QUALITY STATUS AND TERRESTRIAL INPUTS FOR THE NORTH SEA

The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention 1992) requires that Contracting Parties shall 'take all possible steps to prevent and eliminate pollution and shall take the necessary measures to protect the maritime area against the adverse effects of human activities so as to safeguard human health and to conserve marine ecosystems and, when practicable, restore marine areas which have been adversely affected'.

To provide a basis for such measures, the Contracting Parties are required to undertake and publish at regular intervals joint assessments of the quality status of the marine environment and of its development. These assessments should also evaluate the effectiveness of measures taken and planned for the protection of the marine environment and should identify priorities for action.

The Ministerial Meeting at which the OSPAR Convention was signed also issued an action plan for the OSPAR Commission, with a commitment to prepare a quality assessment of the whole maritime area by the year 2000. A comprehensive quality status report on this scale has not previously been produced. To implement these commitments the OSPAR Commission decided, in 1994, to subdivide the maritime area into five regions and to prepare, coordinated by the Environmental Assessment and Monitoring Committee, five detailed quality status reports. As a result, five regional task teams were set up to produce reports for the following areas: Region I (Arctic Waters), Region II (Greater North Sea), Region III (The Celtic Seas), Region IV (Bay of Biscay and Iberian Coast) and Region V (Wider Atlantic). It was agreed that these reports should be developed in a scientifically sound manner and should be based upon an assessment plan and a scientific programme (covering monitoring, research and the use of assessment tools). It was also agreed that the information contained in the reports should reflect the outcome of the appropriate quality assurance procedures.

THE PROJECT

This project covers two specific tasks in relation to a sustainable development of the North Sea: (1) drafting chapter IV of the Quality Status Report of the Greater North Sea and (2) establishing the most recent contamination fluxes from the Belgian territory to the North Sea.

TASK (1)

The assessment process is based upon the most recent information available from national and international sources, including OSPAR committees and specialist working groups, the International Council for the Exploration of the Sea (ICES), published reports and the scientific literature. Although most of the information relates to the 1990s, some topics assessed required the use of earlier data, either because the recent record is sparse or because trend analysis involves consideration of historical data. While every effort has been made to ensure the comparability of data from different times and locations, methodologies may differ considerably and some comparisons will, inevitably, be tenuous. Chapter four contains the latest available information on developments in riverine, sea- based and atmospheric inputs of contaminants, such as heavy metals, persistent organic pollutants, oil, radionuclides and nutrients. For the various groups of substances, geographic and temporal comparisons are made of concentrations in water, sediment and biota. Whenever possible, environmental risks are assessed.

TASK (2)

Although this task is inherently linked to the former one, it only deals with the Belgian situation and the acquisition of new, unreported data. For each of the 3 Regions a state of the art on atmospheric and riverine inputs of contaminants is provided. These data will allow to establish temporal trends and to ensure that Belgium complies with the North Sea Conferences' agreements on input reductions of hazardous substances to the North Sea.

The repartition of the workload between the members of the troïka was mainly based on a selection of contaminants: ANCH, VUB (nutrients, Hg and tributyltin); MiTAC, UIA (organic pollutants, radionuclides); Chemical Oceanography, ULB (trace metals, oils).

ACTIVITIES

- The drafting of chapter IV (Chemistry) of QSR 2000. The report has been recently published.
- The drafting of the individual contaminant flux charts from land (Belgian territory) to sea and the comparison with previously established fluxes.

THE PARTNERS

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The co-ordinator, the Department of Analytical and Environmental Chemistry (ANCH, VUB) of the free university of Brussels (Dr. W. Baeyens), Member of BRUEGEL (Brussels Research Unit of Environmental, Geochemical and Life Sciences Studies) has over 30 years experience in Marine Research. The main research topics actually include pollution (trace metals, organo-metals, PCBs and dioxins) and productivity (N-cycling, Ba export).

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The UIA tasks of the project are carried out in the Micro- and Trace Analysis Center (MiTAC) of Antwerp University (Dr. R. Van Grieken). The laboratory has a long experience in developing and applying various micro- and trace analytical techniques suitable for environmental research. Atmospheric pollution is a major environmental research topic.

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The laboratory of Chemical Oceanography (Dr. R. Wollast) of the Free University of Brussels (ULB) is specialised in estuarine and marine research of biogeochemical processes and cycles. The laboratory was coordinator of the large-scale Ocean Margin Export project (OMEX) of the EU.

EVALUATION OF POSSIBLE IMPACTS OF ENDOCRINE DISRUPTORS ON THE NORTH SEA ECOSYSTEM

In recent years, there has been increasing concern by scientists, regulators and the general public about the possible adverse effects of chemicals present in the environment on the endocrine system of humans and wildlife. A large number of natural and synthetic compounds have been shown (or suggested) to cause endocrine disrupting effects in invertebrates and vertebrates. Potential relationships between the presence of anthropogenic compounds and the occurrence endocrine disrupting (ED) effects in humans are the decrease in sperm count and quality and the increased prevalence of testicular, endometrial and breast cancer. The most reported ED effects in wildlife are the feminization of fish, developmental abnormalities in reptiles and embryonic death and deformities and abnormal nesting in fish-eating birds. Compared to the information available for freshwater ecosystems, little is known about the effects of endocrine disruptive chemicals on the marine environment. However, since the sea is a final sink for many (persistent) pollutants, these ED chemicals are also thought to affect marine organisms.

THE PROJECT

This project aims at establishing a clear overview of the increasing volume of available scientific literature on environmental endocrine disruption. Specific objectives are:

- To address the uncertainties presently associated with the issue of environmental endocrine disruption.
- To specify future research and policy needs.
- To accomplish the above mentioned tasks for endocrine modulating activity in the marine environment.

A scientific review and proposals for policy guidance will be prepared which can be essential tools for formulating governmental management decisions that will help to structure future action plans to tackle this delicate environmental problem.

ACTIVITIES

Based on available scientific literature, an electronic database of compounds, classified according to their endocrine disrupting potential will be established. In a first research phase, all the available information on the problem of endocrine disruption will be collected, including the effects assessment and the physico-chemical properties of the chemicals of concern in a cross linked database system. Secondly, these chemicals will be labeled for their intrinsic endocrine disrupting potential. In the second phase, an overview will be made of the effects on the endocrine metabolism of marine organisms and a preliminary hazard assessment will be made for those compounds where sufficient data are available on their environmental concentrations in the North Sea, their sources and their potential ED effects. The results of phase 1 and 2 will facilitate the formulation of future research needs and policy measures.

