Technical Report No. 4

Availability and Access to Data on Europe's Marine Environment

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1. INTRODUCTION

The Scoping Study on the Improvement of Information on the Marine and Coastal Environment (EEA, 1995) prepared by the European Topic Centre on Marine and Coastal Environment (ETC/MCE) as part of its work for the European Environment Agency (EEA) identified the basic activities in collection, analysis and interpretation of information aimed at assessing the state of the European marine and coastal environment. The scope and difficulties in obtaining comparable and compatible information for assessing the state of the marine environment from all European Sea regions was highlighted.

A synthesis of existing information is provided in the Quality Status Reports (QSRs) produced by regional/international organisations e.g. HELCOM, OSPAR and the Barcelona Convention. Such QSRs contain information on (GESAMP, 1994):

- Geography and Scope of the Assessment
- Human activities throughout the region
- Hydrography and climate
- Chemistry
- Biology
- Overall evaluation.

The information sources include scientific literature, research organisations, industries and environmental organisations.

It is clear that this type of Assessment Report requires the establishment of effective mechanisms for the request and return of data as well as for the quality assurance documentation (good information practice). In other words, data management is the basis of any credible environmental assessment.

Data management is organised on five main levels:
- data collection
- data and information flow
- storage
- quality assurance
- analysis and dissemination

The importance of data management has been stressed in many reports and international meetings. In particular, the 1992 Earth Summit in Rio de Janeiro requested countries to co-operate with international organisations in order to "consider mechanisms 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".

A major problem which is now encountered by data managers is the enormous amount of data generated on the world oceans. For example, as of April 1995, approximately 1.2 million temperature profiles and 300,000 salinity profiles have been archived in the Washington World Data Centre from just one project (GODAR - Global Oceanographic Data Archaeology and Rescue). The amount of data, especially physicochemical, will increase in the near future, due to the development of new technologies and instrumentation. As a consequence, the extraction and synthesis of the information for different user needs will become more and more difficult. The EEA can play a significant role in meeting challenges like the data management in the European context.

This report contains information on flow and management of oceanographic and environmental data in Europe's marine environment. It also contains information on international programmes related to marine waters as well as monitoring programmes that contribute to the data collection and data flow through the international bodies and conventions. Finally, the report also aims to identify the relevant data in order to help assess environmental changes in the different regional European Seas.

2. MONITORING AND DETECTION OF ENVIRONMENTAL CHANGES

Many organisations deal with monitoring activities in the EEA member countries and provide data for environmental quality assessments. These bodies provide information on the status and trends in the marine and coastal environment as presented in the ETC/MC report on "Updated report on data collected within the framework of the Regional European Sea Conventions"(EEA, 1997a in preparation).

A distinction, sometimes subtle, between monitoring and detection of environmental changes in the marine environment is necessary.

Monitoring usually involves the regular, routine plotting and mapping of measurements that are thought necessary for the assessment of the status and trend of the environment. In general, products from monitoring activities are released without further interpretation, or giving few indications on**,** e.g. monthly/seasonal to interannual trends.
Detection usually involves more complex post-processing work for the purpose of identifying environmental changes. Existing understanding of the marine environment is almost completely based on information obtained through the years from a variety of research programmes.

From a general point of view, small-scale, local investigations related to the assessment of the status and trends of the marine environment is done through ad-hoc monitoring programmes, while information on large-scale environmental changes, but site specific, are usually provided by research programmes. The world of research elaborates a lot of products and services that can be useful for the protection of the human health and the environment. Furthermore, it generates large volumes of data that can provide a better assessment of the status and trends of the coastal and marine environment. In that respect the research field could eventually become the primary source of information, even though research programmes are not designed to meet the quality of the assessment done by ordinary monitoring programme. EEA could play an important role in the co-ordination between research and monitoring and could develop such relationships with the more interesting projects in order to drive the elaboration of the products and services for its own purposes and hence produce the best available information providing continuity between research programmes and monitoring activity.

The oceanographic community is carrying out several research and operational programmes aimed at monitoring, assessing and predicting environmental changes globally, regionally and nationally. Brief descriptions of several international initiatives relevant to the marine and coastal environment are given below. The addresses of the international programmes and Conventions, their contact persons and world wide web sites are presented in Annex 1.

International Geosphere and Biosphere Programme (IGBP)

The Secretariat of the IGBP which is located at the Royal Swedish Academy of Sciences has one ongoing core project (JGOFS) and one project in the early planning stages (GOEZS) aimed at understanding how ocean biogeochemical processes influence and respond to climate change. The IGBP Project on Land-Ocean Interactions in the Coastal Zone (LOICZ), in the early planning stages, is aimed at understanding how changes in land use affect the resources of the coastal zone, and how changes in sea-level and climate alter coastal ecosystems.

Global Investigation of Pollution in the Marine Environment (GIPME)

The ultimate objective of GIPME (initiated in the mid 1970s), co-ordinated jointly by IOC and UNEP, is to provide a sound scientific basis for the assessment and regulation of marine pollution, including sensibly planned and implemented monitoring programmes. The present GIPME activities include the Marine Pollution Monitoring Programme (implemented at a regional level), open-ocean baseline studies, the international Mussel-Watch Programme, development of reference methods and standards, and studies of effects of pollutants on marine organisms. Close ties have been established between the GIPME, JGOFS and the UNEP Regional Seas programmes.

Ocean Sciences in Relation to Living Resources (OSLR)

This programme, initiated in 1985, is a joint effort of IOC and FAO. The present activities are threefold, Harmful Blooms (HAB), Ecosystem Dynamics for Living Resources (EDLR), and the International Recruitment Programme (IREP). New streams of research are being investigated within OSLR with the specific aim of developing a strategy and methodology to assess the potential impact of global climate change over marine resources and ecosystems.

Global Ocean Observing System (GOOS)

The Global Ocean Observing System (GOOS) is an international programme preparing the permanent global framework of observations, modelling and analysis of ocean variables to support operational ocean services wherever they are undertaken around the world.

