussion within ISO. One may expect that this requirements will come into force quite rapidly in order to ensure a suitable quality frame for future CRM production.

Analytical procedures may be verified by analysing a CRM with a matrix similar to that of the unknown sample; disagreement between the certified value and the value determined by the laboratory indicates an error, or errors, in the procedure.

Despite an increasing in the production and certification of reference materials, there is still a dramatic lack of CRMs and RMs for most of the analytes and matrices in the environmental field.

In case of marine chemistry, there is a number of certified reference materials available on the market. They include several matrices such as water, sediments (e.g. from harbour and coastal environments), marine organisms (e.g. fish, mussels, oysters, plancton, etc.), and plants (e.g. sea lettuce).

With regard to the certified analytes, major and trace elements are the most available: they have been certified in all the above mentioned matrices at different range of concentrations.

A reduced number of marine reference materials are available for organic contaminants. Most of them are sediments from different marine environments certified for PAHs, PCBs, and other organics such as DDE and DDD, and chlorobenzenes. Nevertheless, there is also a small number of biological reference materials such as shirmps and copepod certified for pesticides and mackerel and cod liver oils certified for PCBs.

Recently, there has been an increasing attention in the development of analytical techniques for the determination of chemical species in environmental matrices. At the same time there has been a correspondent increase in the number of reference materials certified for chemical species. Even if the available number of these reference materials is very low, it is worth to stress that 90% of them have been certified in the last 3-5 years. Mostly of them concern organotin compounds and methylmercury.

3. QUALITY CONTROL PROGRAMMES (COLLABORATIVE STUDIES)

Information from marine monitoring programmes forms the basis for national and international policies, providing insight in the effectiveness of measures which have been taken and basic information for strategic decisions for environmental protection. This information is expensive, e.g. a rapid estimate of the monitoring costs in the North Sea amounted up to 20 millions ECU per year. Economic impact of the measures which may be taken on the basis of this information can even be higher and it is easy to figure out which negative economic and environmental impact can be produced by monitoring data of bad quality.

As a consequence, the need for quality control in marine monitoring programmes became a priority and several proficiency testing schemes, within the frame of single monitoring programmes or not, have been developed.

It is worth to cite at least three examples, NOAA, QUASIMEME and AQUACON Programmes, representing the state of art in U.S.A. and in Europe.

Since 1984, the National Oceanic and Atmospheric Administration (NOAA) has conducted the National Status and Trends (NS&T) Program, a long-term monitoring study of the coastal water of the United States.

This project aims at the evaluation of the environmental conditions of about 100 sites located on the East, West and Gulf coasts, the Great Lakes and on the Alaska, Hawaii and Puerto Rico coasts.

The program envisaged the evaluation of the concentration levels of inorganic and organic contaminants in water, sediment and biota samples.

Since its start, the quality of the produced data has been evaluated through a quality assurance project aimed to document sampling protocols and analytical procedures, and to improve the analytical performances of the laboratories involved in the measurements. All these laboratories were requested to participate in a series of intercomparison exercises, consisting in different types of analysis on different matrices, for the whole duration of the NS&T project. The intercomparisons for organic measurements were coordinated by the National Institute of Standards and Technology (NIST) and those for inorganic analysis were coordinated by the National Research Council of Canada (NRCC).

The Quality Assurance of Information in Marine Environmental Monitoring in Europe (QUASIMEME) Programme was financed by the EU in 1993 on the basis of the following considerations:

- The QUASIMEME proposal envisaged the participation of 89 laboratories from 13 EU and 2 EFTA Countries in a three years proficiency testing scheme dealing with the evaluation of analytical performances in the determination of inorganic and organic contaminants as well as nutrients. Furthermore, more than 60 laboratories involved in marine research were proposed to participate at their own costs.

- The economical justification was made clear by the amount of resources lost every year owing to a poor quality control of marine monitoring measurements. It was estimated that, in some cases 80% of the data produced were no exploitable due to a poor quality assurance.

- The importance for legislation was highlighted (support to Directives on the Protection of Sea), as well as the strong links existing with the Oslo and Paris Commission (OSPARCOM), the Helsinki Commission (HELCOM), the Barcelona Convention (MEDPOL), and the European Comission.