THE PARTNERS

The critical review of the literature concerning endocrine disruptive chemicals was performed by the Laboratory of Environmental Toxicology and Aquatic Ecology (LETAE) (Prof. Dr. C. Janssen) and the Laboratory of Andrology of Ghent University. Furthermore, LETAE has conducted the hazard/risk assessment for marine organisms. Both university groups and ECOLAS (ir. D. Le Roy) are responsible for the identification and priorization of research needs. Finally, the development of policy measures is performed by ECOLAS in consultation with LETAE.

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The Laboratory of Environmental Toxicology and Aquatic Ecology has internationally recognized expertise in fundamental and applied ecotoxicological research. The research activities are aimed at (1) the detection and identification of environmental endocrine disruption in freshwater and marine environments, (2) the bioavailability and the ecological risks of metals in aquatic and terrestrial ecosystems and (3) ecological risk assessment procedures. In the field of endocrine disruption close contacts or involvement in cooperative research with the following institutes has been established: University of Bern (Prof. Segner), Fraunhofer Institute Schmallenberg (Dr. Wenzel), Cardiff University (Prof. Pascoe), MAFF-UK (Dr. Matthiessen), NIVA-Norway (Dr. Hylland) and Plymouth University (Dr. Depledge).

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The Laboratory for Andrology is specialized in assessing the consequences of endocrine disruptors on humans. The research activities are aimed at: steroid analyses on semen plasm; evaluation of sperm motility and morphology; Sertoli cell function; biochemical analyses in semen and their relation with fertility and pathology. The Laboratory for Andrology has international contacts with Pretoria Academic Hospital (Prof. Bornman), National University Hospital Copenhagen (Prof. Skakkebaek), Imperial School of Medicine at St. Mary's London (Prof. Joffe), Aarhus University Hospital (Prof. Bonde), Justus Liebig Universität Giessen (Prof. Schill), Dijkzigt Ziekenhuis Amsterdam (Prof. Weber).

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ECOLAS has an extensive expertise in policy supporting studies concerning ecotoxicology and the marine environment. Several studies have been performed for the EU, the Ministry of Public Health and Environment and for the federal and regional environmental - and science policy authorities. ECOLAS has many contacts with different industrial federations and companies.

DEVELOPMENT OF METHODS FOR THE ANALYSIS OF HYDROCARBONS AND ORGANIC MICRO-POLLUTANTS IN THE MARINE ENVIRONMENT

The Persistent Organic Pollutants, "POPs", are lipophilic compounds with a low vapour pressure, characterised by a strong persistency in the environment. They do bio-accumulate and are considered toxic for living organisms. In 1998, a protocol was signed by 36 countries under the auspices of the United Nations Economic Commission for Europe, in order to take regulatory measures on these compounds. This protocol will enter in force when signed by 16 countries. A treaty on 12 POPs, concerning 122 countries, is currently in preparation under the auspices of the United Nations Environmental Programme. The OSPAR convention, aiming at the protection of the North-Eastern Atlantic, has set up a list of priority compounds for which regulatory measures have to be taken about their emission and monitoring in the marine environment. This list comprises POPs but also many other substances (heavy metals, volatile organic compounds, ...). The last Quality Status Report on the North Sea (QSR 2000) points out that available data on these compounds are difficult to use, due to low Quality Control on the measurements or differences in the modes of expression of results (e.g. on fresh, dry or lipid weight basis). Moreover, data are still lacking for many compounds. Therefore, future programmes of environmental monitoring must be based on standardised, robust and reliable analysis methods, implemented in laboratories working within internationally recognised Quality norms. Those methods will ideally be rapid and of low cost, allowing a statistically significant number of analyses.
The Mass Spectrometry Laboratory, as part of the Centre for Analysis on Trace Residues ("CART"), has focused its skills on the analysis of trace organic compounds by mass spectrometry. The lab is experienced in this field, is working with the best equipment and follows international norms guidelines.

THE PROJECT

Our goal is to make reliable, fast and low cost analytical tools available to authorities for the identification and quantification of organic micro-pollutants. Those tools will fit the priority needs for the OSPAR convention. The laboratory has focused on dioxins, furans and dioxin-like PCBs, within the perspective of BELTEST accreditation. Analyses of other compounds such as poly-brominated molecules are under development. The laboratory is working on the optimisation of reference methods. It also develops semi-quantitative methods for rapid evaluation of large samples series. These are physico-chemical and biological methods.

ACTIVITIES

The laboratory is developing an analytical strategy that fit the requested degree of precision. Three degrees can be drawn out :

1. The rapid screening will give a global image of the contamination in target compounds, without discrimination between molecules of similar effects. The response will be expressed as total toxic equivalents. Techniques for such application will consist in biological methods (EIA, CALUX, BIACORE). Such results are useful in a phase of exploratory measurements, in order to follow a temporal or spatial trend of a pollution, as well as for the determination of the contamination levels with reference to an established norm.

2. The semi-quantitative evaluation of the pattern of congeners within a compounds family allows to obtain an image of the sources of contamination and to follow the preferential bio-accumulation of certain congeners. The method used in

this case is a coupling between gas chromatography and MS-MS mass spectrometry.

3. The confirmation of data is performed with a reference method. This method allows to quantify variations in the contamination patterns, to compare results obtained in different sampling conditions (seasonal variations, compartments of a sampling site, ...), and to reach very low quantification limits. Such a reference method requires a coupling between gas chromatography and high resolution mass spectrometry. The quantification is obtained by the isotopic dilution method, with compounds labelled with 12 atoms of carbon 13 (13C12).

This strategy is currently applied for the analysis of dioxins, furans and coplanar PCBs. Its application to other compounds is also under development in our laboratory, which possess not only the necessary measuring techniques but also efficient sample preparation apparatuses (SFE, ASE, GPC, Power-PrepTM, ...).

In parallel, a proteomic approach is in preparation. Its goal is the identification and estimation of the intoxication level by proteic bio-markers, and requires techniques as matrix assisted laser desorption (MALDI-MS) and electrospray (ESI-MS).

