

63226



# **SUSTAINABLE MANAGEMENT OF THE NORTH SEA**

SCIENTIFIC SUPPORT PLAN FOR A SUSTAINABLE DEVELOPMENT POLICY

Location	5° West - approx. 13° East 48° - 62° North
Area	746,000 km <sup>2</sup>
Average depths of the northern zone	150 to 500 m
Average depths of the central zone	50 to 100 m
Average depths of the southern zone	25 to 50 m
Maximal depth	700 m
Volume of water	94,000 km <sup>3</sup>
Average flow of sea water from the North	41,000 km <sup>3</sup> per annum
Average flow of sea water from the South	3,150 km <sup>3</sup> per annum
Average flow of fresh water from rivers	325 km <sup>3</sup> per annum
Average annual precipitation	425 mm
Average time of discharge	500 days
Catchment area of rivers discharging into the North Sea	841,000 km <sup>2</sup>
Countries included in the North Sea basin	Norway, Sweden, Denmark, Germany, the Czech Republic, Slovakia, the Netherlands, Belgium, Luxembourg, Switzerland and the United Kingdom
Population of the North sea basin	184,000,000
Annual flow of matter in suspension	50 to 65,000,000 million tonnes
Annual fish catch (1995)	2,900,000 tonnes
Annual shellfish catch (1995)	250,000 tonnes
Average maritime traffic	500,000 per annum
Average number of navigation accidents	150 per annum
Number of oil and gas platforms (1996-98)	475
Number of kilometres of pipelines (1996-98)	10,000
Annual gas production (1996-98)	167,700,000,000 m <sup>3</sup>
Annual petroleum production (1996-98)	285,300,000 tonnes
Annual extracted sand and gravel (1996)	40,000,000 m <sup>3</sup>
Annual discharge of dredged matter (1996)	90,000,000 tonnes



# Duurzaam beheer van de Noordzee

PRESENTATIE VAN DE ONDERZOEKSRESULTATEN

# Gestion durable de la mer du Nord

PRÉSENTATION DES RÉSULTATS DE LA RECHERCHE



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Mevr. | Mme. A. Depauw  
Wetenschapstraat 8 Rue de la Science  
1000 Brussel | Bruxelles

21 > 22 / 01 / 2002

## Inschrijvingsformulier Formulaire d'inscription

Naam | Nom \_\_\_\_\_

Voornaam | Prénom \_\_\_\_\_

Functie | Fonction \_\_\_\_\_

Instelling | Institution \_\_\_\_\_

Adres | Adresse \_\_\_\_\_

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e-mail \_\_\_\_\_

Ik zal deelnemen aan het symposium | Je prendrai part au colloque:

- 21 januari | janvier 2002  
 22 januari | janvier 2002

Datum | Date \_\_\_\_\_

Handtekening | Signature \_\_\_\_\_

Inschrijvingsformulier terugsturen of faxen voor 10 januari 2002 naar mevr. A. Depauw (Fax: 02 230 59 12)

Formulaire à renvoyer ou faxer au plus tard pour le 10 janvier 2002 à l'attention de Mme. A. Depauw (Fax: 02 230 59 12)

21 / 01 / 2002

## De strategische onderzoeksprojecten Projets de recherche stratégique

08.45 Onthaal | Accueil

09.15 Verwelkoming | Mot de bienvenue  
ir. E. Beka, Secretaris-generaal van de DWTC  
Ir. E. Beka, Secrétaire général des SSTC

09.30 Biogeochemie van nutriënten, metalen en organische micropolluenten in de Noordzee  
Prof. R. Van Grieken, Universiteit Antwerpen  
Biogéochimie des nutriments, des métaux et des micropolluants organiques dans la mer du Nord  
Prof. R. Van Grieken, Universiteit Antwerpen

10.20 De invloed van zware metalen en polychloorbifenylen geassocieerd aan sedimenten op organismen in de Noordzee  
Prof. Ph. Dubois, Université Libre de Bruxelles  
Impact des métaux lourds et des biphenyles polychlorés associés aux sédiments sur les organismes de la mer du Nord  
Prof. Ph. Dubois, Université Libre de Bruxelles

11.10 Koffiepauze | Pause café

11.40 De zeevogels en zeezoogdieren van de Noordzee: pathologie en ecotoxicologie  
Prof. J.-M. Bouqueneau, Université de Liège  
Les oiseaux et les mammifères marins de la mer du Nord: pathologie et écotoxicologie  
Prof. J.-M. Bouqueneau, Université de Liège

12.30 Lunch

13.30 De structurele en functionele biodiversiteit van de Noordzee-ecosystemen  
Prof. M. Vincx, Universiteit Gent  
Biodiversité structurelle et fonctionnelle des écosystèmes de la mer du Nord  
Prof. M. Vincx, Universiteit Gent

14.20 Eutrofiëring en de structuur van het planktonisch trofisch netwerk in kustzones: mechanismen en modellering  
Prof. C. Lancelot, Université Libre de Bruxelles  
Eutrophisation et structuration du réseau trophique planctonique côtier: mécanismes et modélisation  
Prof. C. Lancelot, Université Libre de Bruxelles

15.10 Koffiepauze | Pause café

15.40 Beoordeling van mariene degradatie in de Noordzee en voorstellen voor een duurzaam beheer  
Prof. F. Maes, Universiteit Gent  
Evaluation de la dégradation marine dans la Mer du Nord et propositions pour la gestion durable  
Prof. F. Maes, Universiteit Gent

16.30 Geïntegreerd en dynamisch beheer van oceanografische gegevens  
Dr. ir. G. Pichot, Koninklijk Belgisch Instituut voor Natuurwetenschappen, BMM  
Gestion intégrée et dynamique des données océanographiques  
Dr. Ir. G. Pichot, Institut royal des Sciences naturelles de Belgique, UGMM

22 / 01 / 2002

## De gerichte wetenschappelijke acties Actions de recherche ponctuelles

08.45 Onthaal | Accueil

09.15 Verwelkoming | Mot de bienvenue  
Mevr. N. Henry, Hoofd van de dienst Onderzoekprogramma's, DWTC  
Mme N. Henry, Chef du service des Programmes de recherche, SSTC

09.30 Evaluatie van de kwaliteit van tarbotpootvis op het herstockingssucces in de Noordzee  
Prof. P. Sorgeloos, Universiteit Gent  
Evaluation de l'influence de la qualité des alevins de turbot sur les chances de restockage dans la mer du Nord  
Prof. P. Sorgeloos, Universiteit Gent

09.55 Ontwikkeling van analysemethoden voor koolwaterstoffen en organische micropolluenten in het marien milieu  
Prof. E. De Pauw, Université de Liège  
Développement de méthodes d'analyse des hydrocarbures et micro-polluants organiques dans le milieu marin  
Prof. E. De Pauw, Université de Liège

10.20 Monitoring van vluchtige organische verbindingen in mariene organismen: analyse, kwaliteitsborging en haalbaarheid  
Dr. ir. R. Declerck, CLO-Gent, Departement voor Zeevisserij  
Monitoring des composés organiques volatiles dans les organismes marins: analyse, garanties de qualité et faisabilité  
Dr. Ir. R. Declerck, CLO-Gent, Departement voor Zeevisserij

10.45 Koffiepauze | Pause café

11.15 Evaluatie van de chemische verontreiniging van de Noordzee en schatting van de pollutie afkomstig van het land  
Prof. W. Baeyens, Vrije Universiteit Brussel  
Evaluation de la contamination chimique de la mer du Nord et estimation de la pollution terrigène  
Prof. W. Baeyens, Vrije Universiteit Brussel

11.40 Identificatie van mariene zones aangetast door eutrofiëring  
Prof. C. Lancelot, Université Libre de Bruxelles  
Identification des zones maritimes affectées par l'eutrophisation  
Prof. C. Lancelot, Université Libre de Bruxelles

12.05 Evaluatie van de impact van endocrien verstorende stoffen op het Noordzee-ecosysteem  
Prof. C. Janssen, Universiteit Gent  
Evaluation de l'impact possible des disrupteurs endocriniens sur l'écosystème de la mer du Nord  
Prof. C. Janssen, Universiteit Gent

12.30 Lunch

13.30 Evaluatie van de "Paardenmarkt" site  
Prof. J.-P. Henriët, Universiteit Gent  
Evaluation du site "Paardenmarkt"  
Prof. J.-P. Henriët, Universiteit Gent

13.55 De collectie Gustave Gilson als historisch referentiekader voor de Belgische mariene fauna: een haalbaarheidsstudie  
Dr. J. Van Goethem, Koninklijk Belgisch Instituut voor Natuurwetenschappen  
La collection Gustave Gilson comme cadre de référence pour la faune marine belge: une étude de faisabilité  
Dr. J. Van Goethem, Institut royal des Sciences naturelles de Belgique

14.20 Intensieve opvolging van een beschermd benthisch habitat  
Prof. M. Vincx, Universiteit Gent  
Suivi intensif de l'évolution d'un habitat benthique protégé  
Prof. M. Vincx, Universiteit Gent

14.45 Koffiepauze | Pause café

15.15 Onderzoek van natuurlijke zandtransporten op het Belgisch Continentaal Plat  
Dr. J. Lanckneus, Studiebureau MAGELAS  
Etude des transports de sable naturels sur le plateau continental belge  
Dr. J. Lanckneus, Bureau d'étude MAGELAS

15.40 Ronde tafel  
evaluatie van het Noordzeeprogramma:  
voorlopige resultaten

Table ronde: évaluation du programme mer du Nord; résultats préliminaires

16.40 Slotwoord  
Dhr. Y. Ylief, Regeringscommissaris toegevoegd aan de Minister van Wetenschappelijk Onderzoek  
Mot de clôture  
M. Y. Ylief, Commissaire du Gouvernement adjoint au Ministre de la Recherche scientifique

17.10 Receptie | Réception

Le programme « Gestion durable de la mer du Nord » a été approuvé par le Conseil des Ministres en 1996 en tant qu'une partie du premier « Plan d'appui scientifique à une politique de développement durable – PADD I ». Environ 410 MFB a été mis à la disposition de la communauté scientifique marine en Belgique durant la période 1997-2001.

Le Programme avait comme objectif de consolider et de continuer à développer l'expertise existante en Belgique en matière d'écosystème de la mer du Nord, afin de développer une base scientifique solide sur laquelle le Gouvernement fédéral puisse s'appuyer lors de la préparation et de l'exécution de sa politique pour la gestion durable de la mer du Nord en de ses ressources naturelles.

Dans ce contexte deux types d'actions ont été financées :

Via les actions de recherche stratégique une recherche thématique a été effectuée pendant 5 années par des réseaux multidisciplinaires. La recherche devait, entre autres, permettre une meilleure compréhension de la structure et du fonctionnement de l'écosystème de la mer du Nord, une meilleure connaissance de l'impact des activités humaines sur l'écosystème et de ses conséquences socio-économiques, ainsi que le développement d'un système d'information pour les différents acteurs concernés. Ce type de recherche est dirigée vers la réduction des incertitudes et jette les bases scientifiques pour l'appui à une politique à long terme du gouvernement.

Au moyen des actions scientifiques ponctuelles, des projets d'une durée limitée ( maximum 2 ans ) ont été financés autour de différents thèmes qui étaient considérés comme pertinent pour une politique à court terme du gouvernement.

Les résultats de la recherche stratégique et des actions ponctuelles seront présentés lors des journées d'étude.

Ces journées d'étude s'adressent à la communauté scientifique marine, les représentants des administrations concernées par la gestion durable de la mer du Nord et toute personne intéressée par cette problématique.

## Praktische inlichtingen

### Informations pratiques

#### Plaats | Lieu :

Paleis voor congressen,  
Ingang nr. 2 Arcaden  
Beneluxzaal, Kunstberg,  
B-1000 Brussel

Palais des Congrès,  
Entrée n°2 Arcades  
salle Benelux, Mont des Arts  
B-1000 Bruxelles

<http://www.palcobru.be>

#### Openbaar vervoer | Transport public:

Centraal station (5 min)  
Gare centrale (5 min)

Parking "Albertina"  
(Toegang via de Stuiverstraat)  
(Accès rue des Sols)

#### Simultaanvertaling | Traduction simultanée: F - N - E

#### Inschrijving | Inscription:

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Het programma "Duurzaam beheer van de Noordzee" werd in 1996 door de Ministerraad goedgekeurd als een onderdeel van het eerste Plan voor wetenschappelijke ondersteuning van een beleid inzake duurzame ontwikkeling - PODO I". Op deze wijze werd ongeveer 410 MBF ter beschikking gesteld van de mariene onderzoeksgemeenschap in België gedurende de periode 1997 - 2001.

Het Programma had tot doel om de in België bestaande expertise inzake het Noordzee-ecosysteem te bestendigen en verder uit te bouwen, teneinde een solide wetenschappelijke basis te ontwikkelen waarop de Federale overheid kan steunen bij voorbereiding en uitvoering van haar beleid inzake het duurzaam beheer van de Noordzee en haar natuurlijke rijkdommen.