GOOS is intended to meet the needs for:

monitoring, assessment and subsequent prediction of environmental and climat***ic*** changes globally, regionally and nationally;

data and data products required for efficient and rational use of ocean resources, protection of the marine environment, and coastal zone management;

research aimed at improving the prediction of the state of the ocean system in relation to climatic and environmental changes.

EuroGOOS is the European component of GOOS, and consists of an Association of National Agencies working together to foster European participation in GOOS, and the development of operational oceanography for the benefit of Europe. EuroGOOS at present has 22 members in 14 European countries.

Monitoring and Assessment of Large Marine Ecosystems (LMEs)

Large Marine Ecosystems are extensive ocean regions, typically over 200,000 km^2 each with a distinctive hydrography, topography, productivity, and ecological structure. A total of 48 distinct LMEs have been geographically defined, and experts are scientifically describing 30 of them. It is central to the LME concept that in each such region there is a definable set of forces which drive the principal changes in the living marine resources and thus determine their management. The rationale of studying a wide range of such regions hinges on the idea that the principal "driving forces" differ from one LME to another, and that progress in the research and management of these marine resources and their yields can be enhanced. Progress can be made by comparing the multiple stable states that develop differently in each, according to the imposed stress on the system (natural or influenced by anthropogenic activities) and the feedback of the

system on the stress. LME studies encompass the entire trophic chain from plankton to fish and cetaceans.

The Centre for Earth Observation - CEO

Data derived from Earth Observation (EO) sensors have proved to be an important source of environmental information. Large volumes of data have already been collected on a European and global scale since the early 1970s. However, in many cases, data are held in a form not readily accessible to a wider user community. By the end the century, with the planned launch of additional polar orbiting platforms by the major space agencies of the world, the situation will worsen.

EO data, along with existing archives of historical data and auxiliary data, will form the basis of research on the earth's environment. Once transferred into an operational endeavour, these data could assist in the management of a range of important socio-economic activities at a local, regional or global level.

A Centre for Earth Observation has been established jointly by the Commission of the European Communities (CEC) and the European Space Agency (ESA) together with individual institutes and industries to develop a co-ordinated, decentralised network for the dissemination of EO data and services.

3. DATA COLLECTION

Presently, marine data are collected by shipboard observations and/or measurements made by automated instruments. Sensors are lowered into the sea, towed by ships, or attached to drifting or moored buoys, and the data acquired are brought back to shore for use, or forwarded through phone, radio or satellite to receiving stations. The data, in many cases, are finally sent to data centres for archiving and subsequent use.

Data collection methods extend over a wide spectrum - from highly sophisticated systems (generally for physical and chemical data collection) to the more classical, 'old-fashioned' methods where samples are taken and analysed manually (generally biological samples). The present observing systems involve coastal stations, ad-hoc cruises, ships of opportunity, drifting and moored buoys, satellites, etc.

In most cases, the sampling and analytical measurements required to generate environmental data are under the responsibility of national authorities operating within regional conventions (e.g. HELCOM, OSPAR, MAP).

Compliance monitoring within national boundaries is carried out through National Monitoring Programmes (Table 1).

Table 1. National Monitoring Programmes in the EEA area

Country	Start Year	End Year	Variables	Geographical Coverage
Denmark	1989	on-going	Chemical, physical	Nation wide
			phytoplankton	
			zooplankton	
			zoobenthos	
			macrophytes	
			metals	
			org. micropollutants	
Finland	1964	on going	Chemical, physical	National coastal waters
			phytoplankton	
			zoobenthos	
Finland	1979	on-going	Chemical, physical	Gulf of Bothnia, Gulf of Finland Baltic Proper
			phytoplankton	
			zooplankton	
			zoobenthos	
France	1974	on-going	Chemical, physical	National coastal waters - RNO
			macrophytes	
			metals	
			org. micropollutants	
France	1989	on-going	Microbiological indicators	National coastal waters - REMI
France	1989	-	Phytoplankton	National coastal waters -REPHY
Germany	1980	on-going	Chemical, physical	Regional North Sea
			metals	
			org. micropollutants	
Germany	..	on-going	Chemical, physical	Regional- Baltic Sea and the Belts
			phytoplankton	
			zooplankton	
			zoobenthos	
Greece	1985	on-going	Chemical, physical	Aegean, Ionian Saronic Gulf
			phytoplankton	
Greece	1988	on-going	Chemical, physical	Cretian marine waters
			metals	
			org. micropollutants	
Italy	1989	1992	Chemical, physical	Coastal waters in Adriatic and Sicily
			phytoplankton	
			hydrocarbon residues	
Country	**Start Year**	**End Year**	**Variables**	**Geographical Coverage**

			metals	
Country	**Start Year**	**End Year**	**Variables**	**Geographical Coverage**
			org. micropollutants	
Italy	1989	1992	Chemical, physical	Nation wide
			phytoplankton	
			hydrocarbon residues	
			metals	
Italy	1964	on-going	Radioactivity in water	National coastal waters
Italy	1977	1986	Chemical, physical	Adriatic Sea (ASCOP)
			phytoplankton	
			zooplankton	
			zoobenthos	
			metals	
			hydrocarbon residues	
Italy	1995	on-going	Chemical, physical	Adriatic Sea (PRISMA)
			phytoplankton	
			zooplankton	
			zoobenthos	
			metals	
Italy	1977	on-going	Chemical, physical	Regional Emilia- Romagna
			phytoplankton	
Ireland	1992	on-going	Chemical, physical	Estuaries and coastal waters
Ireland	1993	on-going	Chemical, physical	Nation wide
			metals	
			org. micropollutants	
Ireland	1970s	on-going	Radioactivity in water, sediments, biota	Nation wide
Ireland	1992	on-going	Chemical, physical	Shellfish waters human food
			metals	
			org. micropollutants	
Netherlands	1972	on-going	Chemical, physical	Nation wide
			phytoplankton	
			zoobenthos	
			macrophytes	
Norway	1990	on-going	Chemical, physical	southern coast
			phytobenthos	
			zoobenthos	
Norway	1980	on-going	metals org. micropollutants	coastal waters
Norway	1991	on-going	metals org. micropollutants	Barents Sea & northern coast
Norway	1994	on-going	metals org. micropollutants	Novaja Zemlya
Norway	1970s	on-going	Chemical, physical	Nation-wide
			metals	
			org. micropollutants	
			phytoplancton	
			phytobenthos	
			zoobenthos	
Spain	1975	1992	Heavy metals,	Mediterranean coastal waters
			org. micropollutants	
Spain	1991	on-going	Heavy Metals	Nation wide
			org. micropollutants	
Spain		on-going	sea level, waves	Nation wide(RAYO)
			marine currents, T, S	
Sweden	1976	on-going	Chemical, physical	Nation wide
			phytoplankton	
			zooplankton	
Sweden	1980s	on-going	phytobenthos	Nation wide
			zoobenthos	
			fish	
UK	1988	on-going	Chemical, physical	Nation wide
			metals	
			org. micropollutants	
UK	1991	on-going	marine algae	bathing waters
UK	..	on-going	heavy metals	shellfish waters
			org. micropollutants	