THE PARTNERS

In order to apply the developed methods, the laboratory is in contact with partners providing marine samples. These are networks of the program "sustainable management of the North Sea".

1. Research contract MN/DD/005 "Birds and mammals of the North Sea : pathology and ecotoxicology". Samples of mammals and birds are provided by the laboratory for oceanology, U.Lg. (Professeur J.-M. Bouquegneau).

2. Research contract MN/DD/003 "ICAS : impact of heavy metals and poly-chloro biphenyls associated with the sediments of the North Sea". Samples of sea-stars and sediments are provided by the laboratory of marine biology, U.L.B. (Docteur P. Dubois).

3. Research contract MN/DD1/006 "IDOD : Integrated and dynamic management of oceanographic data" (S. Scory, MUMM). These contacts are taken for future analyses campaigns.

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MONITORING OF VOLATILE ORGANIC COMPOUNDS IN MARINE ORGANISMS: ANALYSIS, QUALITY ASSURANCE AND FEASIBILITY

Volatile organic compounds (VOCs) like chloroform, tetrachloroethylene, benzene and toluene are industrially produced at large scale. Due to their volatility they are present anywhere in the Western environment, albeit at low concentrations. They are found in the air, water, soil and in the tissue of living organisms. The concentrations of these toxic compounds observed in marine organisms however could not be explained by chemical processes alone. Therefore, there is a need to start monitoring this type of pollution in the near future.

THE PROJECT

The chemical analysis of these VOCs at very low concentrations in animal matrices is technically demanding and may suffer from lack of robustness and reproducibility. Secondly, the ideal way of sampling and storing the (fish) samples is yet unclear. Therefore, the following objectives are to be achieved:

- Improvement of the reliability of the analytical technique
- Development of a reference material with known VOC contents as a tool of quality control
- Improvement of sampling and sample storage conditions, on board as in the lab.

ACTIVITIES

The analytical technique is based on a purge-and-trap equipment, coupled with a gas chromatograph station, in turn equipped with a mass spectrometer. At first, the analytical methodology will be improved and validated, supported by the development of a reference material and the calculation of control limits.

Secondly, the integrity and stability of the reference material under different storing conditions will be studied. The integrity of the samples during sampling and sample storage on board and in the laboratory, using a fish model based on a fish oil containing semipermeable membrane device (SPMD) will be investigated. After validation of the appropriate sampling and storage methodology various international laboratories will be contacted to ask for their willingness to participate in a proficiency testing scheme, in order to further evaluate the robustness of the methodology. This can be done in collaboration with ICES (International Council for the Exploration of de Sea) or the Quasimeme project office (Quality Assurance of information for marine environmental monitoring in Europe).

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The division Analytical Chemistry of the Sea Fisheries Department is specialised at the analysis of organic pollutants present in marine sediments and organisms. In the frame of the Conventions of Oslo and Paris, polychlorobiphenyls (PCBs), persistent organochloropesticides (OCPs) and polyaromatic hydrocarbons (PAHs) are analysed annually at well-described sampling places on the Belgian Continental Platform and in the estuary of the Scheldt river. These data are collected on a European scale and used to evaluate the contamination of the marine environment, in order to support the European environmental policy.

EVALUATION OF THE QUALITY OF TURBOT FRY ON THE STOCK ENHANCEMENT SUCCESS IN THE NORTH SEA

The necessary limitations of the fisheries only came evident in the beginning of the nineties, when the yearly production continuously decreased by 2.5% (Csavas, 1995). It is clear that the aquaculture production of marine fish cannot compensate for this decrease, although the share of cultured fish increases exponentially (13% in 1994). It is assumed that the fish populations are endangered, as a result of extensive mortality caused by overfishing, which prevents numerous populations to recover fast enough. In addition, the critical niches suited for spawning and grow out of several marine and coastal species have decreased in quality or have been destroyed due to pollution, exploitation of coastal areas and other human activities.

The releasing juvenile fish to increase the natural population could stop the effects of insufficient natural renewal of the fish stocks. This has been practised for different species during decennia in Japan, USA and Norway.

THE PROJECT

The project has following aims: research on the potential of stock enhancement of flatfish (turbot) within an international context making use of the expertise present in Belgium and new methods.

ACTIVITIES

1. Standardised production of fry and juveniles of turbot with certain characteristics which play a role in the success of the release (size, resistance to diseases, overall resistance to stress), behaviour (predatory activity, escape reflex), physiological condition, ... through adjustment of zootechnical and nutritional factors in the nursery/hatchery, next to the conditioning of the fry from the hatchery production. Potential negative effects for the environment will be studied and these will be reduced using recirculation techniques.

The fishes will be submitted to different tests in order to determine the production resulting in less stressed fish with a high disease resistance. It is expected that the culture technique will result in a production of predictable numbers of larvae (survival of ± 30 % on day 45) with high quality (good pigmentation, stress resistant and high growth rate).

2. Genetic research on the fry by the use of analysis of microsatelites and at random amplification of genomic DNA (AFLP-technique) to prove potential differences between the North Sea population and the released fish. Possible selection will be determined by comparing the released fish and the recaptured fish. It is expected that there is no difference between the introduced fish and the North Sea population.

3. Technical feasibility study of the production of turbot fry at the Belgian coast. A feasibility study on the possibility of aquaculture at the Belgian coast, financed by the Flemish community and the EU (fisheries Research Station, 1995), suggested the incinerator at Zandvoorde as a suited site.

THE PARTNERS

1. The Laboratory for Aquaculture of the University of Ghent (ARC) has a world wide reputation concerning larviculture of marine fish and crustaceans and can provide a crucial support in 2 important fields:

Production and study of juveniles with certain characteristics that enhance the success after release. The survival chance of the released is dependant on numerous factors, eg. the ability to capture sufficient prey, to reduce the risk of

predation, to adapt to stress and diseases. These characteristics can be obtained through the applied hatchery technique, but still needs to be studied.

2. Reduced production cost by improved production in the hatcheries.

Juveniles of a high quality, produced at the ARC, are grown out at the Department of Fisheries where the behaviour will be observed before the fish are tagged and released.