In deze context werden twee types van acties gefinancierd:

Via de strategische wetenschappelijke acties werd gedurende een periode van vijf jaar thematisch onderzoek uitgevoerd door multidisciplinaire netwerken. Het onderzoek moest onder andere leiden tot een beter begrip van de structuur en de werking van het Noordzee-ecosysteem, een betere kennis van de invloed van de menselijke activiteiten op het ecosysteem en de ermee gepaard gaande socio-economische gevolgen en de ontwikkeling van een informatiesysteem ten behoeve van de verschillende betrokken actoren. Dit type van onderzoek is gericht op de vermindering van onzekerheden en legt de wetenschappelijke basis ter ondersteuning van het langetermijnbeleid van de overheid.

Door middel van de gerichte wetenschappelijke acties werden projecten van beperkte duur (maximum 2 jaar) gefinancierd rond verscheidene thema's die relevant werden beschouwd voor het kortetermijnbeleid van de overheid.

Tijdens de studiedagen zullen de resultaten van zowel het strategische onderzoek als de gerichte acties worden voorgesteld.

Deze studiedagen richten zich naar de mariene onderzoeksgemeenschap, de vertegenwoordigers van de overheidsbesturen die betrokken zijn bij het duurzaam beheer van de Noordzee en eenieder die interesse heeft in deze problematiek.

## Duurzaam beheer van de Noordzee

PRESENTATIE VAN DE ONDERZOEKSRÉSULTATEN

## Gestion durable de la mer du Nord

PRÉSENTATION DES RÉSULTATS DE LA RECHERCHE

21 > 22 / 01 / 2002

# BRIEF BACKGROUND ON BELGIAN MARINE RESEARCH

## BEFORE 1970

The interest of Belgian researchers in marine science dates back a long way.

As early as 1842, Pierre Joseph Van Beneden, a Professor at the Catholic University of Louvain, set up a rudimentary laboratory in Ostend to study marine biology. It is recognised as the first in the field in Belgium.

At the University of Liège, Professor Edouard Van Beneden pioneered research in marine science. He also established a laboratory in Ostend.

At the University of Brussels, Paul Pelseneer was one of the first to offer a regular course in marine biology; he was also an internationally renowned authority on molluscs.

On the initiative of Gustave Gilson, successor of Pierre Joseph Van Beneden, the "First International Conference on the Ocean" was held in Ostend in 1926. A year later the "Zeewetenschappelijk Instituut" (ZWI - Institute for Marine Science) was founded. Over a period of more than 30 years, the Institute's main focus was the science and statistics of fisheries. From the early 60's on, its task was taken over by the "Rijksstation voor Zeevisserij" (Public Station for Sea Fishing) of the Ministry of Agriculture.

In the same period, Ghent University and the Royal Institute for Natural Science began research related to the ocean.

At that time, the research was mainly descriptive, and cooperation between research teams and interdisciplinary work were rare.

## 1970 - 1976

At the end of 1970 the Belgian Government, under the influence of the European Economic Community, took the initiative of starting a national "Environment/Water" research programme, of which the "Sea" project was a part.

The "Sea" project was the first major programme in marine science in Belgium. Its purpose was to "assemble a reliable scientific basis and develop modelling techniques to permit both qualitative and quantitative simulation of the impact of natural phenomena or anthropic effects".

The programme had a very marked interdisciplinary character. Physicists, chemists, biologists, and geologists all cooperated in a study of the marine ecosystem. From 1971 to 1976, about 200 researchers from 40 different university laboratories and scientific institutes worked together on the programme. For 5 years, samples were collected within a network of 25 marine stations, at a frequency of 4 to 6 campaigns a year. The results were collated in a range of mathematical models developed over the period.

In 1976 under the aegis of the Ministry of Public Health and the Environment, a unit was installed to manage the mathematical model of the North Sea and Scheldt estuary (MUMM, the Management Unit of the Mathematical Model of the North Sea). The unit's mission was to exploit in policy decision making the scientific results achieved by the "Sea" project. At this moment the MUMM is the sixth department of the Belgian Royal Institute of Natural Science.

## 1977 - 1992

The "Sea" Project was followed by two coordinated actions in marine science.

From 1976 to 1981, a coordinated "Oceanology" action and from 1982 to 1990, the coordinated interuniversity "North Sea" action. These research actions which, unlike the "Sea" project, had no central coordination system, promoted sustained research in a number of laboratories and facilitated the expansion and improvement of results already achieved.

It then became evident that Belgium needed a special marine research vessel. Up to that point, all research and monitoring activities had depended upon the availability of the infrastructure of the Navy. Consequently, Belgium commissioned the *A 962 Belgica*.

Meanwhile, two organisations were established to reinforce the inter-team and inter-disciplinary interactions already made possible in the "Sea" project and coordinated research actions. These organisations were, in the Dutch-speaking part of the country, the "Instituut voor Zeewetenschappelijk Onderzoek" (IZWO - Institute for Research in Marine Science), founded in 1970, and in French-speaking Belgium, the "Institut de Recherches Marines et d'Interactions Air-Mer (IRMA - Institute for Marine Research and Air-Sea Interactions), founded in 1980.

The 80's were distinguished by the growing interest of the European Community in the environment in general and the sea in particular. This took the form of increased budgets at EC level for research in the field and greater use of such resources by Belgian researchers.

## 1992 - THE PRESENT

In July 1990, the Council of Ministers approved support to and implementation of a programme designed to encourage work in Marine Science.

The objective of the programme was to give several research groups a renewed stimulus to lay the groundwork for better understanding of the marine environment and the natural and human factors that influence it. The programme aimed to contribute to international research efforts regarding the protection and sustainable use of the North Sea and Scheldt estuary and to assist the process of policy decision making at national level.

The programme enabled 18 research teams working on 12 projects to conduct research from September 1992 to December 1996.

The expertise developed in the "Marine Sciences" programme is now used under a new programme, initiated in January 1997 in the framework of the "Plan for Scientific Support for a Policy of Sustainable Development". In the context of the "International Conferences on the Protection of the North Sea" and with a view to cooperating with other North Sea coastal states, this programme aims to contribute to the management and sustainable development of the North Sea and its natural resources. All possible attention will be given to protecting the marine environment and evaluating the dangers that threaten it.





# THE PROGRAMME "SUSTAINABLE MANAGEMENT OF THE NORTH SEA"

## CONTEXT

To exploit and sustainably develop the North Sea and all its natural resources while preserving the marine environment and accurately assessing the dangers that threaten it, it is necessary to describe the system's present situation and to assess future developments. There are still significant gaps in our present knowledge which prevent sustainable management and limit our ability to predict and evaluate possible changes in the environment. Systematic gathering and analysis of marine environmental data will enable us to foresee the consequences of changes caused by man in the marine biota and environment.

In the "Marine Sciences" programme (1992-1996), the foundation was laid for acquiring the expertise needed to better understand the marine environment. The programme "Sustainable Management of the North Sea" in the "Plan for Scientific Support for a Policy of Sustainable Development" represents an effort to explore this knowledge in depth and use it to contribute, in cooperation with other countries of the North Sea basin, to a plan for its sustainable management and for conservation of its natural resources. This will involve two types of scientific activity.

To explore the complex nature of the phenomena that govern and influence the marine environment, longer-term and more basic research is essential. Current basic knowledge is not yet adequate to enable us to understand the various phenomena occurring in the North Sea environment, given their complex and interdisciplinary nature. **Strategic scientific research** would on the one hand help to reinforce and optimally exploit the available scientific expertise, and on the other hand facilitate creation of new centres of expertise. To this end, the programme aims to bring scientific teams together to work in multidisciplinary networks on projects in chosen subject areas, the common goal being to establish a solid foundation on which Federal authorities can base implementation of long-term policies for the sustainable exploitation of the North Sea and its natural resources.

**Targeted scientific actions** are the most appropriate way to enable authorities to formulate a timely answer, based on scientific data, to urgent questions of national and international policy regarding the task of monitoring the North Sea and its natural resources. These actions involve short-term research, restricted in scope and primarily of an applied nature. The research can deal with biological, physical, and chemical aspects or socioeconomic and legal issues.

# OBJECTIVES

To construct a sustainable plan for the management of the North Sea and its natural resources, the authorities need:

- a better understanding of the structure and functioning of the North Sea ecosystem;
- a better understanding of the impact of human activities on the North Sea ecosystem:
  - to gain a better objective understanding of the notion of "how the North Sea can be sustainably exploited to ensure that those living on its banks can maintain a high standard of living";
  - to gain a better understanding of the socioeconomic consequences accompanying the negative impact of human activities on the North Sea ecosystem;
  - to translate properly founded scientific information and opinions from the research community into a policy designed to establish the most favourable balance possible between the various forms of exploitation of the North Sea, and to inform the public.

Apart from these scientific objectives, the goal of the programme is to enable teams of Belgian scientists having acquired expertise in the field to maintain or strengthen their international standing and to offer new teams an opportunity to demonstrate their ability to become qualified for marine research. It will also enable the scientific community to constantly track down new fields of investigation and establish a basis for new forms of expertise.

## IMPLEMENTATION

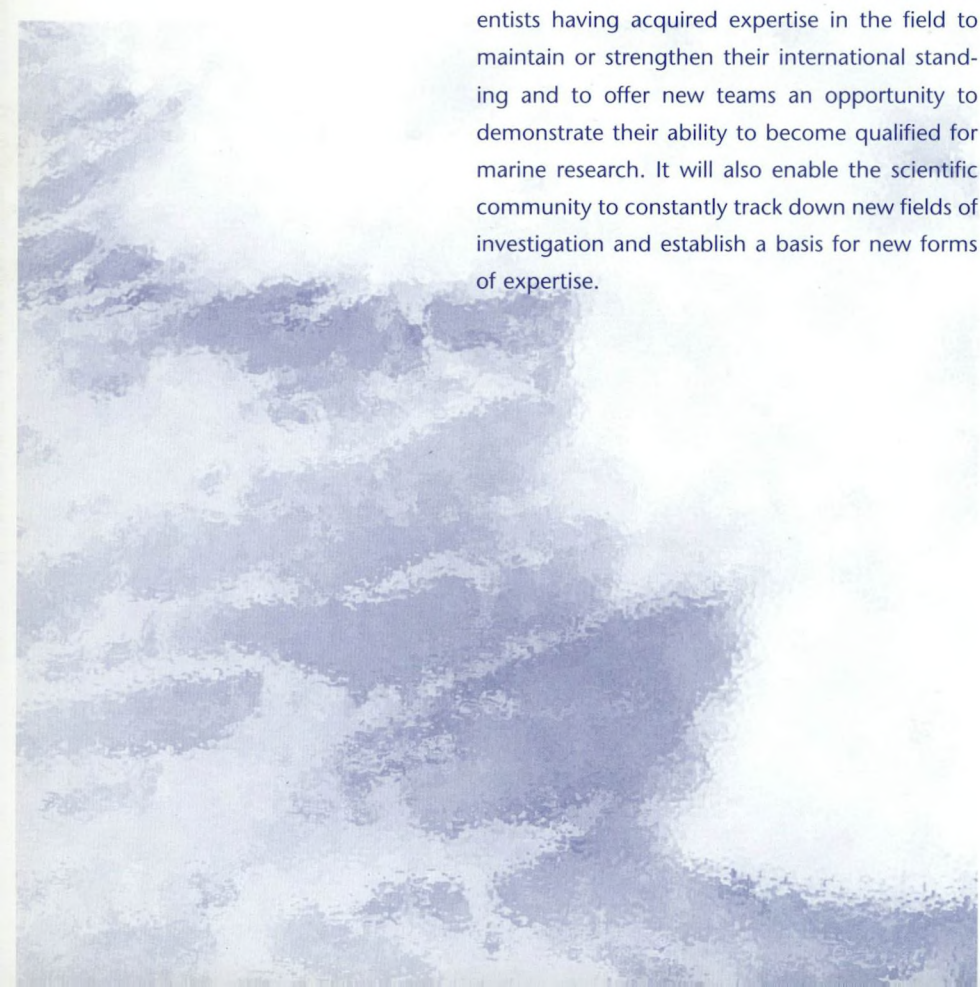
▪ The programme began on 1 January 1997 and will end on 31 December 2002. It continues the "Marine Sciences" programme (1 October 1992 - 31 December 1996).

### ▪ **Strategic scientific research:**

- on the basis of selected proposals, multidisciplinary subject area networks will be developed:
- two calls for proposals were published: one for all scientific fields, socioeconomic and legal subjects excluded. These projects were to start on 1 January 1997 with a maximum duration of five years;
- one for the socioeconomic and legal fields, with projects starting in 1998 with a maximum duration of four years.

▪ **Targeted scientific actions:** to enable public authorities to formulate answers to urgent policy questions quickly and consistently, a call for proposals is published every two years. Activities will start in 1998, 1999, and 2001.