- All exercises and selected parameters had their justification in the improvements needed in support to the OSPARCOM mandatory determinands.

- A questionnaire, for the identification of the needs of laboratories, guidelines, to support the participating laboratories, and a regularly published bulletin, to ensure a liaison between the coordinating committee, the participants, and the European Commission, were also envisaged.

At the moment, QUASIMEME is not anymore financed by the EU but it is now a self-financed programme on the basis of subscrition rates from participating laboratories.

QUASIMEME is coordinated by the Marine Chemistry Laboratory of Aberdeen and the steering committee is mostly formed by Countries from the Northern part of Europe.

The establishment of the QUASIMEME proficiency testing scheme enabled to perform a continuous monitoring of the quality of the methods used in routine analysis, to detect sources of pitfalls and remove them, and to train staff responsible for providing analytical data for marine monitoring purposes.

The Environmental Studies in the Mediterranean Basin: Analytical Quality Control and Assessment Project (AQUACON-MedBas) is a ten years old Programme launched and coordinated by The Ispra Joint Research Center of the European Union. The Programme involves:

- Problem identification by the Scientifc Steering Committee (SSC)
- State-of-the-art assessment by experienced laboratory group
- Definition of appropriate collaborative study structure including the identification of interested laboratories
- Preparation and distribution of test materials by Environment Institute of Ispra
- Evaluation of results and decision by SSC on continuation and modifications

The steering committee is mostly formed by Countries from the Southern part of Europe and more than a hundred of laboratories (also from Eastern Europe and South America) are involved in the Programme.

AQUACON is dealing with the following topics:

- Seawater analysis
- Mercury in the food chain
- Sediment analysis
- Wastewater analysis
- Freshwater analysis
- Rainwater analysis
- Soil analysis
- Waste analysis

Joint field experiments regarding the evaluation and harmonization of sampling procedures have been organized too.

AQUACON is now ending (March 2000) and the needs for similar Programmes in Mediterranean should be faced on.

4. FINAL REMARKS

Quality and validation of data from monitoring campaigns has to be considered a priority target for the environmental analytical chemistry of 2000's.

The implementation in the laboratories of quality systems and then the proper use of RMs and CRMs and the participation to collaborative studies are unvaluable tools to improve the quality of the measurements.

A strong gap in the implementation and the use of these tools still exists between the Southern and the Northern part of Europe.

IS TBT STILL A CURRENT ISSUE OF CONCERN?

by

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1. INTRODUCTION

The environmental concern about organotin compounds remarkably increased in the last twenty years, due to the large use of these compounds as active components in antifouling paints (mainly tributyltin (TBT)) and in pesticide formulations (mainly triphenyltin (TPhT)).

The immission of these compounds in the aquatic environment is both continuous, by release from the hulls of the boats, and intermittent, by release from dockjard activities (paint removal, cleaning, painting, etc.).

The environmental persistence and fate of TBT are strictly correlated to the specific characteristics of the aquatic ecosystem such as temperature, salinity, pH, suspended matter, microbial populations, flushing rates, etc. The distribution of organotins among the different environmental compartments is regulated by physical (including volatilization, adsorption, etc.,), chemical (including chemical and photochemical reactions) and biological mechanisms (including uptake and transformation).

Both TBT and TPhT undergo degradation processes in marine environment, such as microbial and UV degradation, consisting in a progressive dealkylation down to inorganic tin. As the toxicity of the organotins is maximum for the trisubstituted compounds, the degradation can be considered as a mechanism of detoxification. However, at the same time, they are easily absorbed by lipophilic phases such as the lipid fractions of organisms and sediments, with very high bioconcentration (BCF) and accumulation (ACF) factors, respectively.

The bioaccumulation process depends on the lipophilicity of the substance and on its resistance to metabolism and excretion processes. Studies on kinetics and mechanism of accumulation showed that marine bivalves rapidly and effectively accumulate organotins even when exposed to low concentrations of dissolved material. Bivalves accumulate dissolved TBT from sea water, presumably directly into exposed tissues such as gills, followed by migration to other tissues, or by ingesting tainted food. Very high concentrations can be reached in these organisms, because they are not capable, due to a low activity of the mixed function oxidase system, to metabolize a wide range of xenobiotics, including organotins.