3.1. Real-time and delayed mode data

Real time data

The state of the art in ocean monitoring technology offers users a wide range of autonomous instruments for real time monitoring of several physical, chemical and biological parameters in the marine environment. Often, these data, following stringent quality check, are used as input for analytical/numerical prediction models - the basis of many so-called "first warning" systems. The real time data are usually managed by the laboratories/institutions which are involved in the data collection.
Compared to atmospheric processes, time scales of oceanic processes are relatively long. For this reason, the requirements for 'real-time' data are less taxing in marine environmental predictions and studies. For example, data must be available within a few days for short**-** range forecasts, whereas data need to be available once a month for predictions of seasonal and interannual variability.
Although (quasi-)real-time data are collected and used at the local level, dissemination of 'environmental data' to a wider user community has not yet been implemented. Conversely, at the global level, (quasi-)real-time oceanographic data acquisition and dissemination has been implemented through the Global Telecommunication System (GTS) of the World Meteorological Organisation's (WMO) World Weather Watch (WWW).
An example of the WMO's activities concerning ships of opportunity involved in the collection of real time data from sea surface can be seen in Table 2. The ships of opportunity are defined, according to WMO, as all ships collecting sub-surface temperature data as well as in some cases, salinity and /or surface and subsurface current data.
The near-real time data, when archived properly, serve also as accurate benchmarks for the assessment of marine environmental trends.

Table 2. **Number of ships of opportunity (research vessels, merchant ships trawlers and others) of the EEA member countries participating in the collection of near-real time data (generally surface temperature) under the WMO Observing Scheme**

COUNTRY	Selected Ships	Supplementary ships	Auxiliary ships	COUNTRY TOTALS
Belgium	66	0	-	66
Denmark	15	4	17	36
Finland	0	13	-	13
France	142	0	-	142
Germany	482	48	38	568
Greece	8	0	24	32
Iceland	0	24	7	31
Ireland	8	0	-	8
Italy	13	0	-	13
The Netherlands	146	84	-	230
Norway	24	0	-	24
Portugal	15	0	-	15
Spain	47	0	6	53
Sweden	38	0	39	77
United Kingdom	479	3	3	485
TOTAL	1483	176	134	1793

Delayed mode data

The mechanisms for delayed mode data flow are less problematic. Data are collected by laboratories/institutions and sent to National Data Centres and/or regional/international data banks. However, it must be noted that not all European countries have a centralised national 'Information System' for the management of environmental information. Furthermore, regional organisations require the constant commitment of participating countries to the establishment, maintenance, validation, description and accessibility of high quality, long-term data sets.
International standards are now used to the greatest extent possible for processing data sets listed in an IAEA (1996).

Data quality

Data quality depends on:
representative and meaningful sampling programmes
trained personnel
accurate analytical measurements
reporting
suitable storage and pre-treatment procedures
data assessment procedures.

The data needed for assessing change and quality of marine areas comprise a wide range of chemical, biological and physical parameters.

Monitoring Strategies

In principle, there is a strong market requiring oceanographic as well as marine environmental data. However, different users require different spatial and temporal resolutions, as well as different levels of accuracy.

In general, the required spatial resolution varies depending on geographical scales (IACMST, 1993)**:** a high resolution (0.5 - 10.0 km) is required for estuarine, coastal seas and shelf seas**;** while spatial resolutions of 10.0 and 100.0 km are usual for a global basin (e.g. the Baltic) and global ocean (e.g. the Atlantic) respectively.

Temporal resolution defines the time interval of observational data sampling and is linked to spatial resolution.

In designing monitoring programmes, the following issues are considered:

location of samples to be collected
parameters and matrices to be selected
timing and sampling frequency
number of samples to be collected - for example, the number of individual organisms and size**.**
In general, monitoring programmes include a repetition of baseline studies every 3 - 5 years.
For trend studies, there are some standard sampling frequencies depending on parameters and matrices. For example, fish and shellfish are sampled annually, while invertebrates are usually sampled 4-12 times per year.

Table 3 presents a summary of monitoring designs proposed by ICES

Table 3. Some elements of monitoring design

REPORT OF THE ICES ADVISORY COMMITTEE ON THE MARINE ENVIRONMENT 1994: by Co-operative ICES Monitoring Studies Programme (CMP) under OSPARCOM and the Co-operative Monitoring in the Baltic Marine Environment (COMBINE) under HELCOM

MONITORING STRATEGIES AND REVIEW OF MONITORING PROGRAMMES
Strategies for Monitoring Temporal Trends of Contaminants in Biota

In order to assess the efficacy of control measures and then to maximise power (and hence reduce the variance) measures, ICES working group suggests analysing 25 fish samples for organic contaminants in 5 batches of 5, rather than 1 batch of 25, or collecting fish samples on two expeditions each year rather than one**.** This would decrease the total variance by about 20%.
Choice of the monitoring organism is important.
The power of a programme expresses the probability of the program to detect a change of a defined magnitude over a particular number of years. The larger the variance, the lesser the ability of the programme to detect changes.
A feasible approach for the evaluation of the effectiveness of a monitoring programme for temporal trends of contaminants in biota is:
- define in quantitative terms the objectives
- decide what type of evaluation is required (e.g. gaps identification)
- decide criteria for the evaluation of programmes
- if there are sufficient quantitative criteria, an assessment of the power of the programme in relation to the declared objectives should be made
assess whether changes in procedures can improve the power or performance of the programme, both in scientific and in financial terms.