The Department of Fisheries (Oostende) tests 'recapture' methods at the Belgian coast using cultured and tagged turbot juveniles in cooperation with the ARC. Samples of the released fish will be genetically characterised. The juveniles will be grown out in special culture tanks and used for testing different feeds. Afterwards, the tagged fish are released and the data of the recaptured fish are collected.

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The last 20 years, the research at the Laboratory for Aquaculture & Artemia Reference Center has evaluated from fundamental to applied research on the brine shrimp *Artemia* to a multidisciplinary research activity on the specific problems concerning the larviculture of fish, crustaceans and molluscs. The research is focussed on biological, zootechnical and nutritional aspects, recently also on production factors, including egg and larval quality and the impact of microbiological factors. Therefore, standardised research facilities have been developed for the production of different live foods, a pilot hatchery, several culture rooms for testing nutrition and reproduction, separate rooms for microbiological studies, as well as a chemical lab for standardised biochemical analyses and facilities to prepare emulsions and diets.

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The DVZ-CLO is involved in the research for new and better fish techniques, the population dynamics and the exploitation pattern of fish, crustacean and mollusc species, en de potential influences of contaminants on the marine ecosystem. The DVZ-CLO has an outstanding reputation in providing scientifically advice to the Common Fishery Policy (CFP) of the EU for the exploitation of commercial species and is there by involved in several international projects. The DVZ-CLO is also the official delegate for Belgium in the International Council for the Exploitation of the Sea (ICES). The DVZ-CLO has a broad experience with genetic fingerprinting of marine fish species for species determination and population research and is involved in quality, haematological and immunology research of marine species. The Department of Fisheries has next to an extensive international experience in tagging marine fish species also a larger expertise on the release of cultured fish. The DVZ-CLO has for this purpose a large hatchery for the out grow of juvenile flat fish.

"PAARDENMARKT" SITE EVALUATION

After WW1 a considerable amount of war material has been dumped on a shallow sand flat, called "Paardenmarkt", offshore Heist, a few kilometres east of the port of Zeebrugge. The dump site extends over 3 km2; on hydrographic maps it is indicated with a pentagon where neither fishing nor anchoring is allowed by law. The Paardenmarkt has been for years a point of major concern, questions and incertitudes and calls for a detailed and thorough evaluation.

In the past, geophysical "remote-sensing" techniques have been applied to evaluate the extent of the dumped material, with encouraging results. However, the complexity of the question requires an integrated, multi-disciplinary approach blending geophysical, geochemical, biochemical, biological, civil engineering, ecological and economical expertise. Such integrated approach will yield an improved insight in the site, its ecosystem and its potential risks for the shoreline population and the users of the sea.

THE PROJECT

- Detailed synthesis, analysis and scientific evaluation of all available data related to the study area, in order to make a correct evaluation of the actual dimension of the encountered problems.
- Analysis of possible strategies of scientific research, not only with respect to the characterisation of the buried objects but also to the natural setting of the site (more specific the occurrence of gases, biogenic and/or toxic), and the possible perspectives for continuous monitoring of the area.
- Re-evaluation of the present-day 'status quo' policy and the evaluation of different options for possible engineering solutions, which includes the possibility to turn the waste disposal site into a nature conservation area.
- Evaluation of possible strategies related to communication and information transfer in order to meet public concern, in due consultation with the authorities.
- Dissemination and integration into a wider European expertise through project proposals, workshops, and the exchange of logistical, technical and scientific expertise at international level.

ACTIVITIES

MAIN DELIVERABLES EXPECTED

- Historical / scientific database of the dump site.
- Strategy for geological, sedimentological, geochemical and biological research and monitoring.
- Estimation of the possible environmental effects of the present situation.
- A list of possible engineering and management options (including rehabilitation into nature conservation area).
- Information brochure for the general public stating the general problem.

THE PARTNERS

A wide expertise has been gathered in the following project group : Renard Centre of Marine Geology (RCMG) - UG (co-ordinator); consulting office Magelas; consulting office G-Tec; TNO Prins Maurits Laboratory (TNO-PML); CEREGE - Université Aix-Marseille III; Marine Biology - UG; Civil Engineering - UG; Institute for Nature Conservation (INC). The participation of the foreign partners (The Netherlands, France) supports an early international approach for such border-transgressing problem.

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The Institute for Nature Conservation is specialised in ecological research focused on integrated coastal and aquatic management. Expertise (inventories, feeding ecology and breeding biology of seabirds).

INTENSIVE EVALUATION OF THE EVOLUTION OF A PROTECTED BENTHIC HABITAT

THE PROJECT

The geomorphological highly diverse western Coastal Banks of the Belgian continental shelf are internationally known for their high ecological value, e.g. because of the high numbers of wintering seabirds. Hence, it is considered to select the area as a first Belgian marine protected area. The research project aims at providing data, strategies and methodologies to allow a scientific evaluation of the evolution of a benthic habitat within the future marine protected area. This evaluation is indispensable within the framework of the management of the marine protected area. Because of the important function of the macrobenthos within the coastal ecosystem, e.g. as a food resource for the seaduck Common scoter (*Melanitta nigra*), the study focuses on the spatial distribution of macrobenthic organisms in relation to the sedimentological, bathymetrical and hydrodynamical environment.

ACTIVITIES

The research can be divided into five research topics:

1. Initially, all information about the macrobenthic and physico-chemical variables (e.g. sedimentology, hydrodynamics, as well as pigment, organic matter and nutrient contents of the water column and sediments) of the marine protected area will be extracted from literature and compiled into a database. To represent the literature data in a surveyable way and to detect gaps in the current knowledge of the ecology of the marine protected area, this information will be summarised into geographical maps.

2. Additional to the cartographic material resulting from literature data (see above), an intensive and interdisciplinary sampling campaign to study the macrobenthic habitat of a selected sector is organised in Autumn 1999. During this campaign sampling of the macrobenthos and sedimentary environment as well as side-scan sonar recordings are performed simultaneously.

3. To study the temporal variation of the macrobenthos and physico-chemical environment a second intensive and interdisciplinary campaign is organised in Spring 2000. Combining all available literature data and the newly gathered information, the temporal variation of the benthic habitat can now be described.