The direct introduction in the marine environment and the successive accumulation together with the high toxicity of these compounds towards "non-target" organisms, such as molluscs (oysters and mussels) and gastropods, can cause environmental and economic damages as observed in the past in the Arcachon Bay in France, in the Crouch Estuary in U.K. and in the Sado Estuary in Portugal as well as in many other Countries.

In this areas, oyster production was severely disturbed by a lack of reproduction and the appearance of shell calcification anomalies in adult oysters with high economic losses.

It was pointed out that high TBT water concentrations caused mortality in shellfish and microalgae, but even very low TBT concentrations (ng l^{-1} levels) caused sublethal effects such as poor growth rates and low reproduction success in a wide range of marine organisms, among these, Pacific oysters (*Crassostrea gigas*) and Blue mussels (*Mytilus edulis*).

Furthermore, it is nowadays recognized the strict correlation between TBT presence in coastal areas and the induction of imposex (superimposition of penis and vas deferens in females) in many species (mainly in buccinum) with successive population decline.

2. LEGISLATIONS

France was the first country to restrict the use of the TBT based antifouling paint by a legislation that inhibited the use of these paints on boats with hulls less than 25 m long. Similar legislations were enacted by many other Countries such as UK, USA, Canada, etc.

It is worth to stress that all the legal provisions regarding organotin-based antifouling paints inhibit their consumption but not their production and sales. The effectiveness of these legal provisions is still matter of debate.

In 1996 the International Maritime Organization (IMO, the maritime UN body) recognised the need to curb the harmful impact of TBT-antifouling world-wide. In 1998 the Marine Environmental Protection Committee (MEPC) of IMO agreed to develop a legally binding instrument for global prohibition of the application of organotins acting as biocides on ships. The instrument should ensure prohibition of application by 2003 and prohibition of presence of the compounds by 2008.

The IMO decision follows on a long-standing process of gradual recognition of the harmful impact of TBT and related organotins on the marine environment. The decision process in IMO has benefited from effective communication between scientists and policy makers. The recent decision process for antifouling within IMO is exemplary for policy planning based on precaution.

Ever since 1990 there has been an EU prohibition on the use of organotin-based antifouling paints on vessels less than 25 meters in length.

As of June 25th 1999 a modified directive, 1999/51/EEG, concerning the use of antifouling paints, based on tributyltin, has entered into force. As a consequence of that Member states will have to modify their legislation or to make legislation, implementing this directive. The Council of Ministers also decided to follow closely the process in the IMO in order to take over the decisions taken in that framework synchronising both legislations. However, if some delay would occur in the IMO, it is presumable that the EU in that case will try and put some pressure on the IMO in speeding up that process.

The member states have to implement this modified directive before February 29, 2000 and have to inform the Commission immediately. They are obliged to apply the new rules as of September 1, 2000.

3. IS TBT A RISK FOR HUMAN HEALTH?

Relevant TBT concentrations have been found in a number of different species of fish and molluscs sampled worldwide.

The generally high TBT concentrations found in seafood lead to the question if this contaminant poses risks to human seafood consumers.

Only few studies assessing TBT risks to human health are present in literature, also because TBT shows a low toxicity against mammals.

Cardwell, Keithly et al. carried out studies to assess the TBT risks from dietary intake to humans. At the end of '80s, a number of different species of seafood, including mussels and oysters, were purchased from the market in six different US cities. TBT analyses were carried out and a risk exposure assessment was performed on the basis of estimated consumptions of 20.1 grams per day (average case) and 170 grams per day (worst case), an exposure frequency of 365 days per year, an exposure duration of 70 years for an average adult body weight of 70 Kg. The EPA TBT tolerable daily intakes for humans of 0.02 to 0.00025 mg/Kg/day, based on application of 10 to 100 fold safety factors to the Not Observed Effect Levels (NOEL) for mammals, was considered in the study. The conclusion of this study was that the risks for human health from TBT consumption in seafood can be considered negligible.

A similar study was recently (1997) carried out by the same group that considered seafood purchased on the market in eight cities of eight different Countries in four different continents (with the only exception of Africa). In this case again the conclusion was that the TBT risks for humans are negligible.