▪ The programme has a budget of 407.6 million BEF and employs about 40 individuals with scientific training. The employment offered amounts to 160 man-years.



## SUMMARY OF THE SCIENTIFIC CONTENT

### STRATEGIC SCIENTIFIC RESEARCH

This aspect of the programme is intended to facilitate bringing together the various research units from the various disciplines and to enable them to probe in greater depth the complex problems pertaining to the marine environment.

The main guidelines for strategic research are as follows:

#### Eutrophication

- Where, how, and with what consequences does nutrient concentration or inflow generated by human activity produce a change in the frequency, duration, or size of planktonic algal blooms?
- How and to what extent are marine ecosystems (zooplankton, benthos, and higher trophic levels) disturbed by the increased presence of algae, by changes in algal constituents, or by the possible presence of toxic algae?

#### Chemical pollution

- What are the sources, flows, and destinations of inorganic and organic marine pollutants?
- Do the increase and presence of such pollutants in the sea influence marine life?

#### Protection of species and their habitat

- What is the spatial and temporal distribution of ecologically important species, of species playing a key role as biodiversity indicators, of species that are threatened, endangered, or on the brink of becoming so? What is the relationship between their various types of habitat in the coastal zone and high seas?
- How do human activities influence the composition (biodiversity) and density of these species and the sustainability of their various kinds of habitat?

#### Sustainable exploitation of the sea

- How can one determine the state of health of the sea so as to determine the impact of human activities?
- What is the socioeconomic cost of deterioration of the marine environment?
- What are the risks from accidental spills of petroleum and other chemicals in the environment?

#### Setting up a data bank with data series

In order to identify which way the health of the North Sea is moving and to evaluate new mathematical models, it is essential to have series of data collected over a long period. Several Belgian research teams already possess some such data.

To facilitate bringing together the fragmentary available data dispersed among the research teams, we need to evaluate the quality of these data and group them in a homogeneous manner in a central Belgian data bank. The bank will be responsible for optimal dissemination of the data to the subject-area networks and for answering external requests. As for the subject-area network teams, they should supply to the bank the information they possess, quickly and in a structured manner.

#### TARGETED SCIENTIFIC ACTIONS

Belgium will have to justify its international policy towards the North Sea, chiefly in the framework of the "International Conferences on the Protection of the North Sea". Consequently, targeted scientific actions will be dictated mainly by the problems arising when the Quality Status Report on the North Sea is prepared. The Report will be drawn up jointly by the various North Sea coastal States for the next Conference of Ministers in the year 2000.

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# LIST OF PROJECTS

## STRATEGIC SCIENTIFIC RESEARCH

### 1 THE BIOGEOCHEMISTRY OF NUTRIENTS, METALS AND ORGANIC MICROPOLLUTANTS IN THE NORTH SEA

Professor R. Van Grieken (UA/UIA)  
Professor W. Baeyens (VUB)  
Professor Dr. Ir. H. Van Langenhove (RUG)  
Professor R. Wollast (ULB)

### 2 AMORE: ADVANCED MODELLING AND RESEARCH ON EUTROPHICATION

Dr. C. Lancelot (ULB)  
Professor M.-H. Daro (VUB)  
Dr. G. Pichot (MUMM)

### 3 ICAS: THE IMPACT ON NORTH SEA ORGANISMS OF POLLUTANTS ASSOCIATED WITH SEDIMENTS

Dr. Ph. Dubois (ULB)  
Professor M. Jangoux (UMH)  
Professor R. Flammang (UMH)

### 4 THE STRUCTURAL AND FUNCTIONAL BIODIVERSITY OF NORTH SEA ECOSYSTEMS: SPECIES AND THEIR HABITATS AS INDICATORS FOR THE SUSTAINABLE MANAGEMENT OF THE BELGIAN COASTAL SHELF

Professor Dr. M. Vincx (RUG)  
Professor Dr. E. Kuijken (IN)  
Professor F. Ollevier (KUL)

### 5 NORTH SEA SEABIRDS AND MARINE MAMMALS: PATHOLOGY AND ECOTOXICOLOGY

Professor J.-M. Bouqueneau (ULg)  
Professor F. Coignoul (ULg)  
Professor C. Joiris (VUB)  
Professor Dr. E. Kuijken (IN)

### 6 IDOD: INTEGRATED AND DYNAMICAL OCEANOGRAPHIC DATA MANAGEMENT

Dr. Ir. G. Pichot (MUMM)  
Professor J.-P. Donnay (ULg)  
Dr. J. Van Dyck (KUL)

### 7 MARE-DASM: MARINE RESOURCES DAMAGE ASSESSMENT AND SUSTAINABLE MANAGEMENT OF THE NORTH SEA

Professor F. Maes (RUG)  
Professor H. Bocken (RUG)  
Professor C. Janssen (RUG)  
Dr. G. Pichot (MUMM)

## TARGETED SCIENTIFIC ACTIONS

### 1 QUALITY STATUS AND TERRESTRIAL INPUTS FOR THE NORTH SEA

Professor Bayens W. (VUB)  
Professor R. Van Grieken (UA/UIA)  
Dr. Vanderborcht J.P. (ULB)  
Professor Wollast R. (ULB)

### 2 ED-NORTH: EVALUATION OF POSSIBLE IMPACTS OF ENDOCRINE DISRUPTORS ON THE NORTH SEA ECOSYSTEM

Professor C. Janssen (RUG)  
Professor F. Comhaire (RUG)

### 3 DEVELOPMENT OF METHODS FOR ANALYSING HYDROCARBONS AND ORGANIC MICROPOLLUTANTS IN A MARINE ENVIRONMENT

Professor Dr. E. Depauw (ULg)

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

Professor dr. R. Declerck (CLO-Dep. Zeevisserij)

### 5 EVALUATION OF THE QUALITY OF TURBOT FRY ON RESTOCKING SUCCESS IN THE NORTH SEA

Professor P. Sorgeloos (RUG)

### 6 EVALUATION OF "THE PAARDENMARKT" SITE

Professor J.P. Henriet (RUG)

### 7 INTENSIVE MONITORING OF THE EVALUATION OF A PROTECTED BENTHIC HABITAT (HABITAT)

Professor M. Vincx (RUG)  
Professor P. Jacobs (RUG)

### 8 RESEARCH ON NATURAL SAND TRANSPORTS ON THE BELGIAN CONTINENTAL SHELF: BUDGET

Dr. J. Lanckneus (MAGELAS)  
Professor M. De Batist (RUG)

### 9 IDENTIFICATION OF MARINE ZONES AFFECTED BY EUTROPHICATION (IZEUT)

Dr. C. Lancelot (ULB)

## SPECIAL ACTIVITY

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

Dr. J. Van Goethem (KBIN-IRSNB)

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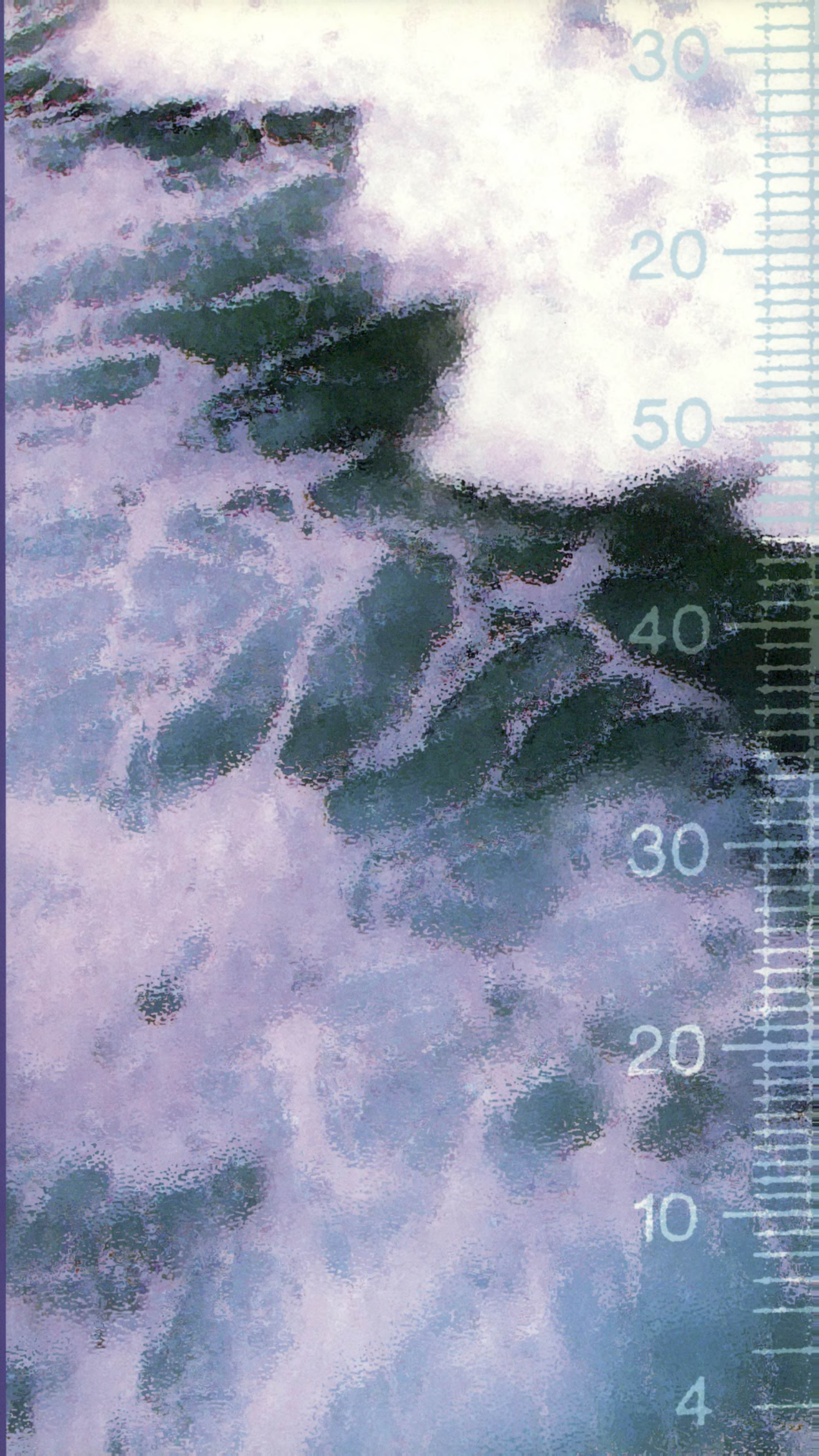
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# THE BIOGEOCHEMISTRY OF NUTRIENTS, METALS AND ORGANIC MICROPOLLUTANTS IN THE NORTH SEA

There can be no doubt that men and their activities have weighed heavily on coastal areas in the last fifty years. In some respects, the situation may even continue to deteriorate which will further reduce their attraction. The discharge of waste, their carriage by the Scheldt and the deposit of atmospheric pollutants all constitute threats. There is, on the one hand, increasing eutrophication and a proliferation of algae resulting from the increased carriage by

water of nitrogen and phosphorus and, on the other, the threat that the life of animals and plants will be reduced by contamination by heavy metals and micropollutants. The so-called "red tides", the dramatic proliferation of certain colonies of algae and mercury and cadmium pollution are already universally recognised. The purpose of this research project is to examine the principle means by which pollutants are carried to the North Sea and to track them once they reach it.

## THE PROJECT

**The atmosphere** Atmospheric flows of certain toxic metals, polychlorobiphenyls, polycyclic aromatic hydrocarbons and pesticides have already been studied for some time. However, with other significant groups of inorganic and organic pollutants and data on the interaction between the air and the sea currently either do not exist or else are unreliable. Everybody realises that atmospheric transport to the oceans is one of the principal sources of nutrients on a world-wide scale (such as nitrogen and bioavailable trace elements of which silicium is one) which play a vital part in primary production. Extremely high levels of deposit can have a profound effect on the ecosystem of the North Sea and, locally, in certain atmospheric conditions, produce excesses of algae. So far, no one has given it any thought in mathematical models. Consequently detailed and reliable data on the quantities of the main nutrients deposited by the atmosphere have to be gathered. This will involve monitoring based on location, season and the origins of the atmospheric mass above the North Sea.

A very significant part of organic contaminants is Volatile Organic Compounds (VOC), a large group of chemically different substances which have multiple and diverse effects. VOC affect atmospheric processes, some types are carcinogenic, others are persistent and have the effect of causing bioaccumulation. Nine types of VOC, all of them chlorinated, have been included in the list of the 36 priority toxic pollutants presented at the Third Conference on the North Sea. Consequently there will have to be research into their sources, concentrations

and flows in the marine environment. A first monitoring campaign has shown that the Scheldt is a significant source of VOC in the marine environment. As regards these composites, it seems that there is a flow from the water into the air with the various places located in the centre of the continental plateau. On the occasion of outbreaks of algae, high concentrations of certain hydrocarbons were measured. Whatever causal relationship may exist between the proliferation of algae, increased concentrations and air/sea flows will have to be studied.