4. All gathered macrobenthic and physico-chemical information will be summarised in a generalising habitat structure map of the marine protected area. This habitat structure map will present the macrobenthic and physico-chemical variables in a well-organised way. The map will describe the benthic habitat before the execution of the management plan (t_0-situation) and will be of direct use to set up the management plan. Furthermore, the map will create opportunities for the development of a raster-based Geographical Information System (GIS).

5. The results of the interdisciplinary investigation of the benthic habitat will be used to develop time- and cost-efficient evaluation tools of the management plan. A first method will model the specific habitat preferences of the macrobenthic communities. This model (*habitat-model*) will be useful to predict the spatial distribution of the macrobenthic communities in an area with a known physical-chemical environment. By means of a second method the spatial distribution of the macrobenthic communities will be analyses through a standardised interpretation of side-scan

sonar recordings (*macrobenthic side-scan sonar interpretation*). The applicability of both methods to develop methods for a time and cost-efficient permanent surveillance of the marine protected area (= monitoringsstrategy and -methodologies) will be evaluated.

THE PARTNERS

Because of the interdisciplinary character of the benthic habitat, the research is performed by a team with marine-biological (Ghent University, Department of Biology) as well as marine-geological expertise (Ghent University, Department of Geology & Soil Science). All data (macrobenthos, sedimentology, bathymetrical and side-scan sonar recordings) are collected simultaneously. Data exchange between both partners is stimulated by means of formal and informal meetings as well as a central data management.

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Since 1970, the Marine Biology Section of the Department of Biology (Ghent University, Belgium) has been involved in ecological and systematic research of marine benthic ecosystems. Research is going on in the North Sea and adjacent estuaries. Since about ten years, other geographical areas have been included: Deep-sea areas in the Atlantic Ocean, Biology of the Antartic meiobenthos, Ecology of tropical estuaries and lagoons, Population dynamics of macrobenthos of coastal sandbanks and several Ph.D. studies.

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The Research Unit Sedimentary geology and Engineering geology of the Department of Geology and Soil Science of Ghent University studies shallow-marine siliciclastic sedimentation systems by means of stratigraphy and comparative sedimentology of active and fossil forms. The Research Unit participates in studies on the sustainable management of the North Sea: HABITAT (OSTC, WWK) and BUDGET (OSTC). The project is carried out in co-operation with the Renard Centre of Marine Geology (Ghent University) and a private contractor Magelas. Staff members of the Research Unit are also actively involved in the Flemish Marine Institute (VLIZ).

BUDGET: BENEFICIAL USAGE OF DATA AND GEO-ENVIRONMENTAL TECHNIQUES

The seafloor sediments of the Belgian continental shelf are transported by hydrodynamical and meteorological processes. Obtaining an insight in both the continuous movements of the sediment and the residual transport directions is not only interesting from a scientific point of view but it allows the scientist as well (i) to understand better the coastal erosion phenomena, (ii) to forecast the effects of human activities which alter the natural sediment dynamic processes, (iii) to define the most efficient dumping grounds for dredged material and (iv) to estimate the consequences of aggregate extraction on the environment. Results on the sediment transport can be obtained by using mathematical models and by performing field measurements. The sediment dynamic models are however, due to the large complexity of sediment transport mechanisms, not as efficient as hydrodynamical models. Information on the sediment transport can be obtained with the help of several measuring techniques but the results can in many cases not be compared one to another as they apply to a specific spatial scale and to a particular time period. In spite of a variety of sediment dynamic studies performed by both governmental organisations and research institutions, a overview image of the residual sediment transport directions on the Belgian shelf is missing.

THE PROJECT

The main objective of BUDGET is to collect the various studies concerning the sediment dynamic behaviour of sediments on the Belgian continental shelf, to analyse them critically and to compile their results in order to obtain an overview picture of the sediment fluxes on the Belgian shelf. BUDGET includes three major aspects:

Inventory of background information and of sediment dynamic studies
An inventory is made of all relevant geological, morpho-sedimentological and hydrodynamical data.

Critical analysis of compiled studies and methods
The studies are analysed in function of the three-dimensional scale of the processes and (apparent) contradictions in results are examined. At the same time a comparison is made with the results of the mathematical models.

Recommendations for future research
Recommendations for future research and a proposal for an integrated research on the Belgian continental shelf are formulated.

ACTIVITIES

EXPECTED RESULTS

A sediment dynamic overview map of the Belgian continental shelf
This map will give an overview of all relevant geological and sedimentological information, bedforms, and hydrodynamical data based on models and field measurements. The map will present as well directions of residual sediment transport deduced from the compiled studies.

Multidisciplinary database
A database will list all analysed studies and their principal results.

Evaluation criteria
Criteria are defined to evaluate the applicability of existing measuring methods for the analysis of particular sediment dynamic problems.

Sediment budget

A sediment budget of the Belgian continental shelf based on the compiled studies is worked out.

THE PARTNERS

The co-ordinator, Magelas (Prof. Dr. J. Lanckneus), has 20 year experience on the field of sediment dynamics and morphodynamics. The Renard Centre of Marine Geology (RCMG) (Dr. V. Van Lancker) enjoys a broad expertise on the field of geological studies in marine and lacustrine environments. The Management Unit of the Mathematical Model of the North (MUMM) (Ir. D. Van den Eynde & Dr. M. Fettweis) is specialised in mathematical modelling of marine systems and is active in the quantitative analysis of sediment transport on the Belgian continental shelf. The Research Unit of Sedimentary Geology and Engineering Geology (SGEG) (Prof. Dr. P. Jacobs) is active in the study of shallow-marine siliciclastic sedimentation systems and in the cartographic processing of geological data.

COORDINATOR

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Magelas is a company specialised in the field of sedimentology, sediment dynamics and morphodynamics. Co-operation of relevance to the BUDGET project include the research project COAST3D (funded by the MASTIII programme) and the research project MOBAG (funded by the Flemish Community).

PARTNER 1

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The Renard Centre of Marine Geology (RCMG) has more than 20 years of experience in high-resolution reflection-seismic and geological investigations in marine and lacustrine environments. RCMG's research work is most often carried out in the framework of nationally or internationally funded programmes (THERMIE, MASTI, MASTII, MASTIII, ENVIRONMENT, INTAS). The project BUDGET is carried out in collaboration with the Management Unit of the Mathematical Model of the North Sea and Scheldt estuary and the Research Unit Sedimentary Geology and Engineering Geology of Ghent University.