It is worth to stress, however, that the TBT concentrations found in the purchased seafood ranged up to a maximum of ca 1 ppm (dry weight). In many cases, and in particular where TBT is not limited by legislation (or it was only recently), higher TBT concentrations in seafood have been reported. Human risks associated to a local consumption of highly TBT contaminated seafood have been suggested.

Studies on the degradation of TBT in less harmful compounds during cooking are going on.

4. IS TBT STILL AN ENVIRONMENTAL PROBLEM?

This matter is controversial.

Paints producers sustain that the environmental regulations have led to a worldwide reduction of TBT contamination and that TBT does not represent an environmental problem anymore.

On the contrary, most scientists sustain that TBT still represent one of the most important problem of direct, diffuse and continue contamination of marine environment.

Data collected during the 90's, following the TBT legal provisions, showed that, despite a lowering of the TBT water concentrations, the concentrations of TBT in sediment and marine organisms are still high. Furthermore, the incidence of imposex is high as well.

Within the frame of an EU Project, "Action to demonstrate the harmful impact of TBT. Effective communication strategies between policy makers and scientists in support of policy development", financed by the LIFE Programme and aiming to show evidence of correlation between shipping routes and the incidence of imposex in the North Sea and in the Mediterranean Sea, samplings of gastropods and sediments have been carried out.

For the Mediterranean Sea, snails and sediment have been sampled, in the second half of 1999, at five locations along the northern Sicilian coasts and around Ustica Island off Sicily. The locations were representing areas of different shipping density, ranging from very low (Ustica natural sea reserve), low (Ustica), intermediate (Castellamare and Termini Imerese) and high shipping density (Palermo). At one of the locations off Ustica island additional sources of TBT were present.

In total 206 snail specimens have been collected, investigated for the presence of imposex and analysed for organotins. The sampled snail species where: *Hexaplex trunculus, Bolinus brandaris*, *Thais haemastoma* and *Tonna galea*. In each sampling area sediment that is representative for the location has been sampled for analysis of organotin. Imposex in the snails has been rated according to well-defined stages 1-5; with higher numbers representing further advanced stages of imposex.

The data showed that imposex is widespread around Sicily. In four locations on the north-western coast all female specimens showed imposex at further developed stages, even in areas with a fairly low shipping density. Only in the Natural Sea Reserve of Ustica Island, imposex was not so common and less severe. This finding appears to reflect a different environmental situation of lower TBT contamination compared to other sampling sites.

CURRENT ISSUES OF CONCERN WITHIN THE OSLO AND PARIS (OSPAR) CONVENTION REGION

by

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BACKGROUND

During the past two years the experts groups of OSPAR, particularly the Assessment and Monitoring Committee, have compiled and reviewed information on the marine environment for the purpose of preparing the first holistic Quality Status Report (QSR) for the region. This report, which is based on the information provided by the five regional QSRs (Arctic Ocean, North Sea, Celtic Sea, Iberian coast and Bay of Biscay, and the eastern Atlantic Ocean) is scheduled to be published by the summer of 2000. At this time only the regional QSRs are available to interested parties.

Each regional QSR comprises six chapters, the last one of which (entitled "Overall assessment") includes a summary of the impact of human activities on the marine environment. There are a number of impacts which the five regions have identified collectively as the most severe or of highest priority in terms of any future action - commercial fishing, organic contaminants, endocrine disrupters (including TBT), eutrophication, oil and coastal development

1. ISSUES THAT MAY BE OF CONCERN TO THE BARCELONA CONVENTION AREA

Most of the issues arising from the regional QSRs are addressed in the paper prepared by Michael Bernhard. Commercial fishing, which appears to be a matter of concern for all five OSPAR regions and is not dealt with in Bernhard's paper, is possibly an issue that the meeting in Rome might address, for the reasons outlined below.

Commercial fishing has direct and indirect effects on the marine ecosystem. The direct effect is simply that target stocks of fish or shellfish are reduced; the degree of reduction being directly related to fishing effort. The direct effects also include capture of non-target species (other fish species, seabirds and marine mammals), damage to benthic fauna and flora and damage to the physical and chemical environment of the seabed. Indirect effects on fish stocks include the increase in prey populations following removal of predatory fish. Discards of fish may lead to shifts in species composition due to the excess food available to scavenging species.