Where heavy metals are concerned, the level of atmospheric pollution above the North Sea seemed to rise when the wind was from the Southeast, for example, from Belgium. Airborne deposits of cadmium and lead equal those from rivers or direct outflows of industrial waste and wastewater. Quantities of zinc and lead, unlike other elements, seem to be decreasing. The great variations in concentrations and deposits have required taking a large series of measurements in order to establish reliable and accurate averages.

Another significant observation is that the main differences in the flow of deposits modelled and those measured are caused by particles which are relatively among the largest (>4µm) which are responsible for from 85 to 99% of dry deposits. Such particles settle rapidly and do not fly far. Since virtually all of the North Sea is close to their continental sources, special attention is paid to such particles in the project.

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## The aquatic phase

As regards the aquatic phase in the North Sea, the research is intended, within the general context of the problems involved in eutrophication, to give a qualitative and quantitative description of how nitrogen is absorbed. This is determined by (1) the availability of nutrients, (2) the relationships between the various nutrients (covering, among others, those between nitrogen and phosphorus and nitrogen and silicates) and the various forms of nitrogen and (3) species of phytoplankton.

The description will have to be drawn from the study of two aspects: (1) the sequestration of carbon through primary productivity, and, (2) the quality aspect underlying the food chain in the form of the relationships between the different types of plankton (diatom and non-diatom).

The study of trace elements in the water, both those which are essential and those which are toxic, will focus on their

bioavailability and the biogeochemical cycles. This will include rates of adsorption, assimilation and chemical speciation. Such studies of speciation in the waters of the North Sea are of crucial importance in gaining a better understanding of transport mechanisms and conversion and the contrast between bioavailability and toxicity. The study will concentrate chiefly on parasite elements such as mercury and cadmium and on those which are essential such as iron and manganese.

Additionally, a number of volatile organic compounds will be measured in water and sediment of the North Sea and the Scheldt estuary. Also, possible natural production of certain VOC in sediment will be studied.

## THE PARTNERS

Thanks to the experience acquired in the course of the Impulse Programme Marine Sciences of the OSTC, the Centre for Analysis of Micro- and Trace Elements at UIA (Universitaire Instelling Antwerpen, Professor R. Van Grieken) and the Laboratory for Organic Chemistry of the University of Ghent (Professor H. Van Langenhove), the focus in the project will be on research into air/sea flows of certain new organic composites (UG) and nutrients (UIA) and refining our quantitative understanding of the behaviour of heavy metals (UIA) by reducing uncertainties and studying speciation in atmospheric transport.

The contribution of the Laboratory for Analytical Chemistry of VUB (the Flemish Free University of Brussels, VUB, Prof. W. BAEYENS), consists of analyzing the distribution of nutrients, the relocation of nitrogen and the dissemination of trace elements such as aluminium, iron, manganese, copper, zinc, nickel, cadmium and lead, with particular attention to the dissolved phase, the mechanisms and the kinetics of trace elements using stable

isotopes. Special attention will also be paid to mercury in the air and in water. The main objective of the contribution of the Chemical Oceanography Laboratory (Prof. R. Wollast) of the U.L.B. (French-speaking Free University of Brussels) is to gain a better understanding of the biogeochemical behaviour of trace metals such as manganese, copper, zinc, nickel, cadmium and lead.

To achieve this aim, attempts have to be made to better define the speciation of the particulate trace metals and the physico-chemical properties of the suspended matter.

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**Coordinator**

The UIA group is a unit of MiTAC (Micro- and Trace Analysis Center), which is a consortium of three research groups, involving some 80 scientists. The aim is to develop micro- and trace analysis methodologies and to apply these to relevant environmental problems. In MiTAC the research group of Prof. Dr. R. Van Grieken has a long experience in developing and applying various micro- and trace analytical techniques suitable for environmental research. The group of the coordinator is involved in many scientific programs.

Relevant recent projects, concerning the North Sea, were the EU Environment Project ACE (Aerosol Characterisation Experiment) (1996-1998), EU Environment Project on the Effect of Marine Aerosols on Historical Buildings (1996-1999), Impulse Programme on Marine Sciences, Belgian OSTC (1992-1996) and EUROTRAC Programme ASE (Air Sea Exchange) through OSTC (1990-1993). In the framework of the above projects, collaboration exists or has recently existed with a number of research teams.

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The major research activities of the Laboratory of Analytical Chemistry and Geochemistry are related to studies of the biogeochemical cycling of nutrients, major elements and trace metals in the sea including the interfaces air/sea and sea/bottom and the development of analytical tools required for the study of those cycles. During the past 20 years this Laboratory participated in a number of national and international programs and field experiments. The participation to international field experiments such as

FLEX-JONSDAP in the North Sea (1976); MEDETNA, PHYCEMED and ALBORAN in the Mediterranean Sea (1980 & 1981); ANTARES, EPOS in Antarctic waters (1988-1996); Lake Baikal (1990-1992); JGOFS (1989-1991); OMEX (1993-1996); the North Sea and the Scheldt estuary were frequently studied in collaboration with national and foreign colleagues

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The research of the Environmental Chemistry and Technology group of the Faculty of Agricultural and Applied Biological Sciences of the University of Ghent is focused on volatile organic compounds. The Laboratory is working on the environmental fate and behaviour of VOC, next to the study on chemical and biological abatement techniques for these compounds. A necessary prerequisite is that high performant analytical methods to measure these compounds at the environmental concentration levels are developed, with paying special attention to

include quality assurance protocols. Specifically to the marine science research, a first research programme, i.e. in the Impulse Programme Marine Sciences 1992-1996 of the Federal Belgian Government was carried out, investigating the presence of VOC in the North Sea environment. The research has been continued with a new project : "Biogeochemistry of nutrients, metals, and organic micropollutants at the North Sea."

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The Laboratory of Chemical Oceanography of the Université Libre de Bruxelles (ULB) has an international and pluridisciplinary dimension and is specialized, among others, in the study of chemical and biological processes influencing the transfer of trace elements from the dissolved to the particulate phase. In addition to its collaboration to the "Sustainable management of the North Sea", the laboratory takes part in several international programs. The laboratory acts as coordinator of the project OMEX (Ocean Margin

Exchanges), for which the studies are focussed on the ocean margins and the typical processes occurring in these regions. It is also involved in BIOGEST, where the biogases (CO<sub>2</sub>, CH<sub>4</sub>,...) and their air-water exchanges are studied in 9 European estuaries. All these programs imply the determination of many parameters: contents in nutrients, dissolved and particulate carbon-nitrogen-phosphorus, metals; uptake rates of radioisotopes: <sup>60</sup>Co, <sup>54</sup>Mn, <sup>109</sup>Cd, <sup>65</sup>Zn, <sup>59</sup>Fe, <sup>32</sup>P, <sup>14</sup>C.



# AMORE – ADVANCED MODELLING AND RESEARCH ON EUTROPHICATION

The coastal waters of the Southern Bight of the North Sea receive large quantities of nutrients of anthropogenic origin via rivers and the atmosphere. Eutrophication is apparent in the coastal zone in the form of undesirable qualitative changes in the structure and functioning of the planktonic ecosystem, and can be observed in the form of occasional accumulation of foul-smelling foam on beaches. Guaranteeing sustainable North Sea resources for future generations and protecting the quality of coastal waters is now both a national and an international

concern. National and international regulations on sewage treatment facilities and farming practices aiming at the reduction of nutrient supply to the coastal sea have already been implemented in the various countries which border the North Sea. However, the scientific knowledge needed for a rational estimate of the reduction required and of the nutrient(s) which have highest priority for reduction (ammonium, nitrates and/or phosphates) is currently lacking.

## THE PROJECT

**The goal** This research project contributes to the implementation of an integrated land-coastal zone research methodology to assess and predict the eutrophication level of the coastal North Sea and the associated undesirable

effects. The ultimate aim is to reduce the current context of uncertainty in which decisions to counteract the eutrophication of the North Sea and protect its natural resources are made.

**The environmental** **Questions involved**  
What is the natural capacity of the coastal North Sea planktonic system to absorb surplus nutrients resulting from human activities in the surrounding river basins ?

What are the relative contributions made by natural processes and human activities to the phenome-non of eutrophication and is there a synergy?

**The methods** • To establish an observational data base of key biogeochemical parameters from which changes in the quality of North Sea coastal waters can be monitored, signs of future deterioration can be rapidly detected and the positive and negative results of new purification regulations can be evaluated.

(meteorological conditions) and/or by anthropogenic factors. The current set of nutrient and phytoplankton monitoring parameters has been extended to secondary trophic levels.

Sampling site selected: station 330, 20 miles offshore of Ostend and subject to the influence of water from the Scheldt. The reference station has been sampled by ULB-GMMA since 1988 under the joint framework of the National Programmes for joint Oceanographic Research Activities and the Impulse in Marine Science and the European Commission's Environment and MAST Programmes (Phaeocystis projects and COMWEB). Results so far indicate that station 330 is sensitive to disturbances induced both by natural changes

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- To improve understanding of the mechanisms which structure coastal trophic networks in response to changes in the input of nutrients.

Two principal questions will be dealt with and studied by conducting process-level studies in natural and laboratory-controlled conditions :

- How does the structure of the phytoplankton community change when the input of nutrients alters?
  - And what are the related changes in the higher trophic levels, particularly zooplankton?
- The knowledge gained will be integrated in a mathematical model resulting from the 'on-line' coupling of a 1km-resolution 2D-hydrodynamic model simulating the dispersal of the waters of the Scheldt in the coastal zone with an upgraded version of the existing mechanistic biogeochemical model MIRO, revised on the basis of knowledge gained in the process-level studies.

MIRO is an ecological model developed by ULB-GMMA which describes the dynamics of *Phaeocystis* colonies blooms in the North Sea coastal zone in response to riverine nutrients loads. Although already operational, the model suffers from weak points as regards the low resolution of hydrodynamic and related resuspension processes and the lack of knowledge of some physiological parameters for which adequate measurement methods are presently lacking. Resolving these uncertainties is MUMM's main task in co-operation with ULB-GMMA and VUB-ECOL.

#### Main deliverables expected

A list of key physico-chemical and biological indicators allowing the rapid diagnosis and prediction of significant trophic changes and their harmful effects. A "Green Book" will be published listing the parameters, how they are measured and the sampling strategy.

A validated mathematical model to be used as a scientific tool for predicting eutrophication phenomena in the Belgian coastal zone and their effects on adjacent zones and to guide decision-making regarding the reduction of the input of nutrients into the sea.

A data bank gathering physico-chemical and biological data recorded at station 330 of the Belgian monitoring network since 1988. This will be used for (i) the long term assessment of trophic changes in the ecosystem, (ii) the validation of the mathematical model and (iii) the evaluation of the effects of present and future water treatment policies.

## THE PARTNERS

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The laboratory for Ecology and Taxonomy (VUB-ECOL) of the free University of Brussels

(Dr. M-H. Daro), specialist in zooplankton dynamics and the evaluation of its trophic influence with 20 years experience.

The Management Unit of the Mathematical Model of the North Sea (MUMM) (Dr. Ir. G. Pichot), specialised in mathematical modelling of marine systems and active in exploiting scientific research to provide support for decision-making.

**Dr. C. Lancelot**  
**Dr. Ir. V. Rousseau**

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**Coordinator**

GMMA, head by Dr C. Lancelot, is an interdisciplinary research unit of the Université Libre de Bruxelles, active since more than 10 years in the study of general aspect of aquatic microbial ecology. It is developing an integrated conceptual methodological approach based on field observations, process-level studies and numerical work, that aims to develop a generic mechanistic biogeochemical model of the planktonic ecosystem based on physiological and geochemical principles. When coupled with hydrodynamical models of appropriate spatio-temporal resolution, such a model can address local, regional

and more global environmental questions. International collaboration of relevance to the AMORE project includes EC research projects on biogeochemical interactions between the Danube river and the north-western Black Sea (EROS-21 funded by the Environment and Climate Programme) and on comparative analysis of food webs (COMWEB funded by the MAST Programme)

**Professor M.-H. Daro**

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**Partner 1**

The plankton group of the Ecology and Systematics Laboratory of the Vrije Universiteit Brussel focusses on interactions between suspended particulate matter and mesozooplankton. Spatio-temporal distributions and trophic processes are studied in estuarine and coastal zones situated in both temperate and tropical regions. International collaboration of relevance to the AMORE project includes research projects on the environmental effects of the Sigma Plan (OMES project in

cooperation with The Netherlands), on comparative analysis of food webs (COMWEB funded by the MAST Programme), on the construction of an interdisciplinary geographic information system (G.I.S.) of the Guayaquil area aiming at the monitoring and modelling of the Guayas estuary and the Estero Salado (INOCAR, Guayaquil, Ecuador) and on causal factors of biodiversity: community structure, phylogeny and biogeography in the scope of a 15-year collaboration with Kenya (KMFRI, Mombasa).