MONITORING GUIDELINES AND TECHNIQUES IN THE REPORT OF THE ICES ADVISORY COMMITTEE ON THE MARINE ENVIRONMENT, 1994
Organisms for Spatial Monitoring of Contaminants in Biota
Chemical and biological effects measurements for sediment quality assessment
Techniques for monitoring contaminants in sediments

4. DATA FLOW

4.1. Data collection responsibility and data flow - OSPARCOM, HELCOM, MAP

Regional conventions/programmes such as Oslo and Paris Convention (OSPAR), the Convention on the Protection of the Marine Environment of the Baltic Sea Area represented by the Helsinki Commission (HELCOM) and the Mediterranean Action Plan (MAP) provide a framework for assessing the need for, and the effects, of international measures and provide a focus for improving standards in all marine contaminants monitoring. Responsibilities for monitoring biological, physical and chemical determinants are assigned nationally to laboratories/institutions/agencies depending on the location of the stations. Some stations are monitored jointly by two or more agencies. The regional programmes are thus constituted by sets of national/local monitoring schemes, and are primarily aimed at producing quality data on environmental parameters.

To achieve the objectives of the monitoring programmes the regional conventions/programmes have established central computerised data bases for important contaminants in biota, sediment and water, as well as for biological effects. Data are forwarded to data banks following established 'Data Reporting Formats' (e.g. ICES data format, MEDPOL data format). Data collected on behalf of HELCOM monitoring programmes are archived in the HELCOM central data bank and in ICES. Data collected on behalf of the OSPARCOM programmes are stored in ICES. The central archival facilities for MAP are in Athens (MEDPOL data).

Design of monitoring programmes and subsequent data submission principles to the centralised data banks are very closely linked and complementary to each other.
The monitoring components of regional conventions/programmes consist of three main elements:

- modalities of co-operation, legal aspects of the monitoring activity, and specification of communication channels
- planning of monitoring
- technical annex with details on monitoring protocols.

Details on the available data in the major European Regional Sea Conventions is presented in Table 4.

Table 4. Data availability in the main European Regional Conventions.

	Element	Parameters	HELCOM	MAP	OSPAR
	temperature		x	x	x
	salinity		x	x	x
	pH		x	x	x
	oxygen		x	x	x
Physico-chemistry	alkalinity		x	x	x
	total .P		x	x	x
	phosphate		x	x	x
	total N		x	x	x
	nitrate/ammonia.		x	x	x
	silicate		x	x	x
	heavy metals				
		Cd/Hg/Pb	x	x	x
		Cu/Zn	x	x	x
	tot.Sn/TBT		x	x	x
	Petrolium .HC		x	x	x
		PAH	x	x	x
	Chlorinated. HC				
		DDT/PCB	x	x	x
		HCB/HCH	x	x	x
	dioxin	PCDD/Fs		x	x
	toxaphener	PCCs			x
	bromin. biph.				
	biph.ethers				x
	chl. naphtal.				x
		chlordanes/dieldrines	x	x	x
Biota					
	phytoplankton				
		primary production	x		x
		chl.a/pigments	x	x	x
		species composition.	x		x
		no/biomass	x		x
	zooplankton				
		species composition	x		x
		transport	x		
		abundance/biomass			x
	macrozoobenthos				
		biomass			x
		species composition			x
	soft bottom				
		species .composition	x		x
		abundance/biomass	x		x
	microorganisms.				
		Total no./biomass	x	x	x
		microbiological activity		x	x
	phytobenthos				
		species composition			x
		biomass			x
	fish				
		fish diseases			x
		fishery activities			x
	sea mammals				
Biological effects	Enzyme meth.				x
	Physiology meth.				
	Bioassays				x

4.2. Data access of the main European Regional Conventions

HELCOM

The results of the HELCOM work and the information collected within HELCOM are not only used on high political level but also to inform the general public about the Baltic Sea and its environmental status. Under the HELCOM Programme Implementation Task Force there is a special working group on Public Awareness and Environmental Education with the main task to spread information on the Joint Comprehensive Environmental Programme and its results.
Easy access to data is given to the Helsinki Commission and the Contracting Parties, and after validation, to the scientific community and the public. The HELCOM data bases are handled by independent data centres, preferably thematic data centres, working on contractual agreement with HELCOM.

OSPAR

OSPAR has decided that ICES will serve as the data centre for environmental monitoring data. To have a synthetic view of the actual situation, it is possible to divide data into three categories:
raw scientific data (e.g. data on contaminants in biota, nutrients in sea water), ICES is in charge of these data;
data concerning inputs of nutrients and contaminants to the marine environment from atmospheric deposition, rivers, etc, OSPARCOM is responsible for these data;
information on compliance with Commission decisions by Contracting Parties.
All the Contracting Parties (European Commission, representing the European Community is one of these) have access to the data. Other organisations can have access on the basis of formal request. In general all information are available to the general public, but the laboratory which provides data can limit data accessibility.

UNEP/MAP

Since the mid 1980s, the primary data processing activity of the UNEP/MEDU has been computarization of the marine pollution monitoring data generated by MED POL. The Project "Enhancement of Data Processing Facilities for Environmental Data at the Co-ordinating Unit for the Mediterranean Action Plan" (financed by the Italian Government) gave an opportunity to increase efforts in storage, analysis, and presentation of the monitoring data. Other activities of the project included also publishing and INTERNET communication. A number of hardcopy products planned within the implementation of the Project will be disseminated in a short time to the marine pollution community in the Mediterranean region. Among these are marine pollution data codes, MED POL data transfer formats for regional data exchange on magnetic media; pollution data computerization media; data verification and guidelines; objectives and validation guidelines; objectives and effectiveness of the trend monitoring programme; MED POL data inventory on selected datasets.
All the Contracting Parties (European Commission representing the European Community is one of these) have access to the data. Raw data are not accessible to the general public, while assessment documents (digested data) are available.