IZEUT: IDENTIFICATION OF MARITIME ZONES AFFECTED BY EUTROPHICATION

THE EUTROPHICATION PROBLEM OF THE BELGIAN COASTAL WATERS

The Belgian coastal waters receive large quantities of anthropogenic nutrients *via* the nutrient-enriched SW Atlantic waters, the rivers Ijzer, Scheldt and Rhine/Meuse, local coastal effluents and the atmosphere. Eutrophication is apparent as blooms of *Phaeocystis* colonies that escape grazing by zooplankton. Most damage related to *Phaeocystis* blooms has been reported as deposits of foam on the beaches and clogging of fishnet.

INTERNATIONAL AGREEMENTS TO COUNTERACT EUTROPHICATION OF THE NORTH SEA

As contracting party of the North Sea Conference and the Oslo and Paris Conventions, Belgium has agreed to classify their maritime areas as 'problem areas, potential problem areas and non-problem areas' with respect to eutrophication following the *Common Procedure for the Identification of the Eutrophication Status of the Maritime Area* edited by OSPAR. The Common Procedure is a stepwise process including the Screening (descriptive) and Comprehensive (quantitative assessment criteria) Procedure. Although the Common Procedure provides North Sea riparian countries with a common basis to classify the maritime areas according to their eutrophication status, the procedure is restrained up to now to a list of possible qualitative criteria.

THE PROJECT

The overall objective of IZEUT is to develop and apply eutrophication criteria for an internationally accepted identification of problem areas, potential problem areas and non-problem areas in the Belgian coastal waters. It is based on the *Common Procedure for the Identification of the Eutrophication Status of the Maritime Area* of the OSPAR Convention.

ACTIVITIES

METHODOLOGY

- Collect updated information concerning the riverine, atmospheric, Atlantic & benthic inputs of nutrients in the Belgian coastal zone to determine the quantitative and qualitative nutrient enrichment of the Belgian coastal zone and the contribution of anthropogenic (agriculture, industry, households) and natural sources.
- Conduct surveys among different communities (civilian, scientific, fishermen, seaside resorts...) to identify possibly measurable indicators of eutrophication-related ecosystem changes, damages and loss in the Belgian coastal waters or parts of it and use them for a socio-economical valuation of *Phaeocystis* damages.
- Collect existing physical, optical, nutrient, chlorophyll a and phytoplankton data collected in the Belgian coastal waters since 1971 and the adjacent French and Dutch coastal waters and establish cause-effect relationships between key ecological criteria (e.g. *Phaeocystis* magnitude) and nutrient loads (absolute concentration and ratios).

EXPECTED RESULTS

Upon completion IZEUT is expected to define eutrophication-related background reference levels and ecological quality criteria that will be used to produce a map showing the geographical extent of problem areas, potential problem areas and non-problem areas in the Belgian waters and its evolution since 1971. These ecological criteria will be useful as quality target to be reached in future nutrient reduction plans and/or for monitoring trends in the quality of the Belgian waters.

THE PARTNERS

The project IZEUT combines the scientific efforts of the laboratory of Ecology of Aquatic Systems of the Université Libre de Bruxelles ULB-ESA (Dr.C. Lancelot) and the environmental consultancy office ECOLAS (Ir D. Leroy).
The coordinator, ULB-ESA, an internationally recognised expert in coastal eutrophication and Belgian representative (Dr Ir V. Rousseau) in the OSPAR Eutrophication Task Group, focuses research effort on the establishment of scientifically-based criteria for assessment of eutrophication in the Belgian coastal waters.
The sub-contractor ECOLAS, at the frontier between natural and social science and specialised in estimating socio-economic impacts of marine environmental damages is responsible of the socio-economical valuation of *Phaeocystis* damages.

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ULB-ESA is conducting since 20 years national and EU-funded research on the functioning of aquatic ecosystems and its response to natural and man-induced changes. International collaboration relevant to IZEUT includes informal contact established with IFREMER-Boulogne (France) and RIKZ (The Netherlands) for a regional view of eutrophication problems in the Southern Bight of the North Sea. It also includes participation to OSPAR-SGQAE and -ETG and membership to the SCOR Working Group on Phaeocystis, the EU-ELOISE initiative and the PNEC (Programme National d'Ecologie Côtière, France).

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The environmental Consultancy Office Ecolas has a wide expertise on integrated policy studies regarding the management of coastal and marine zones and is member of the Advisory Council for Sustainable Development of the Province West-Vlaanderen related to Integrated Coastal Zone Management (ICZM) issues. Specific interests include oil pollution, eutrophication, harbours, aquaculture and fisheries, socio-economic issues of ICZM, Global Ocean Observing System (EuroGOOS), EUROMAR, biodiversity issues and climate change effects on the coastal zone.

LONG TERM TRENDS IN THE MACROBENTHOS OF THE BELGIAN CONTINENTAL SHELF

The Belgian Continental Shelf (BCS) has a very high diversity in marine habitats and associated biological communities. Also, the socio-economic importance of the BCS is very high. As in most areas around the North Sea, a lot of anthropogenic activities, such as sea fisheries, maritime transport, military shootings, dredging activities and others occur on the BCS.

The combination of the ecological and the socio-economic value of the BCS causes conflicts between both interests. Therefore it is very important to develop a sustainable management plan for the natural resources of the BCS. To obtain this goal, information and knowledge is required about (1) geographical distribution of the marine biological communities, (2) the structure of these communities, (3) their relationship with the physical and the chemical environment, (4) the natural ecological and genetic variability, and (5) the nature and the effect of the anthropogenic influences on these ecosystem components.

Macrobenthic organisms are good candidates for monitoring the short and long-term effects of natural and anthropogenic impacts on and within the marine environment because of their direct link with the sediment and with the processes that occur immediately above the sediments.

GLOBAL OBJECTIVE

The global objective of this proposal is to deliver a substantial contribution to the knowledge of the long term variability in the biodiversity of the macrobenthos and the relationship with anthropogenic activities.