**Dr. K. Ruddick**

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**Partner 2**

MUMM is a federal government scientific institution with activities in marine research, monitoring and management. Research at MUMM focusses on providing the necessary knowledge and tools for scientific management of the North Sea ecosystem based on mathematical modelling (with particular experience in physical oceanography), remote sensing and in situ measurements. International cooperation of relevance to the AMORE project include

research projects on river plume dynamics ("PROFILE"), 3D ecosystem model coupling and dissemination ("COHERENS") and optical remote sensing ("MULTICOLOR") as well as environmental management activities such as participation in the Oslo and Paris conventions for the prevention of marine pollution. Oregon State University (contact Y. Spitz), sub-contactor to MUMM, has particular expertise in adjoint model techniques for ecosystem models.



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# ICAS: THE IMPACT ON NORTH SEA ORGANISMS OF POLLUTANTS ASSOCIATED WITH SEDIMENT

Although releases of persistent pollutants such as heavy metals and polychlorinated biphenyls (PCBs) into European seas are strictly controlled or forbidden, such pollutants continue to represent a threat to numerous marine ecosystems. What has happened is that their low solubility has caused them to associate with sediment which is now a major source of secondary pollution and contributes to the persistence of the initial pollution. In the North Sea, the main areas affected by polluted sediment are the estuaries (the Western Scheldt for example) and the "hot spots" resulting from the direct discharge of residues into the sea.

The information available on the impact of heavy metals and PCBs associated with sediment on marine organisms, particularly benthos, mainly comes from bioassays for toxicity studying the impact of complex non controlled pollution. That makes it impossible to distinguish between the relative toxicity of the various pollutants involved. Further, the species studied are rarely key or dominant species which are representative of the benthic ecosystems of the North Sea. The result is that the principal ecological impact of pollutants associated with sediment is, as yet, mostly unknown.

## THE PROJECT

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**The objectives of the research**

To determine the impact of heavy metals and PCBs associated with sediment on representative species of macrobenthos in the North sea. These include the common starfish, *Asterias rubens* and the sea urchins *Echinocardium cordatum* and *Psammechinus miliaris*.

To use the common starfish to study heavy metal pollution in the North Sea.

## ACTIVITIES

The impact of heavy metals and PCBs associated with sediment will be investigated at several levels of biological organization ranging from biochemistry to ecology (population biology) to cover the broadest possible spectrum of effects. We will, therefore, study the effects on:

- the induction and activity of molecules implied in detoxication of these pollutants;
- the activity of the immune system;
- skeletal growth (an element characteristic of the organisms studied);
- the development and metamorphosis of larvae.

Heavy metal pollutants will be biomonitoring by using the common starfish (the digestive system provides a short term indicator (days or weeks) and the skeleton functions as a long term integrator (months and years)).

The work projected will make it possible to evaluate the risks from heavy metals and PCBs associated with sediment and contribute to compliance with the commitments Belgium has made to various international organizations (international conferences on the protection of the North Sea, the Oslo and Paris Commissions). The data obtained, combined with that from other networks which measure flows of pollutants, can provide a basis for deciding whether clean-up is necessary (in tourist or fishing areas, for example), or whether special attention should be paid to certain regions (as regards, for example, the disposal of sludge from dredging).

## THE PARTNERS

The research as a whole will be based on the knowledge acquired by the laboratories participating in the network.

- **The Marine Biology Laboratory** of the (French-speaking) Free University of Brussels (Dr. Ph. Dubois): the biology and ecotoxicology (heavy metals) of adult starfish and sea urchins. More particularly the research proposed is a direct application of the most recent laboratory results acquired under the Programme of Encouragement of Marine Science funded by the Federal Office for Scientific, Technical and Cultural Affairs (OSTC) from 1992 to 1996.
- **The Marine Biology Laboratory** of the University of Mons-Hainaut (Professor M. Jangoux): biology of larvae, and particularly metamorphic events.
- **The Organic Chemistry Laboratory** of the University of Mons-Hainaut (Professor R. Flammang), analysis by mass spectrography of complex organic mixtures. It will be used on its own or coupled with gas chromatography (apart from its reputation in general, the laboratory is well known for having developed a new type of tandem mass spectrometer of which only a few specimens exist).

Pooling these skills will make it possible to deal with the impact on the entire life cycle of the organisms studied (adult and larval life, including metamorphosis) of the principal pollutants associated with sediment and which have a long remanence (which means that they constitute a long term threat to the marine environment and human activities associated with it).

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**Coordinator**

The research activities of the Marine Biology Laboratory deal with the biology, ecology and ecotoxicology of marine invertebrates. Investigations mostly concern the Echinodermata used as paradigm of the macrobenthos. The overall aims of the research are: (1) the fine understanding of the original biological model developed by the Echinodermata, (2) the precise determination of their role in both healthy and altered (i. e. polluted) marine benthic ecosystems, (3) the farming of echinoderms of commercial interest (aquaculture). Main themes of research encompass morpho-physiology of digestive, reproductive, immune, and skeletal systems, larval biology and ecology of metamorphosis, ecology of populations and symbioses, aquaculture of sea-urchins, and metal ecotoxicology. The

latter theme focuses on the study of the distribution, fluxes, and biological effects of metal contaminants in the *Posidonia oceanica* (sea-grasses) meadows and in littoral communities of the North Sea. In these ecosystems, echinoderms are key species and used as bioindicators of metal contamination. The experimental approaches include in situ, aquarium, and cell culture procedures. International collaborations concerning ecotoxicology include the International Atomic Energy Agency (Monaco; Prof. S.W. Fowler), the Istituto Nazionale Tumori (Napoli, Italy; Prof. G. Pagano), and the Universidad de Barcelona (Spain; Prof. J. Romero).

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**Partner 1**

The research activities of the Laboratory of Marine Biology of the University of Mons-Hainaut mainly focus on (1) structures and functions of defensive organs, (2) study of symbioses with echinoderm host, (3) adhesion mechanisms of larvae and adults to benthic substrata, and (4) biology of individuals (larvae and postlarvae) prior and just after metamorphosis. In the frame of the latter research theme, the Laboratoire of Mons performs in routine -as well for echinoids as for asteroids- (1) fertilizations

and follow up of embryonic development, (2) rearing of larvae, (3) induction of metamorphosis and follow up of postlarval stage, and (4) rearing of small juveniles during the first weeks of their benthic life. International collaborations are developed with the University of Lille (France; Dr D. Davoult), the Bødo Colege (Norway; Dr N. Hagen), the Marine Laboratory of Banyuls-Sur-Mer (France; Prof. A. Guille), and the University of Bangor (Wales, U.K.; Prof. G. Walker)

**Professor R. Flammang**

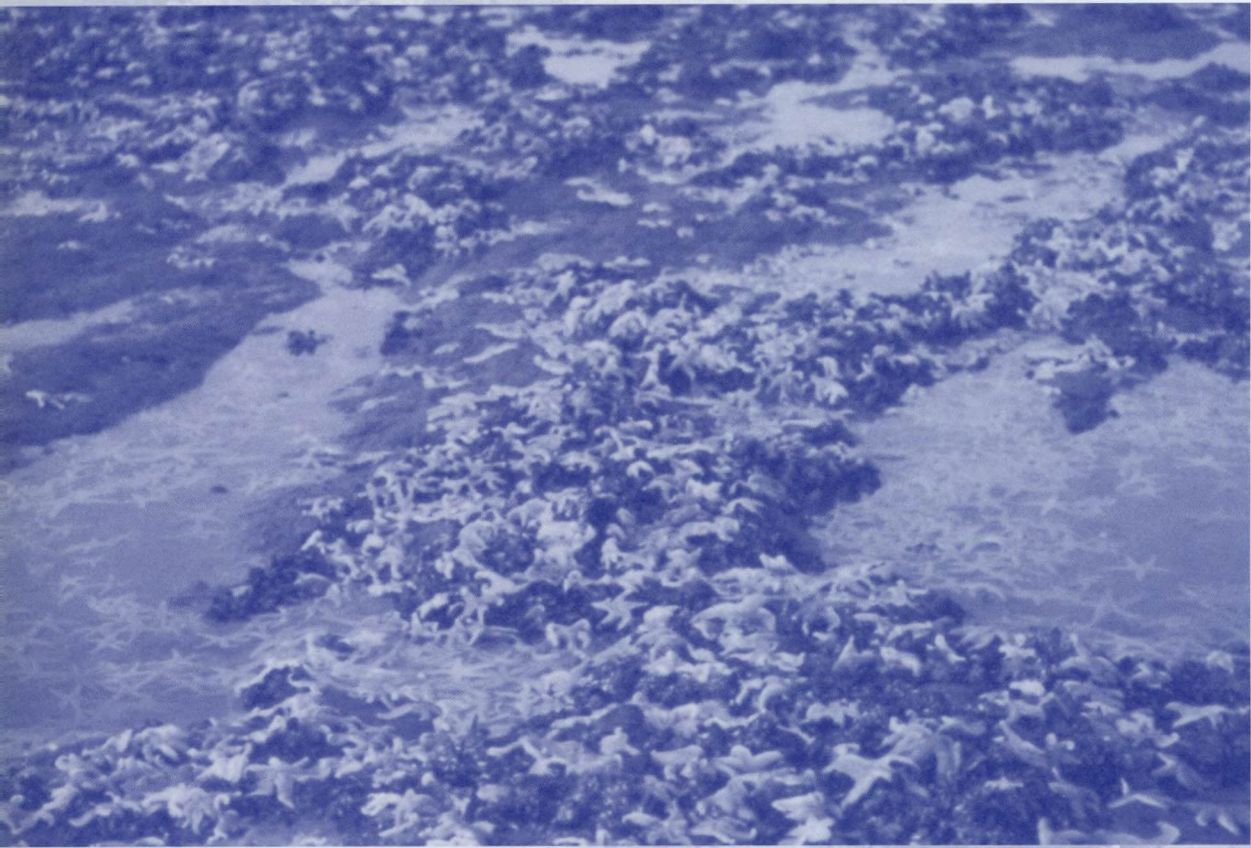
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**Partner 2**

The major research themes developed by the Laboratory of Organic Chemistry of the University of Mons-Hainaut are (1) the determination of new molecules (particularly heterocycles with 5 or 6 atoms derived from azols and azines, respectively) that are pharmacologically-active and the subsequent optimization of their production at the industrial level, (2) the study of fundamental aspects related to production and characterization of new families of reactive molecules, and (3) the analysis of complex environmental mixtures. Tandem Mass Spectrometry or MS/MS is the main analytical tool used. (From 1991, the laboratory has been developing a new prototype of tandem mass spectrometer in close collaboration with Micromass Inc., UK.) For the analysis of complex environmental mixtures, the Laboratory uses

chromatographic techniques coupled with mass spectrometry (GC-MS/MS). The GC-MS/MS approach is currently used in the laboratory for the characterization of atmospheric organic pollutants and PCBs in the marine environment. International collaborations are developed with the University of Queensland (Australia; Prof. Curt Wentrup & Dr. Ming Wah Wong), the Ecole Polytechnique (URA CNRS 1307, France; Prof. Guy Bouchoux), the Odense University (Denmark; Prof. C.Th. Pedersen), the Université Pierre et Marie Curie (Paris VI, France; Prof. J.P. Morizur), the McMaster University (Canada; Prof. J.K. Terlouw), the Instituto de Quimica fisica (Madrid, Spain, Prof. J. Elguero), the University of Trondheim (Norway; Prof. E.H. Morkved), and the Technical University of Berlin (Germany; Prof. H. Schwarz).



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# THE STRUCTURAL AND FUNCTIONAL BIODIVERSITY OF NORTH SEA ECOSYSTEMS

## SPECIES AND THEIR HABITATS AS INDICATORS FOR THE SUSTAINABLE MANAGEMENT OF THE BELGIAN COASTAL SHELF

The diversity of ecosystems is an aspect of "biodiversity" which has recently become a popular notion. It refers to the diversity of life of all forms, beginning with the genetic heritage and extends to the ecosystems on which the biosphere is built (UNESCO, Rio de Janeiro, 1992). As a whole the various biological levels are marked by an alarming reduction in their biodiversity. Structural

biodiversity (in terms of numbers, biomass, the composition of species and the population structure of communities) and functional biodiversity (presented as series of interactions between the various trophic levels) are different concepts which most certainly must be related one to the other if one is to have a good understanding of how an ecosystem functions.

### THE PROJECT

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- There are two facets**
- An analysis of the factors which determine the biodiversity of marine ecosystems and the changes in them.
  - The translation of what is known into parameters which can serve as a basis for the policy to be implemented (for example, the species which serve as ecological indicators). Special attention will be paid to the benthos (organisms which live close to or at the

bottom of the sea) and the upper trophic levels (fish, seabirds and marine mammals) and their parasites.