4.3. Other international organisations

At the international level, one of the major activities related to archival and data exchange is covered from one side by the Integral Global Ocean Services System (IGOSS), a programme carried out under the Intergovernmental Oceanographic Commission (IOC) an the World Meteorological Organisation (WMO). It is an international operational system for global collection and exchange of oceanic data and

the timely preparation and dissemination of oceanographic products and services. In addition one of the major activities concerning the data exchange is the International Oceanographic Data Exchange (IODE)**,** an international system for the archival of non-operational exchange of all types of oceanographic data. IODE, developed under the auspices of IOC, also provides relevant marine data and information products and services through internationally agreed arrangements within the participating countries..

The IGOSS and IODE goals are (UNESCO 1993):

IGOSS - *to provide operational oceanographic data, products (including datasets) and services involved in marine activities and the management of international scientific programmes;*

IODE - *to provide accurate and complete oceanographic databases, synthesised datasets, products and information to users concerned with the advancement of the knowledge and understanding of oceanographic processes and oceanic conditions over time and space.*
The close synergism of the two activities has led to an integrated IGOSS-IODE data management service.

IGOSS data flow:

IGOSS data originates from sensors onboard ships, satellites or buoys. These data are temperature, salinity and currents. Observations are encoded (manually or automatically) into an appropriate reporting code and transmitted via satellite or radio telecommunication agencies to national agencies.

IODE data flow:

This is generally based on magnetic tapes or diskettes. The data collected by means of various observing platforms are processed and validated**,** and forwarded to National Oceanographic Data Centres (NODC)**.** From NODC the data is first sent to Responsible National Oceanographic Data Centres (RNODC), and from these to the World Data Centres (WDC). For data exchange a special format (GF3) has been established by IOC. The availability and access of data from NODCs is presented herein.
Data availability and access from World Data Centres (WDC) and National Oceanographic Data Centres (NODC) are provided without restrictions (Table 5)

Table 5. Data availability and access to World Data Centres (WDC) and National Oceanographic Data Centres (NODC)

WDCs and NODCs data	World Ocean Atlases of he National Oceanographic Data Centre, Washington DC
temperature	Climatological Atlas of the World Ocean (Temperature & Salinity)
salinity	World Ocean Atlas - Nutrients
phosphate	World Ocean Atlas - Oxygen
nitrate	World Ocean Atlas - Salinity
silicate	World Ocean Atlas - Temperature
chlorophyll	World Ocean Atlas - Interannual variability of upper ocean thermal structure.
primary production	
plankton taxa	
biomass	

4.4. Elements of the information flow

There are four functional levels that are necessary for efficient flow of information.

i) The technical level.
The actual standard of equipment and computer technology is very advanced and commands considerable resources. Recent computer technology has also shown its ability to serve the needs of scientists and the public.

ii) The institutional level
Computer technology also allows the establishment of a web of complex, fluid, co-operating and co-ordinated structures. Visibility and accessibility can now be achieved through computer networking for better circulation of information.

iii) The administrative level.
This comprises most of the users of environmental information. At this level**,** policies are developed, decisions are made, and resources are allocated. Information is used in different ways, depending on objectives and users**,** from international fora, to the European Council adopting directives, to the national level. The information flow leads scientists to move closer to their legal and administrative counterparts and vice-versa.

iv) The public level
Citizens are the final decision makers. Schools and the media are the principal channels of flow of information to the public. However, information on the state of the environment at this level is often confusing and sometimes biased.

Data Collection and information flow in HELCOM

Since 1979 the Helsinki Commission has carried out a co-ordinated monitoring programme - the Baltic Sea Monitoring Programme (BMP) - which comprises physical, chemical and biological investigations. The aim of the BMP is to follow the long-term changes of selected determinants in the Baltic Sea ecosystem. The guidelines for the measurements are updated regularly by experts representing the Baltic Sea States as well as by relevant organisations, such as International Council for Exploration of the Sea (ICES), the Baltic Marine Biologists (BMB), the Conference of the Baltic Oceanographers (CBO) etc. The programme is divided into two parts, a mandatory part performed by all contracting parties and a baseline part, in which laboratories can participate according to their expertise.

The investigations are carried out by different institutions and laboratories in the countries concerned. In order to secure data quality HELCOM organises training courses, seminars and intercalibrations exercises among the institutions participating in the work. To a certain extent participation in these activities is mandatory.

The collected data are used for the preparation of comprehensive assessments of the marine environment of the Baltic Sea. These evaluations of the state of the Baltic Sea have been published by the Commission three times. The first one, a background evaluation covering all information even from the first decades of this century, was published in 1980. The first periodic assessment (1980-1985) was published in 1986/87 and the Second Periodic Assessment (1984-88) in 1990. A third periodic assessment was published in the first half of 1997.

A comprehensive assessment of the environmental status of the coastal areas has been carried out and guidelines for a joint monitoring programme for the coastal areas will be elaborated.
Within a special programme radioactive substances in water, biota and sediments are monitored and evaluated as well as releases from nuclear power plans in the drainage area. Both BMP data and the data on radioactivity are collected into the HELCOM data bank, which makes data sets available to all possible users after publishing the periodic assessment reports.

Investigations are also undertaken in order to estimate the magnitude of the contribution from airborne fall-out to the pollution of the Baltic Sea, based on a joint airborne pollution monitoring programme. At present the monitoring is being developed in co-operation with ECE-EMEP (Co-operative Programme for Monitoring and Evaluation of Long-range Transmission of Air Pollution in Europe).

HELCOM is also the co-ordinator for the development of a Geographic Information System for the Baltic Sea drainage area, to be established in co-operation with other intergovernmental organisations, such as ECE, WHO, CEC, UNEP/GRID.