SPECIFIC OBJECTIVES

1. Spatial distribution and long term variation of the macrobenthos

- Preparation of an Atlas with distribution maps of the macrobenthos of the Belgian Continental Shelf (BCS) for the periods 1977-1983 and 1994-2000 (through a compilation of available and new macrobenthic data)
- Evaluation of the long term variation of the macrobenthos of the BCS (end 19th – begin 20th century (Gilson collection) versus 1977-1983 versus 1994-2000)
- Evaluation of the differential effects of anthropogenic activities on the macrobenthos ('Quick' method)

2. Detailed long term variation of the macrobenthos of the Belgian Continental Shelf

- Detailed investigation of the long term variability of the macrobenthos of the BCS (in 4 stations with different anthropogenic influences)
- Detailed evaluation of the impact of a selected number of anthropogenic activities on the macrobenthos of the BCS (investigation of the causal relationships)

ACTIVITIES

SPATIAL DISTRIBUTION AND LONG TERM VARIATION OF THE MACROBENTHOS

(comparison of the new data from the samples of 1977-1983 with the already available data of the samples from 1994-2000)

- Collecting meta-data of the available, not-processed samples
- Determination of the gaps in inventory information in the spatial distribution of the macrobenthos of the BCS
- Selection of the samples to investigate
- Investigating the selected samples
- Integration of the new data with the already available data
- Preparation of the Atlas with the distribution maps of the macrobenthos of the BCS for the periods 1977-1983 and 1994-2000
- Integration of the 'Gilson data' within the macrobenthos dataset of the BCS

- Evaluation of the long-term variation of the BCS
- Collecting the information of the anthropogenic activities during the period 1977-2000
- Evaluation of the differential effects of anthropogenic activities on the macrobenthos ('Quick' method)

DETAILED STUDY OF THE LONG TERM VARIATION OF THE MACROBENTHOS OF THE BCS

- Classification of the (monitoring)stations based on the macrobenthic communities
- Classification of the (monitoring)stations based on the presence/absence of changes in anthropogenic activities in the periods 1977-2000
- Selection of the stations to investigate
- Investigation of the selected samples
- Integration of the new data with the already available macrobenthic data
- Detailed study of the long term variation of the macrobenthos
- Detailed evaluation of the impact of the selected anthropogenic activities on the macrobenthos

THE PARTNERS

The collected marcobenthos-material of the North Sea is present as well in the Marine Biology Section of the Ghent University as in the Department of Sea Fisheries in Ostend. The biologists who will investigated the material will work as well in Gent as in Ostend which will guarantee a perfect integration of the data.

COORDINATOR

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The Marine Biology Section of the Department of Biology (University of Ghent, Belgium) has been involved in ecological and systematic research of marine ecosystems from 1970 onwards. The research started with the investigation of North Sea benthic communities, with special focus on the macro- and meiobenthos. From 1980 onwards, research was expanded to include the hyperbenthic and epibenthic compartments. Research is still going on in the North Sea and adjacent estuaries (OSTC and FWO programmes). Next to the biological subjects (for which the marine biology section is equipped with the best microscopes and a very complete library) also more geochemical characteristics are determined and analysed.

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Research at the Department of Sea Fisheries is strongly service-oriented towards international scientific organizations and management bodies, the government, the fishing industry and the consumer. The main task of the department is to provide the scientific basis for the rational and sustainable exploitation of living marine resources, the protection of the marine environment, and the quality control and assurance of fishery products. The department active in four different research areas. The Biology Section does fundamental and applied research on the life history aspects, the population dynamics and the exploitation patterns of commercial fish and shellfish. Besides, attention is paid to restocking and aquaculture of shellfish. The research area is the monitoring, in which various routine research programmes are carried out on the possible repercussions of contaminants on the marine ecosystem. Biological monitoring of sand extraction areas and dredge spoil disposal sites, and chemical monitoring of trace metals, PCBs, PAHs, and volatile organic compounds. The major aim for the Fishing Gear Technology Section is the development of "efficient" fishing gear, thereby combining technical, biological, ecological and economic concerns. The Product Technology Section is actively involved in the development of methods to determine the authenticity and the quality of fishery products.

FAST AND LOW COST ANALYSIS OF DIOXIN-LIKE COMPOUNDS IN MARINE MATRICES

FRAMEWORK OF THE PROJECT

The recent Quality Status Report on the Greater North Sea (referred as "QSR 2000") includes almost no data for those compounds of major concern. These compounds are however subject to new EC policies aiming the reduction of the population exposure. Furthermore, the report points out a lack in Quality Assurance procedures leading to useless data production concerning organic contaminants. The aim of this project is to provide the authorities with efficient, validated monitoring tools for dioxin-like compounds based on the application of a three-levels analysis strategy to a real sampling campaign situation. The analytical strategy is a three levels modular strategy, in which, according to the level of information required, the cost/efficiency is optimized.

The three levels are the following: Total toxicity in TCDD equivalents (TEQ) screening by bioassays, congener specific TEQ screening and semi-quantification by HRGC/MSMS with large volume injection, confirmation and reference measurements by HRGC/HRMS. In addition, the scope of the strategy will be extended to newly added compounds in the Priority Substances List of OSPAR. The proposed strategy will allow a sound assessment of an integrated monitoring tool in a real sampling situation. The optimisation and the validation of the analytical strategy will include the following steps :

1. Optimisation of the sample preparation

2. Optimisation of the detection step (MS methodology or bioassays)

3. Comparison of TEQ values obtained at the different levels

4. Statistical analysis of the results and implications for quality managment

This tool finds its place within the framework of international efforts aiming at the reduction of inputs and the monitoring of these compounds in the marine environment. It will allow the optimal use of resources, bringing together the best currently available analytical methods within an officially recognised quality system.

GOALS

Our goal is to make reliable, fast and low cost analytical tools available to authorities for the identification and quantification of organic micro-pollutants. Those tools will fit the priority needs for the OSPAR convention. The laboratory has focused on dioxins, furans and dioxin-like PCBs, within the perspective of developpping a general strategy ready for BELTEST accreditation. Analyses of other compounds such as poly-brominated molecules are under development. The results obtained by the different techniques will be compared on the same marine matrices. This should allow defining figures of merit for each method and to optimize their complementary use in real situations. This optimization will allow a better use of the resources allocated to the monitoring and contribute to a better knowledge and understanding of toxic persistent compounds in marine environment.