### ACTIVITIES

In the first phase a synthesis will be made of all the information available having to do with the spatial and temporal distribution (structural biodiversity) of the components mentioned above of the Belgian coastal shelf. The data will be used together with an analysis and interpretation of the connection between the biological indicators and the environmental variables to establish criteria for the selection of ecological indicators for sustainable development. Special attention will be paid to sandbanks, not only because of their extreme ecological significance, but also because they are greatly affected by human activities. Comparison with neighbouring areas (open sea, the Belgian East coast) will enable us to evaluate those characteristics which are peculiar to sandbanks. Maps will be made available for use by policy makers. They will not only

indicate the places where different species of bird, benthos, fish and their parasites occur, but also the vulnerable areas.

The connection between biodiversity and production is of fundamental importance in ensuring that ecosystems are efficiently managed. In this respect there are two different approaches which will have to be considered:

- maintaining the large "visible" species, which often occupy an important position in the food chain, and which, in the policy context, are easy to monitor as ecological indicators;
- reaching an understanding of the underlying biological relationships (predation, competition) and the structuring interaction with the abiotic environment.

The feeding ecology of the different components will be quantified and qualified with special emphasis on the trophic place of those species which serve as ecological indicators. The significance of the primary production of the water column in the benthos structure will be studied to quantify the direct interdependency between the pelagos and the benthos. Models of morphological variation do not always coincide with auto-ecological, molecular and biogeographical models. This is of crucial significance in ecological research, since it implies that morphological diversity does not necessarily correspond to functional diversity which latter can be either greater or less than the morphological diversity would indicate. We are basing ourselves on the principle that the population genetics of fish (biodiversity at the level of population) constitutes an essential element in understanding the ecosystem of sandbanks (biodiversity at the level of the ecosystem). The choice of which species to study will be determined by what is already known in the fields of ecology and genetics and their significance both as food for birds and the commercial fishery (for example gudgeon). The importance of parasites of fish and seabirds will also be considered as biological and genetic markers.

This research is of direct interest to policy makers at the Belgian Federal level for the following reasons:

- The implementation of the Ramsar agreement of 1971 covering water rich areas and in the framework of which the implementing decrees establishing a protected zone in the Flemish banks (coastal sandbanks) are overdue.
- The preparation of the next Conference on the North Sea (2000), at which the Belgian Government will draw on the expertise of its own researchers as regards the information available on eutrophication, the deterioration of the habitat, pollution, the extraction of sand and overfishing (including opinions on the proper management of genetic characteristics).
- The supply of basic information for the optimum management of the natural resources of the Flemish banks, if appropriate, by setting up a marine reserve.
- Establishing criteria for ecological monitoring of the sustainable development of the North Sea (with priority on the sandbanks).
- The application of the UNESCO convention on biodiversity signed in Rio de Janeiro (1992). So far none of it has been implemented on Belgian territory. The inventory of the fauna of the Belgian continental shelf is incomplete.
- The intention of the Federal and Flemish governments of setting up a data bank as a management instrument and including an information system based on geographical coordinates.

## THE PARTNERS

The Department for Marine Biology of the University of Ghent (Prof. Dr. M. Vincx, Drs J. Vanaverbeke, Dr. A. Cattrijsse and ir. D. Van Gansbeke) already has thirty years of experience in research on benthos in general and in the North Sea in particular. It will provide data on the biodiversity of the different benthos components.

The Laboratory for Ecology and Aquaculture of the Catholic University of Leuven (Prof. Dr. F. Ollevier and Prof. Dr. F. Volckaert)

will study the genetic variation of a number of species which serve as indicators and the ecology of parasites.

The Institute for Nature Conservation of the Flemish Community (Prof. Dr. E. Kuijken, Prof. Dr. P. Meire and Drs J. Seys) will be responsible for the upper trophic levels such as birds and marine mammals and drawing up maps of the distribution of benthic communities.

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**Coordinator**

The Marine Biology Section of the Department Biology of the University of Gent 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). European estuaries have been investigated in the framework of international programmes such as EC-MAST I-JEEP92, EC-ENVIRONMENT-MATURE, EC-ENVIRONMENT-ECOFILAT, EC-CONCERTED ACTIONS-ESTUARINE FISHERIES. Since about ten years, other geographical areas have been included : Deep-sea areas in the Atlantic Ocean (EC-MAST I, II and III),

Biology of the Antarctic meiobenthos (OSTC-ANTAR III and IV; FWO), Ecology of tropical estuaries and lagoons (FWO), Population dynamics of macrobenthos of coastal sandbanks (AMINAL, Flemish community) and several Ph.D projects.

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 : grain size of sediments (Coulter Particle Size Analyser), Organic C and N, Nutrients (SKALAR), Pigments (HPLC), Redox profiles of sediments, oxygen. All chemical methods are adapted for analysis within the sediments. Microbial aspects (radio-active labelling) and experimental microcosmos research (culture chambers and respiration chambers) are available.

**Professor Dr. E. Kuijken**

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**Partner 1**

In the early 1970s the knowledge on the distribution and abundance of top-predators, like seabirds and marine mammals, was limited. The demand for additional data of seabirds grew in the early 1980s. In 1986, the Institute of Nature Conservation (IN) started with systematic aerial surveys in the Belgian coastal zone. These counts are of great value for determining the total numbers of sea ducks, but can not be used for counting seabirds further offshore. After strandings of big numbers of oiled seabirds on the Belgian coast the Institute of Nature Conservation commenced in 1992 with shipbased surveys in the Strait of Dover and the Belgian Continental Shelf, funded by World Wide Fund for Nature and later by the Management Unit of the Mathematical Model of the North Sea (MUMM).

The Institute participates in the 'European Seabirds At Sea (ESAS) coordinating group' and gives assistance to the development and updating of the ESAS-database (development of atlases of the North Sea).

The IN has an international co-operation with the Netherlands Institute for Sea Research (NIOZ) at Texel (the Netherlands), the Institute for Forestry and Nature Research (IBN-DLO) at Texel and Ornithology Consult at Copenhagen (Denmark) for the ship-based and aerial surveys. For determining the vitality of breeding populations of seabirds along the Belgian coast we get expertise from the Institute for Forestry and Nature Research (IBN-DLO) at Arnhem (the Netherlands) and the Ministry of Transport, Public Works and Water Management, Tidal Water Division (RIKZ) at Middelburg (the Netherlands).

**Professor F. Ollevier**

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**Partner 2**

The Laboratory of Ecology and Aquaculture is involved in fundamental and applied research in the fields of aquatic biology, ecological genetics and population genetics. Our expertise on marine systems deals with population genetics of gobies and fish parasites, ecology of estuarine and tropical fish, microbiology (pasteurellosis), marine parasitology, ecotoxicology and endocrinology. The following staff members are currently involved:

National financing organisations are the University of Leuven, IWT, FWO, OSTC,

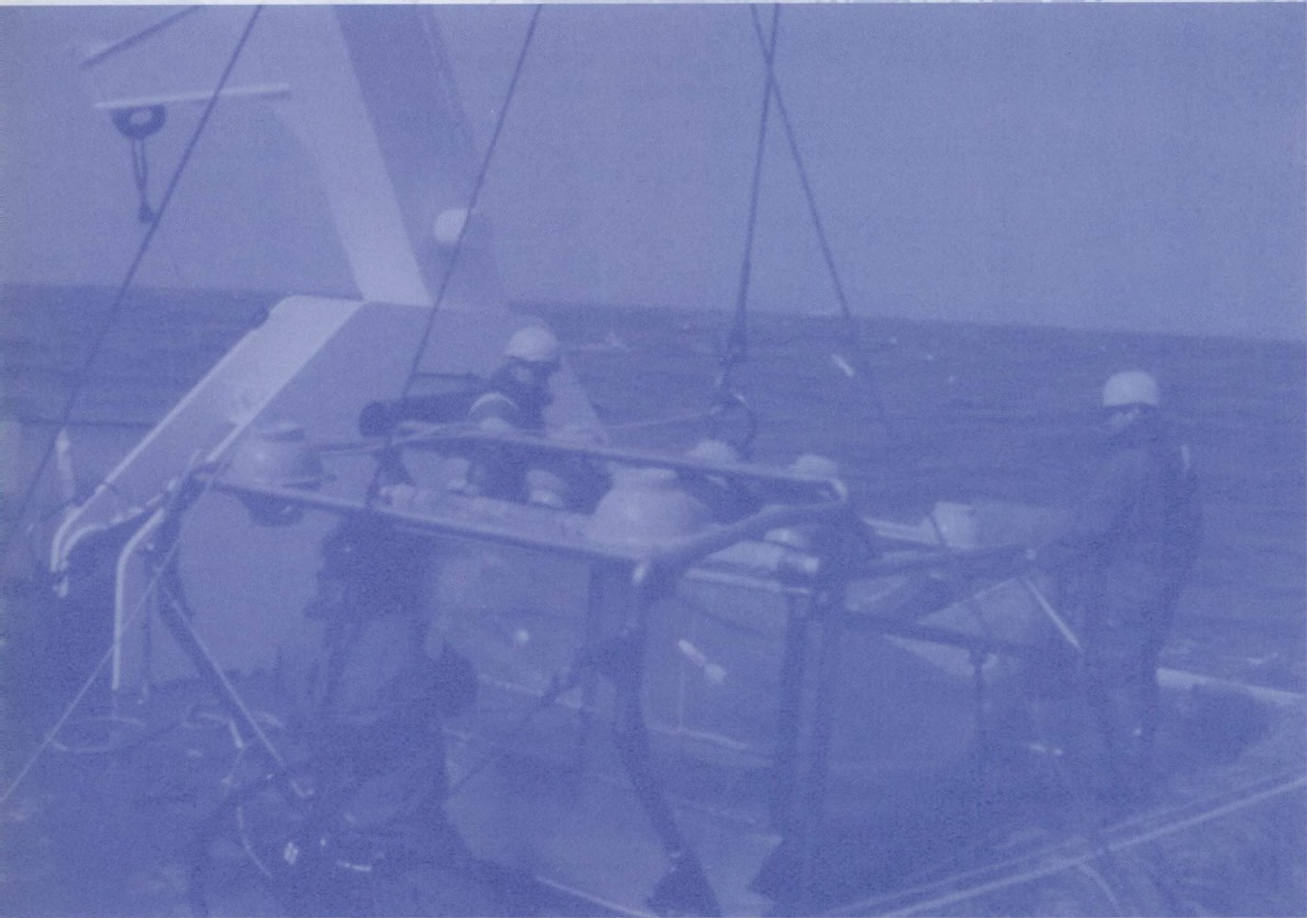
AMINAL. Funds also come from international organisations like the European Commission and the European Science Foundation. Next to these the industry and own funds further sustain our research.

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# BIRDS AND MARINE MAMMALS OF THE NORTH SEA: PATHOLOGY AND ECOTOXICOLOGY

In winter large colonies of pelagic birds settle on the Flanders Banks. In the past they were also largely frequented by marine mammals. Now they are only rarely to be seen and every year, some of them and many hundreds of birds are washed up along the Belgian coast. These species should be protected and the purpose of this research project is to study the state of health of these populations, trends over time, the pathologies observed and the pollutants

associated, as also the possible causes of abnormal deaths. The most significant damage to seabirds caused by human activities seems to be the pollution by hydrocarbons, but the actual reasons why birds which are not poisoned by oil fuel wash ashore and the rarity of mammals are still unknown (heavy traffic shipping routes, other chemical pollution, decrease in the availability of food, disease, etc.).

## THE PROJECT

To examine the greatest possible number of seabirds and mammals which wash up on the Belgian coast: perform autopsies and take the samples needed to determine what pathogenic agents and pollutants are present.

To examine individuals, insofar as possible, animals accidentally caught in fishing nets, to determine how representative the individuals collected from the beaches are of the natural population.

To study wild populations, in the field, so as to reach a better understanding of their ecology and behaviour and estimate the actual impact of hydrocarbons on the seabird population.

To study, in the laboratory, the effects of the various toxic substances to which these animals are subjected (hydrocarbons, heavy metals, etc.) and the efficacy of any physiological detoxification mechanisms which such animals develop in response to pollutants.

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## THE PARTNERS

The research network consists of the following research teams:

- **The Oceanology Laboratory** of the University of Liege (Professor J.-M. Bouquegneau, coordinator);
- **The Laboratory for Ecotoxicology and Polar Ecology** of the (Flemish) Free University of Brussels (Professor C. Joiris);
- **The Pathological Anatomy Department** of the University of Liege (Professor F. Coignoul);
- **The Institute for Nature Conservation** of the Flemish Community (Professor E. Kuijken).

## ACTIVITIES

To conduct such research successfully requires a multidisciplinary approach, i.e. one which involves the cooperation of specialists from various disciplines. The multiplicity of examinations to be effected on single animals is an original aspect of the research network's approach.