Pollution load compilations are basic instruments for decision-making on actions to improve the environmental conditions in the area. Water discharges from point and non-point sources are measured/calculated by the Contracting Parties and reported to HELCOM. The riverine transports are estimated on the basis of water quality measurements and calculations. All figures are stored in a database and used in the load compilations. So far**,** two pollution load compilations have been carried out, the first for the year 1985 and the second for the year 1990. The preparation of the third pollution load compilation for the year 1995 has started in 1996.

Due to its sensitivity**,** the Baltic Sea Area is recognised as “a special area” under Annexes I, II and V of MARPOL 73/78 where anti-pollution requirements are much stricter than elsewhere. These requirements concern operational discharges of oil, chemicals and garbage and have been valid since 1980. Since Annex IV of MARPOL 73/78 (sewage) is not yet in force**,** the Helsinki Convention provides a set of strict obligations related to discharge of sewage and the use of reception facilities in ports. Port reception facilities for wastes containing harmful substances have been established in all main terminals. Air pollution from ships is now also addressed by the Helsinki Commission.

The Baltic Sea States have agreed upon procedures and guidelines for co-operation in case of oil and chemical accidents at sea. The future activities of the Contracting Parties will also include the elaboration of a co-ordinated surveillance plan for the entire Baltic Sea Area. The Contracting Parties elaborate every year their national reports on oil spills observed in waters under their jurisdiction. These reports are evaluated by Germany**,** which provides the HELCOM countries with a summary of the national oil spill reports.

5. DATA STORAGE

Data Classification criteria

Data storage is based on the analysis of both operative and analytical methodologies used by different disciplines in the process involved from the acquisition of data to final data storage in the data base. The objective is to group data into defined environmental components. Hierarchical archives are generally structured as follows:
information is referred to selected marine environmental and interface properties (macro-classes or environmental sectors)
macro-classes are composed of matrices describing the sample properties
matrices are composed of variables defining the data (parameter values, images or alpha-numeric data).

Information Systems

An "Information System" is defined not only directly associated with measured variables but mainly as a system that must manage all information.
The monitoring systems incorporate large numbers of measurements and generate a large suite of processed samples, analyses and products. An efficient information strategy is then necessary for the use and dissemination of these products among users and the public.
In this report "information" is used in a broad sense and includes raw and processed data, information on measurements methods (metadata), data analysis and information on analysis.
Likewise, "management" includes communications from measuring instruments to responsible centres, quality control, data storage and exchange, data sharing policies and dissemination.

The Goal of an Information System for the Marine and Coastal Environment

The overall goal of an Information System is to provide data management and communication facilities that are necessary for routine monitoring, analysis and assessment of the state of the marine and coastal environment.

The aim is then to make a flow of information that should satisfy certain criteria. In particular the measurements should satisfy the following conditions:
*long-term***,** in order to ensure the trend of observed variables**;**
*systematic***,** the measurements should have a spatial and temporal dimension tuned to detect the overall changes on the marine and coastal environment**;**
*under continuous examination***,** improvements in scientific knowledge and technology can maximise the possible returns of a monitoring system in a cost-effective way.

6. QUALITY ASSURANCE AND INTERCOMPARISON EXERCISES

International organisations such as IOC, UNEP, IAEA and ICES are actively engaged in inter-laboratory exercises to ensure comparable results.

Quality assurance for the European marine monitoring programmes has been of increasing concern during recent years. Methods and measures to evaluate and guarantee the quality of laboratory performance were established, involving quality assurance rules and guidelines (e.g. Good Laboratory Practice). Manuals and guidelines for marine pollution measurements are issued by UNEP, WHO, IOC, IAEA, and are regularly revised.

Among the initiatives at European level, those co-ordinated by ICES/IOC, IAEA and BCR have produced a series of certified reference manuals and materials for the assurance of data quality.

Examples of calibration and intercomparison exercises include:

QUASIMEME (Quality Assurance of Information for Marine Environmental Monitoring in Europe) funded by EC with the aim to assist laboratories throughout Europe to develop their own Quality Management Schemes.

Background: The Programme was developed in response to the requirements of the NSTF/JMP-OSPARCOM for a fully integrated quality assurance programme for the chemical determinants measured in marine monitoring programmes; encouraged by the Community Bureau of Reference of the EU (DGXII) form 1989, it started in February 1993 with EU funds.

Project co-ordination: The Scottish Office Agriculture and Fisheries Department, Marine Laboratory of Aberdeen (UK) under the direction of Dr David Wells. Members from each of the participant countries as well as representatives from IOC, JMG and MCWG formed the Quality Assurance Steering Group (QASG).

Participants: 84 laboratories from 16 countries submitting data to International or National Monitoring Programmes

Timetable: Intercalibration exercises in 4 Rounds**:** ***Round 1***: February-July 1993; ***Round 2***: December-May 1994 ; ***Round 3:*** July- November 1994; ***Round 4:*** December-May 1995.

Objectives:

- To establish a Quality Assurance Management Programme to develop the use of Quality Manuals in each laboratory**,** and to improve documentation, reporting, accountability and tractability of information.

- To establish a QA proficiency testing scheme for continuous assessment, initially, of the mandatory determinants, and subsequently, of the voluntary determinants required by the Monitoring Programmes. A stepwise learning programme in parallel with the proficiency testing scheme will assist to the less experienced laboratories to improve performance and join the proficiency scheme.

- To establish a communication network through technical meetings and workshop***s***. A QUASIMEME bulletin will disseminate information and experience, not only to

participants, but for communication with the international Monitoring Organisations and wider scientific community.

Link with International Organisations: OSPARCOM-SIME working Group on Contaminants, Trends and Effects of Substances in the Marine Environment; HELCOM is assisted in Quality Assurance; ICES Marine Chemistry Working Group and Marine Sediment Working Group comments QA requirements and programmes; IOC representative is member of QUASG; MAST laboratories involved in the Mediterranean Targeted Programme (MTP) give informal support in similar chemical measurements.

ICES (International Council for the Exploration of the Sea)

Since 1970 ICES co-ordinates and organises many intercalibration/ intercomparison exercises on Chemical analysis.