EXPECTED RESULTS

The laboratory is developing an analytical strategy that fit the requested degree of precision. Three degrees can be drawn out :

1. The rapid screening will give a global image of the contamination in target compounds, without discrimination between molecules of similar effects. The response will be expressed as total toxic equivalents. Techniques for such application will consist in biological methods (EIA, CALUX, BIACORE). Such results are useful in a phase of exploratory measurements, in order to follow a temporal or spatial trend of a pollution, as well as for the determination of the contamination levels with reference to an established norm.

2. The semi-quantitative evaluation of the pattern of congeners within a compounds family allows to obtain an image of the sources of contamination and to follow the preferential bio-accumulation of certain congeners. The method used in this case is a coupling between gas chromatography and MS/MS mass spectrometry.

3. The confirmation of data is performed with a reference method. This method allows to quantify variations in the contamination patterns, to compare results obtained in different sampling conditions (seasonal variations, compartments of a sampling site, ...), and to reach very low quantification limits. Such a reference method requires a coupling between gas chromatography and high resolution mass spectrometry. The quantification is obtained by the isotopic dilution method, with compounds labelled with 12 atoms of carbon 13 (13C12).

This strategy is currently applied for the analysis of dioxins, furans and coplanar PCBs. Its application to other compounds is also under development in our laboratory, which possess not only the necessary measuring techniques but also efficient sample preparation apparatuses (SFE, ASE, GPC, Power-PrepTM, ...).

In parallel, a proteomic approach is in preparation. Its goal is the identification and estimation of the intoxication level by proteic bio-markers, and requires techniques as matrix assisted laser desorption (MALDI-MS) and electrospray (ESI-MS).

THE PARTNERS

In order to apply the developed methods, the laboratory is in contact with partners providing marine samples.

BIRDS AND MAMMALS OF THE NORTH SEA : PATHOLOGY AND ECO-TOXICOLOGY
Samples of mammals and birds are provided by the laboratory for oceanology, U.Lg. (Professeur J.-M. Bouquegneau).

ICAS : IMPACT OF HEAVY METALS AND POLY-CHLORO BIPHENYLS ASSOCIATED WITH THE SEDIMENTS OF THE NORTH SEA
Samples of sea-stars and sediments are provided by the laboratory of marine biology, U.L.B. (Docteur P. Dubois).

IDOD : INTEGRATED AND DYNAMIC MANAGEMENT OF OCEANOGRAPHIC DATA
(S. Scory, MUMM). These contacts are taken for future analyses campaigns.

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THE COLLECTION GUSTAVE GILSON AS A HISTORICAL REFERENCE FRAMEWORK FOR THE BELGIAN MARINE FAUNA: FEASIBILITY STUDY

The world-wide problem of global change, pollution of coastal waters and the biodiversity crisis has stimulated researchers to monitor and counter anthropogenic changes of the environment. This implies that one has to be able to distinguish between natural and anthropogenic impacts. In addition, there is a need to estimate the time scale at which these effects act. Such information can only be obtained if the recent conditions of an ecosystem can be compared with the situation at a time short before anthropogenic pressures started to play a significant role (historical reference point or "zero point").

In this context, the Royal Belgian Institute of Natural Sciences has a unique historical collection concerning the fauna of the Belgian North Sea: the GILSON collection. Gustave GILSON (1859-1944), oceanographer-biologist and former director of the Royal Belgian Institute of Natural Sciences, performed an intensive sampling campaign in the Belgian coastal waters during the period 1898-1939. More than 14,000 samples were collected, with the majority being taken between 1898 and 1913.

THE PROJECT

The present research project aims at evaluating the suitability of the GILSON collection as a historical reference framework ("zero-point") for the Belgian marine fauna. The collection will be i) taxonomically revised, ii) the quality, quantity and geographical distribution of the samples will be determined and iii) the available information will be incorporated in computer databases and will be mapped. The importance of the collection in the framework of a sustainable management of the North Sea, will be evaluated via case studies. Finally, the possibility for national and international co-operation will be examined.

ACTIVITIES

Development of an annotated bibliography concerning all publications related to GILSON's marine explorations and collection.

• Compilation of a computer database of the sampling localities: information concerning the sampling methods, localities, in situ environmental parameters and date of sampling of all the GILSON sampling localities will be made available as a computer database.

• Establishment of a historical reference framework: 1898-1913 can be considered as a period just before the North Sea became severely affected by anthropogenic stress factors. Therefore, only GILSON samples collected during this period will be used for the establishment of a historical reference framework. However, more recent GILSON samples, as well as samples from other Belgian collections preserved in the RBINS will be included in the case studies.

• Case studies: the present project will focus on a limited number of representative species from four different groups: fish, crustaceans, molluscs and echinoderms.

• Revision of the collections: determination of the quality and quantity of selected samples (used in the case studies) and their geographical distribution. This information will be combined with the computer database of the localities to establish an integrated computer database called "The Southern North Sea Species Database".

• Further research areas in the framework of a sustainable management of the North Sea: several case-studies will be performed to evaluate the scientific value of the GILSON collection as a historical reference framework such as the suitability of the samples for i) DNA analysis, ii) morphometric and morphological studies, iiil) geographical and ecological distribution of different species and iv) ecotoxicology studies.

THE PARTNERS

ROYAL BELGIAN INSTITUTE OF NATURAL SCIENCES

The Department of Invertebrates deals with taxonomic, phylogenetic, zoogeographic and faunistic research on Mollusca, Crustacea, Nematoda, Porifera, Cnidaria and Echinodermata. This research is carried out in Belgium and worldwide. The research team has skills and the necessary infrastructure for marine biological fieldwork, faunistic and phylogenetic studies, collection management, scanning electron microscopy, molecular techniques, statistical data treatment and informatics. The department acts as the National Focal Point for the Convention on Biological Diversity. It created and manages the Belgian Clearing-House mechanism under this convention (www.naturalsciences.be/bch-cbd/home.htm).

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The activities of the MUMM involve marine research, monitoring and data management. Research at MUMM focuses on providing the necessary knowledge and tools for scientific management of the North Sea ecosystem based on mathematical modelling, remote sensing and in situ measurements. MUMM intensively co-operates with other European and non-European oceanographic laboratories and governmental institutions.

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