Lesions will be studied by veterinarian anatomo-pathologists (Dr. T Jauniaux of the Department of Pathological Anatomy), ecotoxicologists will study levels of contamination and the effects of pollution (V. Debacker and S. Pillet from the Oceanology Laboratory and Dr. L. Holsbeek from the Laboratory for Ecotoxicology and Polar Ecology) and observations in the field will be performed by ecologists (J. Van waeyenberg from the Institute for Nature Conservation). The following will also be involved in the

research: Dr. J. Van Gompel, a veterinarian who will cooperate in collecting samples and in necropsies; J. Tavernier of the Royal Institute for Natural Science of Belgium (IRSNB) and Dr. T. Jacques of the Management Unit of the Mathematical Model of the North Sea (MUMM) who will cooperate in collecting samples in the field and for the MUMM itself in developing a database.

### **Professor J.-M. Bouquegneau**

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### **Coordinator**

The Oceanology Laboratory has long been involved in marine ecology and ecotoxicology. The production and recycling of the organic matter is studied in several environments, mainly in the Mediterranean basin, through biomass and primary production measurements, and delineation of carbon and nitrogen transfers in the ecosystems using stable carbon and nitrogen isotopes determination.

The mechanisms of uptake, toxicity and detoxification of heavy metals are studied in marine organisms, mainly in seabirds and marine mammals. Regular international

contacts at different levels as well as participating in network discussion groups and intercalibration programs, allows the Oceanology Laboratory to exchange ideas and materials with other teams working in the same field (collaboration with Professor A. Abarnou -Brest, France- for the study of heavy metals contamination in bottlenose and common dolphins from the French Atlantic; collaboration with Professor A. Viarengo -Genova, Italy- to study metallothionein determination in avian and marine mammals tissues, ...).

### **Professor F. Coignoul**

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#### **Partner 1**

The department is currently engaged in three research areas: xenotransplantation of pigs kidneys, pathogenesis of emphysema in cattle, and pathology of marine mammals and seabirds.

Techniques available are quantitative evaluations of organs and tissues through image analysis, cell populations identification by histochemistry and immunochemistry (DNA adducts evaluation and PCR are in the process of acquisition).

The Department works in collaboration (international network for marine mammals) with the Harderwijk Marine Mammals Park, Harderwijk, The Netherlands (Dr. Kastelein), with the National Museum for Natural Sciences, Leiden, The Netherlands (Dr. Smeenk and Ms Addink), with the Duisburg Zoo, Duisburg, Germany (Dr. Garcia Hartmann), with Zoological Society, London, United Kingdom (Dr. Jepson), with the NAUSICAA, Boulogne sur mer, France (Dr. Bourgain) and with the Marine Mammals Research Center, La Rochelle, France (Dr. Collet).

### **Professor C. Joiris**

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#### **Partner 2**

The Laboratory for Ecotoxicology & Polar Ecology displays activities in two main areas:

- Behaviour and impact of stable pollutants (PCBs, organochlorine pesticides, heavy metals) on the different trophical levels of marine ecosystems (phytoplankton, zooplankton, bentos, fish, birds and mammals) with special interest for background concentrations (levels in Arctic and Antarctic areas). Impact of stable pollutants on populations of birds and marine mammals. Fluxes of pollutants through the food webs.

- At sea study of the distribution of marine birds and mammals: seasonal variations of distributions, linkage with hydrographical regimes, estimations of population sizes and densities. Estimations of food demands and energy fluxes through higher trophical levels of the marine ecosystems.

International contacts include long standing collaborations with the Murmansk Marine Biological Institution, European marine mammal network collaboration schemes and the coordination of a research program on marine mammals of the Black Sea involving Ukrainian, Bulgarian and Georgian teams.

### **Professor Dr. E. Kuijken**

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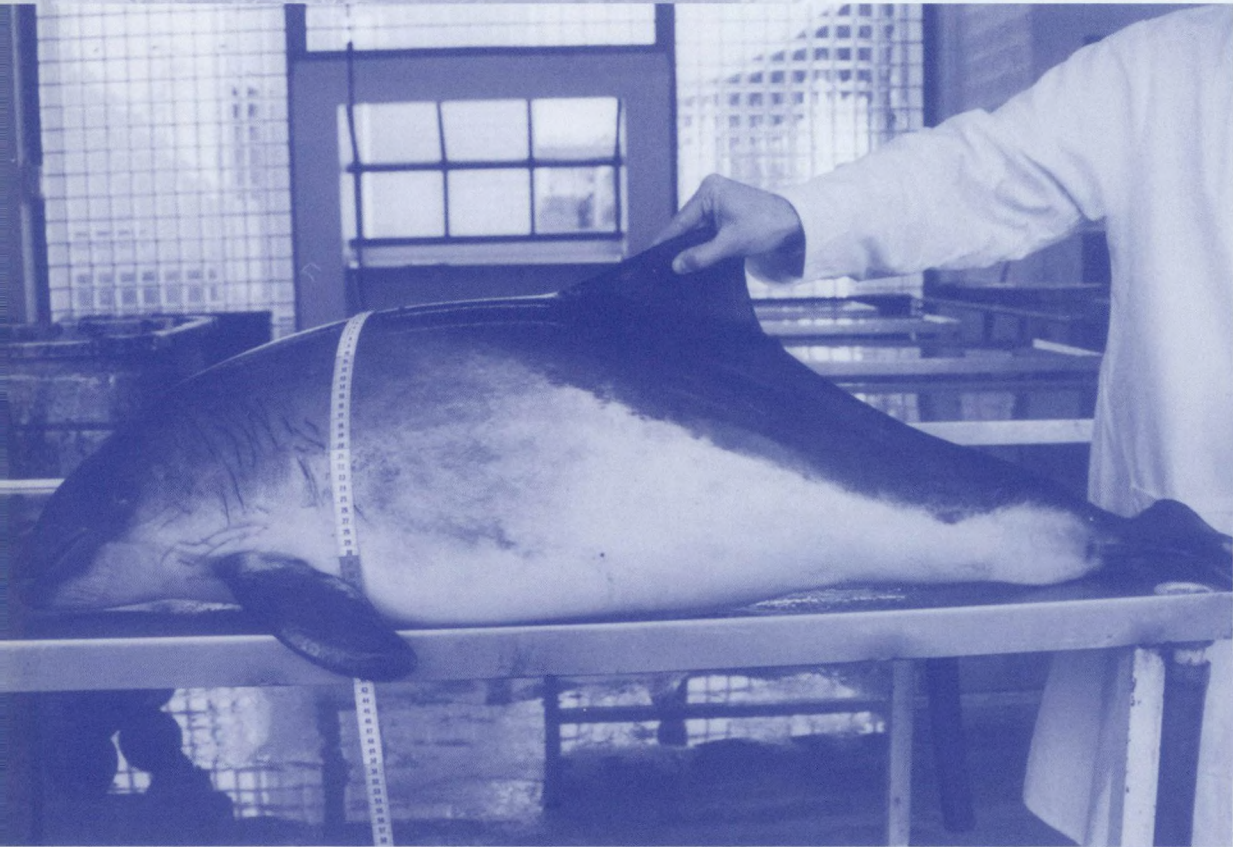
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#### **Partner 3**

The impact of oil pollution on the North Sea ecosystem became obvious from the large numbers of beached seabirds that were oiled. Already in the sixties an international monitoring scheme of beached birds was setup in order to assess the impact of oil pollution on their populations. In Flanders these counts started in 1962 and are coordinated by the Institute of Nature Conservation (IN) since 1992 as part of a European network.

In 1986, the IN started with systematic aerial surveys in the Belgian coastal zone. These counts are of great value for determining the total numbers of sea ducks, but can not be used for counting seabirds further offshore. In 1992 the IN started with ship-based surveys in the Strait of Dover and the Belgian Continental Shelf, funded by World Wide Fund for Nature and later by the Management Unit of the Mathematical Model of the North Sea (MUMM) and at present by the OSTC. This work gives us insight in the population sizes of seabirds at the Belgian Continental Shelf.

The Institute also participates in the "European Seabirds At Sea (ESAS) coordinating group" and gives assistance to the development and updating of the ESAS-database (development of atlases of the North Sea). The IN has an international cooperation with the Netherlands Institute for Sea Research (NIOZ) at Texel (the Netherlands), the Institute for Forestry and Nature Research (IBN-DLO) (the Netherlands), Ornis Consult at Copenhagen (Denmark) and the Ministry of Transport, Public Works and Water Management, Tidal Water Division (RIKZ) at Middelburg (the Netherlands).



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# IDOD: INTEGRATED AND DYNAMICAL OCEANOGRAPHIC DATA MANAGEMENT

Any kind of scientific work quite obviously must be based on structured, validated knowledge. This is particularly so as regards the marine environment. Any future policy or decision determined with a view to the sustainable management of the North Sea

would lack any basis if there were no validated and readily accessible measurements or experimental data. Building an integrated oceanographic database is therefore a key action in the programme for "Sustainable Management of the North Sea".

## THE PROJECT

The purpose of this five-year project is to establish, manage and promote a marine environmental geographical information system, ensuring a smooth and scientifically sound flow of data between the data producers (scientists in the field and in the laboratory, modellers, public authorities, etc.) and the end users (policymakers, scientists, sea professionals and the general public).

The categories of data to be considered cover a wide range of natural processes and human activities connected with the North Sea. Up to date Quality Control procedures will be followed in entering and processing the information to be included in the database. The tools and products to be

developed in the course of the project will make it possible to gain a better understanding of the structure and functioning of the marine ecosystem and the influence upon it of human activities, by providing a basis for scientific assessments in the perspective of the definition of a sustainable management policy of the North Sea. This is a basic need for the fulfilment of Belgian commitments under the International Conferences on the Protection of the North Sea and the Paris and Oslo Conventions. Lastly it should be noted that an important part of the project involves data gathering and supplying information from and to scientific teams working in the framework of the other topics covered by the programme.

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## ACTIVITIES

The project can be divided into six different but highly interdependent activities: Initially an inventory will be made of relevant data sets and databases.

Procedures for the incoming flow of data will be defined and implemented. This covers not only the practical aspects of the transfer of information but the very important matter of quality control of data.

The design of the database itself will be analysed in depth, in function of the intrinsic characteristics of the data and in order to meet the present and future needs, ensuring the viability and the usefulness of the tool over the years.

In order to understand the processes driving the marine phenomena "hidden" in the data, a set of data analysis tools will be developed.

Various approaches will be used: statistical techniques, geostatistics and spatial analysis techniques, space and time "corrections" of data sets by means of advection-diffusion models. It is also expected to take advantage of the information given by these tools to improve the quality control on the incoming data.

Given their two important characteristics –namely their capability of simulating and forecasting processes and events– we believe that mathematical models also are an important source of information for the project. Suitable validation procedures will be defined and the results of relevant (and validated) models will be incorporated in the database.

Lastly, since one of the most important objectives of this project is to supply useful

and scientifically sound information to a broad range of users, derived products will be developed (maps, tables, reports, etc.) that meet the specific requirements and levels of expertise of the various categories of users.

It should be emphasised also that the network supporting the project consists of teams with a high level of expertise

in physical, chemical and biological oceanography, statistics and geo-referenced data analysis, ensuring a coherent and comprehensive force to bring the project to a successful conclusion.

## THE PARTNERS

The Management Unit of the Mathematical Model of the North Sea (MUMM) (Dr. ir G. Pichot), the Federal department for the management of the marine ecosystem, co-ordinates the project. More specifically it will take care of the effective implementation of the developed tools, of providing information to the database and of the production of "value added products" for use by policymakers, sea professionals and the public.

The SURFACES Laboratory (Dr. ir J.-P. Donnay) of the University of Liège will be more particularly involved in developing analysis and geo-referenced data processing tools and in the conceptual design of the database.

The University Centre for Statistics (Professor J. Billiet & Dr. J. Van Dyck) of the Catholic University of Leuven will develop the quality control procedures to apply on the incoming flow of data. They will bring their experience in statistical analysis to bear on the development of data processing tools.

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**Coordinator**

The Management Unit of the Mathematical Model of the North Sea (MUMM) is a federal government scientific institution with activities in marine research, monitoring and management. Research at MUMM focusses 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. Co-operation of relevance to the IDOD project includes, for instance, environmental management activities in the frame of the Oslo and Paris conventions for the prevention of marine pollution and participation in co-ordination efforts of the European oceanographic data centers in the frame of the MAST programme sponsored by the European Union.

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**Partner 1**

The Laboratory SURFACES at the University of Liège was created in 1988 to promote fundamental and applied researches in the domains of digital cartography, geographical information systems (GIS) and satellite remote sensing. The main part of the fundamental research and several feasibility studies are granted by the national programme, so called TELSAT, under the direction of the Office for Scientific, Technical and Cultural

Affairs (OSTC). Many applications, notably in environment concern fundamental research : integration of high spatial resolution imagery in remote sensing, land country planning, GIS, contribution to the seamless cartography of the Walloon Region, etc. The CONGOO formalism specifically designed for geographical databases and GIS conceptualisation was developed at the laboratory.