Trace Metals in Biota (Biological Tissue), Sea Water, Marine Sediments, Suspended particulate

- Intercalibration Exercises on Trace Metals in biological tissue: seven exercises (1972, 1973, 1975, 1977, 1978, 1979, 1983, 1985); participation from 8 to 52 laboratories.

- Intercalibration Exercises on Trace Metals in Sea Water: five exercises (1976, 1977, 1978, 1982) and for JMG OSPARCOM (1979); participation by up to 59 laboratories.

- Baltic Sediment Intercalibration Exercise (Intercomparison of Analysis of Reference Samples ABSS and MBSS) (1983); participation by 42 laboratories.

- Baltic Sediment Intercalibration Exercise (Intercomparison of analysis of Sliced Wet Cores: (1984); participation by 11 laboratories around Baltic Sea.

- Intercalibration Exercises on Trace Metals in Marine Sediments: (1984) ; participation by42 laboratories.

- Intercomparison Exercise for Trace Metals in Suspended Particulate Matter; Three phases (1984,1989,1993); participation from 8 to 24 laboratories.

Organochlorines in Biological Tissue

- Intercalibration Exercise for Organochlorine Residues in Biological Tissue: six Exercises (1972, 1974, 1978, 1979, 1982, 1983)**;** participation from 12 to 58 laboratories.

Hydrocarbons in Marine Samples

- Intercomparison Exercise for crude oil. 37 laboratories from ICES countries and Bermuda participated.

Nutrients in Sea Water

- Intercomparison Exercise for Nutrients in Sea Water: two Exercises (1989, 1993); participation from 68 to 132 laboratories (in the framework of QUASIMEME)

HELCOM (Baltic Monitoring Program - BMP)

Intercomparison/intercalibration exercises have been conducted recently; some of them were co-ordinated by ICES.

Biological Measurements: benthic and pelagic

-Biological Intercalibration Workshop *1991 Baltic Sea Environment proceedings 38*
-two workshops (Kiel and Warnemunde March-April 1994) organised by ICES Steering Group on Quality Assurance of Biological Measurements in the Baltic, one for benthic parameters and one for pelagic focused on revision and implementation of QA procedures for BMP. Guidelines on QA procedures in benthos studies from ICES Benthos Ecology Working Group (May 94). Training course for phytoplankton methods and intercomparison exercise in 1997.
Zooplankton intercomparison by ICES Study group on Zooplankton Production with the production of a new manual. HELCOM Expert group on microbiology intercomparison/intercalibration exercise (August 1994: joint multinational microbiology cruise organised by Germany.

Chemical Measurements:

ICES/HELCOM workshop on QA of Chemical Analytical Procedures for BMP (October 93, Hamburg).
- ICES/IOC/OSPARCOM Intercomparison Exercise on the Analysis of Chlorobiphenyl Congeners in Marine Media.
- Intercomparison study of the Determination of CBs in Baltic herring oil.
- Intercalibrations and intercomparisons of measurements methods for airborne pollutants.

Nutrients in Sea Water

- Intercomparison Exercise for Nutrients in sea water were organised by HELCOM since 1977. Three intercalibration exercises were done in 1979, 1983 and 1991. Recently QUASIMEME has also included marine chemical laboratories in the Baltic Sea area.

OSPARCOM (Joint Monitoring Programme - JMP)

Many initiatives in QA were carried out within the former JMP, especially for chemical analysis, mostly in collaboration with ICES. QA information are stored in ICES Environmental Data-Bank It was from the results of some of these initiatives that OSPARCOM requested the creation of the QUASIMEME programme.

Determinants:
Chemical Measurements:
ICES/IOC/OSPARCOM co-ordination:
- Intercomparison Programme on the Analysis of Chlorobiphenyls (CB's) in Marine Media;
Step 1 1989: 57 laboratories from 17 countries
Step 2 1990: 46 laboratories from 15 countries
Step 3 1992: 46 laboratories from 15 countries
Step 4 1993: 43 laboratories from 15 countries

Intercomparison Exercise on analysis of non-*ortho* CB's in Fish Oil, co-ordinated by ICES;
Intercomparison exercise on Measurements of Lipids in marine samples;
Fifth Intercomparison exercise on the analysis of nutrients in sea water and implication for laboratories reporting to OSPARCOM conducted concurrently with the QUASIMEME nutrients intercomparison, e.g.. nitrate, nitrite, phosphate, ammonia;
Intercomparison exercise on the Analysis of Trace Metals in Suspended Particulate Matter.

ICES/JMG Fifth round intercalibration on trace metals in sea water.

UNEP/MAP (Mediterranean Action Plan)

Intercalibration exercises, and instrument services missions and visits by experts for analytical QA problems, organised by International Laboratory for Marine Radioactivity of IAEA in Monaco. Training Workshops.

Ten intercalibration exercises 1974-93; trace elements and organic contaminants in sediments and biological tissue. 70 laboratories from 13 countries.
Twelve intercalibration exercises 1982-93 organised by WHO on microbiological methods.
1984-87 Organochlorinated compounds in freeze-dried mussel homogenate (MA/OC) and sediment (SD/OC).
1987 petroleum hydrocarbons in sediment (SD/K) and biota (MA/K).

7. DISSEMINATION PRACTICES

Depending on objectives, variables and parameters, data and data products should be quickly and easily accessible to users. The latency of delivery, defined as the time elapsed between observation and the delivery of the data or product to the user, can range from few hours to a year.

Delivery of data and products is also varied from tape, diskette fax or e-mail.
Reports, bulletins, and articles are still the most practical tools for information dissemination. Recently there was visible progress in the usage of CD-ROM technology as an inexpensive way to put data and information into the hands of numerous users. The software which accompanies the disks enables users to access, select, copy and display data.

Workshops are also organised for facilitating information exchange. Computer networks and Internet have become powerful tools for dissemination.
Although the main philosophy of dissemination practice is for an open exchange of information, there are several issues that limit such a concept in practice:
confidentiality of information
a need to limit access to information to avoid controversies or misinterpretation.
data availability: there are also important differences in the extent to which data collected by public bodies is made available to users throughout Europe. These include restrictions on access, variations in cost recovery strategies and different views regarding legal liability and copyright.
data policies: differences in data collection policies between European countries represent major barriers to geographic data integration. Priorities must be defined with respect to data referencing standards for geographic data collection. At the same time a comparative analysis of selected national policies, data collection methods and their impacts on geographic data base development is needed.