The extent of direct effects in the OSPAR region is difficult to assess, partly due to incomplete data on discards and recorded fish landings. Thus, it is often difficult to estimate fishing mortality and size of fish stocks. This has a consequential effect in that it is not always possible to define a level of fishing effort that will adequately protect the stocks. Thus, OSPAR countries have accepted the ICES concept of 'safe biological limits' (SBL). A stock is considered to be outside the SBL when the spawning stock biomass is below the Minimum Biologically Acceptable Level (MBAL), or is expected to fall below MBAL in the near future. In 1999, ICES reported that 40 of the 60 major stocks for which OSPAR requested information were outside the SBLs. Since a number of Mediterranean countries have large fishing fleets, the SBL approach may be one for consideration to safeguard fish stocks in the Mediterranean.

Another major issue that is common to all OSPAR subregions, and thus likely to be of concern to MEDPOL, is that lack of some data and information about processes has hampered the assessment process. This has resulted in the inability to draw definite conclusions about some aspects of the state of the environmental quality.

The issues and topics for which more comprehensive data or better understandings of the underlying processes are required are given below.

2. POOR OR LIMITED DATA

The lack of data on organic hazardous substances is very apparent. This arises as a result of the inability of most laboratories to provide accurate measurements at typical environmental concentrations. This is partly due to insufficient effort to establish the required detection limits. Further intercalibration exercises and harmonisation of procedures are needed o generate reliable and comparable data sets.

For some regions, there is a lack of quantitative and comparable riverine input data. The inability to make accurate measurements of contaminants at the trace levels, combined with the use of methods which have to high a limit of determination, are the major reasons for the absence of reliable and comparable data.

For all regions, there is a lack of quantitative data on atmospheric inputs of contaminants and nutrients.

There is a lack of data for some fish stocks, since only the most economically important ones are assessed on a regular basis. More accurate fish catch statistics are required.

There is a lack of adequate data on fishing discards, both of target species and of non-target species, Because of this and limited time series on population sizes of seabirds, the impact of discards on sea bird populations cannot be quantified

A lot of existing data are not made available to scientists making the assessment. This is a problem of accessibility and organisation and needs to be resolved at the highest level of the international organisation responsible for the assessment.

Information on tourism from different countries is incomplete, despite the fact that this is one of the major human activities in the coastal areas of the OSPAR region. Appropriate assessment indicators on tourism need to be developed and adopted by all countries contributing to the assessment.

The lack of consistent time-series data sets on nutrients and plankton to establish trends and other relationships (see below)

3. LIMITED INFORMATION ON OR UNDERSTANDING OF KEY MARINE PROCESSES

The relationship between enhanced levels and forms of nutrients and the development of shifts in composition of the plankton community is not well understood

The risks to native populations of plants and animals from alien species introduced with the discharge of ship's ballast waters

Understanding the effects of different fishing gears on benthic species and marine mammals to provide a quantitative assessment of this impact

Understanding the interrelationship between the nutrient sources and eutrophication, and the influences of seasonal variations on this process should be improved.

The need for a better understanding of the processes leading to the development of toxic-forming algae and why sometimes their presence and abundance does not result in the accumulation of toxins in populations of shellfish.

The relationship between inputs of contaminants and their concentrations in receiving waters is not well understood.

Chronic and combined effects of hazardous substances on organisms are largely unknown. This means that it is very difficult to assess the environmental risk of such substances. Endocrine disruption is one of the emerging issues in OSPAR region. Furthermore, we need a much better understanding of the relationship between contaminant levels in various marine compartments and their biological effects on resident biota

Ecological (or Environmental) Quality Objectives (EQOs) can play an important role in improving and maintaining an appropriate level of marine environmental quality for a specific purpose. This approach and the development of guidelines and standards are under development by scientists in the North and Black Seas.

4. FINAL COMMENT

It is clear that most of the above have been issues of concern over the past 15 years. One only has to read the previous QSRs to draw this conclusion. One must therefore ask the question "Why is taking so long to address some of these issues when we are constantly reminded by organizations that a lot of effort and thought is being put into marine monitoring work". This could be an important task for the meeting in Rome.