8. DISCUSSION AND CONCLUSIONS

The availability and the accessibility of marine data and information is diverse, complex and relates a wide range of topics. This report has shown that the information to perform environmental assessment does exist in the different data bases around Europe. There is, however, a clear understanding that the available information is not always accessible and assessed in the way that the individual organisations would like to. There is also a clear need for providing metainformation of data sources in the marine environment. In that respect, the European Environment Agency and the ETC/MCE could have a central role in disseminating relevant marine European environmental information, in co-ordination with the main regional conventions/organisations. The first approach of coordination has been initiated by the EEA through the organisation of the Inter-Regional Forum, in order to facilitate the exchange and possible integration of existing data and information (EEA 1997b).

At a global level, there is a need for an efficient information exchange facility for managers and policy makers due to:

- the wide diversity of information and data sets provided and accessed;

- a significant dissatisfaction with the adequacy of currently available information;

- the wide mix of organisations involved, which makes it hard to find the required information as well as to locate the person/laboratory who can provide it.

The benefits from such an "exchange facility" are considered to be:

- **networking**; a user will find in an easy way where information is currently available since in the EEA there is a link between EEA and the ETC/MCE server. The ETC/MCE lead organisation, by providing marine environmental metainformation, could then supply the basic information on the kind of data that can be found in Europe, where the data are as well as how to get access to it and present a link to external servers. This way the ETC/MCE could help the users to locate and retrieve relevant sources accurately and in a relatively short time.

- **cost and time saving;** users are now wasting time and money to find the available/required information through the relevant sources. In addition the management of maintaining an information system requires a lot of resources. Considering that many of the data have been introduced in existing systems, it will be a cost as well as a duplication of effort to build a new centralised data base. Finally the use of the existing systems will also improve these systems since they would have to cooperate with vast numbers of users and hence will be further developed;

- **avoidance of duplication**; the ability to access existing information will prevent duplication of this service which could be done through the appropriate effort to establish the dissemination of the information and which was repeatedly requested from the member countries of the EEA as well as the contracting parties to the Conventions;

-**easy availability of governmental policy and legislative framework at national and European level**; the general public asks for information on existing legislation at national and European level regulating the emission of 'pollutants' into the sea (dredging, pipeline constructions, drills, etc.). In order to be able to provide the available information on time, solutions could be adopted in which the role of EIONET could be enhanced e.g. to create links to the national information systems.

Of course one should not underestimate the difficulties that will need to be addressed in setting up a co-ordinating body for information. These include

- **costs,** which involves not only the equipment, but also the charges for the involved organisations, furthermore there should be incentive to provide information free of charge;

- **management of information load ,** the amount of information could be too big;

- **accuracy of information,** there is a risk of litigation if inaccurate information is provided to the public. In addition there is a risk that the analysis of same data sets could lead two different organisations to two different conclusions;

- **participation,** the main regional organisations and member states should participate. The participation of the regional organisations could create political problems but the idea is to establish a network, in which the main data holders should participate;

- **confidentiality,** this could delay (or limit in many ways) the dissemination of information to the public;

- **lack of human and financial resources**;

However, the need to carry out assessments of the European marine and coastal environment requires that the difficulties should be minimised through coordination and cooperation between the different international organisations in order to improve the information basis, using and accessing the best available data. The EEA and the ETC/MCE will be examining requirements for setting up this exchange facility during 1998-99.

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UNEP 1996. Enhancement of Data Processing facilities for environmental data at the Co-ordinating Unit for the Mediterranean Action Plan - 1995 MedPol monitoring agreements- Selections. Project CP/ME/0401-94-14

GLOSSARY

BMP	Baltic Sea Monitoring Programme
BMB	Baltic Marine Biologists
CBO	Conference of the Baltic Oceanographers
CEC	Commission of the European Communities
CEO	Centre for Earth Observation
CMP	Cooperative Monitoring Programme
COMBINE	Cooperative Monitoring in the Baltic Marine Environment
EC	European Community
ECE	Economic Commission for Europe
EDLR	Ecosystem Dynamics for Living Resources
EEA	European Environment Agency
EO	Earth Observation
ESA	European Space Agency
FAO	Food and Agriculture Organisation
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environment Protection
GIPME	Global Investigation of Pollution in the Marine Environment
GODAR	Global Oceanographic Data Archeology and Rescue
GOEZS	Global Ocean Euphotic Zone Study
GOOS	Global Ocean Observing System
GTS	Global Telecommunication System
HAB	Harmful Blooms
HELCOM	Helsinki Commission
IAEA	International Atomic Energy Agency
ICES	Internation Commission for the Exploration of the Sea
IGBP	International Geosphere and Biosphere Programme
IGOSS	Integral Global Ocean Services System
IOC	Intergovernmental Oceanographic Commission
IODE	International Oceanographic Data Exchange
IREP	International Recruitment Programme
JGOFS	Joint Global Ocean Flux Study
LME	Large Marine Ecosystem
LOICZ	Land-Ocean Interactions in the Coastal Zone
MARPOL	International Convention on the Prevention of Pollution from Ships
MEDPOL	Long-Term Programme for Pollution Monitoring and Research in the Mediterranean Sea
MAP	Mediterranean Action Plan
MEL	Marine Environment Laboratory
NODC	National Oceanographic Data Centre
OSLR	Ocean Science in Relation to Living Resources
OSPAR	Oslo and Paris Convention
OSPARCOM	Oslo and Paris Commission
QA	Quality Assurance
QSR	Quality Status Report
RNODC	Responsible National Oceanographic Data Centre
UNEP	United Nation Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
WDC	World Data Centre
WHO	World Health Organization
WMO	World Meteorological Organization
WWW	World Weather Watch

ANNEX 1

List and Contact Points of the Main Organisations and Programmes
(in alphabetical order)

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