**Dr. J. Van Dyck**

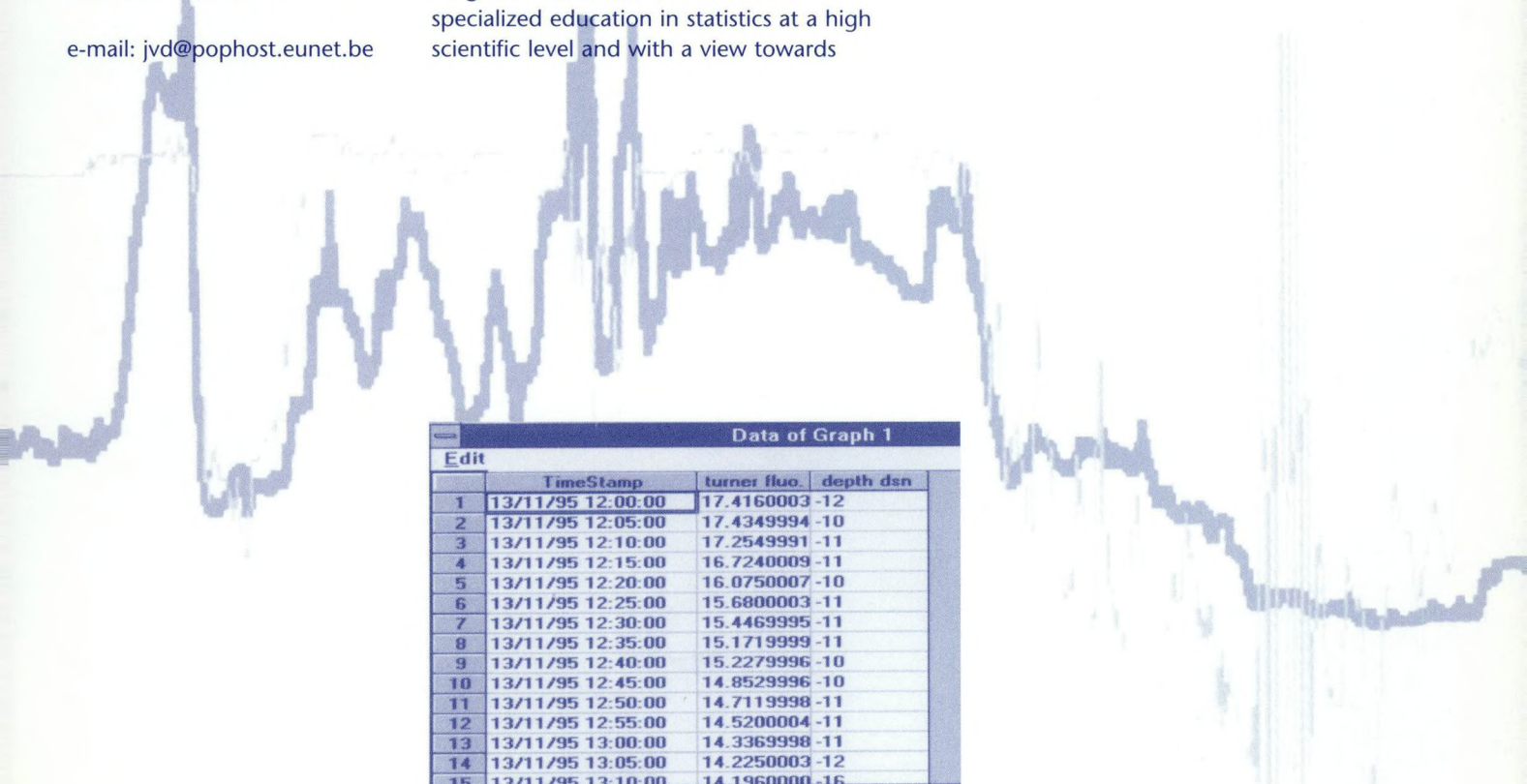
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**Partner 2**

The University Centre of Statistics (UCS) is a centre that merges the know-how and research of statisticians at the different departments and faculties of the Katholieke Universiteit Leuven. UCS has a longstanding and extensive experience with data mining techniques and has executed a wide variety of statistical consulting projects. UCS also organizes an International Study Program in Statistics which offers a specialized education in statistics at a high scientific level and with a view towards

important fields of application. Program participants are intensively trained in statistical theory and its practical use in problem-solving.



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1	13/11/95 12:00:00	17.4160003	-12
2	13/11/95 12:05:00	17.4349994	-10
3	13/11/95 12:10:00	17.2549991	-11
4	13/11/95 12:15:00	16.7240009	-11
5	13/11/95 12:20:00	16.0750007	-10
6	13/11/95 12:25:00	15.6800003	-11
7	13/11/95 12:30:00	15.4469995	-11
8	13/11/95 12:35:00	15.1719999	-11
9	13/11/95 12:40:00	15.2279996	-10
10	13/11/95 12:45:00	14.8529996	-10
11	13/11/95 12:50:00	14.7119998	-11
12	13/11/95 12:55:00	14.5200004	-11
13	13/11/95 13:00:00	14.3369998	-11
14	13/11/95 13:05:00	14.2250003	-12
15	13/11/95 13:10:00	14.1960000	-16



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# MARE-DASM: MARINE RESOURCES DAMAGE ASSESSMENT AND SUSTAINABLE MANAGEMENT OF THE NORTH SEA

To be assured of a high standard of living riparians of the North Sea make different uses of the North Sea. In order to achieve a sustainable use of the North Sea, it is necessary to restrict the harmful use of it. In recent years a lot of national and international measures and principles to protect the ecosystem of the North Sea were adopted. In the new OSPAR Convention of

1992 all North Sea states and the European Commission agreed to use the precautionary principle and the polluter pays principle for the protection of the marine environment. The implementation of these measures and principles often causes practical problems. The research done in the framework of MARE-DASM will propose a solution for these problems.

## THE PROJECT

The project has two main objectives who have a different goal but the results of the first objective (theme 1) will partly be integrated to obtain the second objective (theme 2).

### **Theme 1: the socio-economic cost of a degradation of the marine environment**

The first objective of the project is to make an identification and quantification of different factors contributing to the degradation of the marine environment in the Belgian part of the North Sea (*Laboratory of Environmental Toxicology and Aquatic Ecology, Prof. Dr. C. Janssen*). This identification and quantification must be the basis for the evaluation of the direct and indirect economic and social costs of degradation, accidentally or permanently (*Maritime Institute, Prof. Dr. F. Maes, with subcontractor Environmental Consultancy and Assistance (ECOLAS), Dr. P. Vanhaecke*). The cost of degradation will be compared with the economic and social profits of the use of the Belgian part of the North Sea by the current generation, in order to come to

propositions of measures to be taken by the government to guarantee a sustainable use of the sea for the future generations (*Maritime Institute, Prof. Dr. F. Maes*).

### **Theme 2: The risk of the accidental oil/chemical pollution of the marine environment**

The second objective of the project aims at making an estimation and prediction models of the potential damage of the ecosystems of the Belgian part of the North Sea caused by oil and other chemical products, as well as the socio-economic impact of this damage in a number of selected cases (*Management Unit of the Mathematic Models of the North Sea, Dr. G. Pichot*). The mathematical determination of the damage must enable the development of technical and legal procedures that allow to evaluate the degradation of the marine environment and to recover it financially on the polluter (*Centre for Environmental Law, Prof. Dr. H. Bocken (national law) and Maritime Institute, Prof. Dr. F. Maes (international law)*).

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## ACTIVITIES

Task I "identification and quantification of different factors contributing to the degradation of the marine environment" will study, next to the identification and quantification, the distribution of the contaminants in the environmental compartments in order to fine-tune the Biological Effects Submodel for the long term effects. The results of task I should enable to estimate the degradation of the marine environment. This estimation is a starting

point for a part of the research that will be done in task II "the development of socio-economic assessment criteria to determine in an objective way the cost of degradation", namely the quantification of damage to the environment based on use values. For the socio-economic assessment criteria the quantification of environmental damage based on option and existence values (Contingent Valuation Method) will also be used. Research from tasks I and II will

contribute to the research in tasks III and IV. In task III "the development and evaluation of measures that need to be taken by the government in order to guarantee a sustainable use of the sea", measures will be proposed allowing Belgium to obtain an optimal integrated policy and sustainable use of the North Sea, taking into account the social costs and the political and legal-technical feasibility. The uses at sea will be set out on a priority scale in function of their degradation impact on the marine environment of the North Sea (cf. task I). The different uses will also be given an economic and social value, varying according to the different uses. Using the policy option "sustainable management" as a starting point, policy measures for every use will be proposed, taking into account the efficiency, the social costs and benefits that can be expected for the socio-economic groups and the possibility for the government to take action. The ecological effects (task I) and the defined socio-economic assessment criteria (task II) will be integrated into the

mathematical model (task IV "to develop and evaluate mathematical models assessing the risks bound to accidental spillage of oil and other chemicals at sea and the damage they can cause, at the environmental and socio-economic levels"). The mathematical model will be developed by the Management Unit of the Mathematical Model of the North Sea (MUMM), but is however limited to the assessment of risks for environmental damage in case of accidental discharges of oil and other chemical products. Task V contains "the development of technical and legal procedures that allow to evaluate the degradation of the marine environment and to recover it financially on the polluter". On the one hand we are dealing with national and international liability law, with the polluter pays principle as a starting point and on the other hand with legal-technical and administrative procedures in order to evaluate the degradation (environmental damage as well as disruption to the environment) financially and to recover it from the polluter.

## THE PARTNERS

The Maritime Institute of the University of Ghent is the coordinator and will work with ECOLAS (Environmental Consultancy and Assistance) as a subcontractor. Other partners are the Laboratory of Environmental

Toxicology and Aquatic Ecology of the University of Ghent, the Management Unit of the Mathematical Models of the North Sea (MUMM) and the Centre for Environmental Law of the University of Ghent.

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### **Coordinator**

The Maritime Institute is an independent research unit advising and carrying out studies for governmental administrations, non-governmental organizations and private companies. The staff of the Institute is

specialized in research topics concerning maritime law, law of the sea, marine environmental law, transport law and related policy studies.

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**Partner 1**

ECOLAS has been responsible for the implementation of research tasks concerning the development of socio-economic criteria to define damage to the marine environment (use values). To implement the results of this

type of research, ECOLAS made good contacts with other organisations, in particular in the United States. ECOLAS is also appointed by the Belgian court as expert for the financial quantification of damage by pollution.

**Prof. Dr. C. Janssen**

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**Partner 2**

The research within the Ecotoxicology unit of the Laboratory of Environmental Toxicology and Aquatic Ecology (LET) is aimed at the development and evaluation of methods for the effects assessment of contaminants on biota (present in water, sediment and soil). In a recent study a specific methodology was

developed for the ecological impact assessment of contaminants in the marine environment. The Laboratory of Environmental Toxicology established throughout the years several contacts with international marine research institutes.

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**Partner 3**

The Management Unit of the Mathematical Model of the North Sea (MUMM) is a federal government scientific institution with activities in marine research, monitoring and management. Research at MUMM focusses on providing the necessary knowledge and tools for scientific management of the North

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**Partner 4**

The Centre for Environmental Law of the University of Ghent conducts research on various aspects of environmental law and the influence of the European and Belgian institutional context on environmental law, compensation for environmental damage,

soil sanitation, nature conservation and town and country planning. The Centre is also responsible for the elaboration of computerized information systems on legislation, jurisprudence and doctrine in the field of environmental law.

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## 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 troika 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****COORDINATOR**

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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.

**PARTNER 2**

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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 prioritization of research needs. Finally, the development of policy measures is performed by ECOLAS in consultation with LETAE.

**COORDINATOR**

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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 ( $^{13}\text{C}_{12}$ ).

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-Prep<sup>TM</sup>, ...).

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. Bouqueneau).

**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 the 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  $\pm 30\%$  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 microsatellites 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, and the potential influences of contaminants on the marine ecosystem. The DVZ-CLO has an outstanding reputation in providing scientific advice to the Common Fishery Policy (CFP) of the EU for the exploitation of commercial species and is therefore 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 km<sup>2</sup>; 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 uncertainties 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 economic 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.

RCMG, Magelas and G-Tec co-operate closely in the evaluation of optimal strategies for geophysical and geochemical research and monitoring programmes. The Marine Biology group and INC focus on the analysis of different monitoring options for benthos, sea birds and mammals in the study area. CEREGE and TNO-PML are involved in the evaluation and simulation of the migration of gas and pollutants at the site. The Civil Engineering group, RCMG, TNO-PML and INC work together closely on the different aspects of risk evaluation and rehabilitation of the study site.

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The project co-ordinator, the Renard Centre of Marine Geology (RCMG) of the University of Gent, has 20 years experience in reflection seismic and geophysical surveying. RCMG has built an international reputation in the design and application of original very high-resolution seismic techniques in the marine environment. Research areas include the North Sea, the North Atlantic, Alpine lakes, African and Central Asian rift lakes, rivers and canals.

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TNO Prins Maurits Laboratory has expertise in chemical warfare agents, munition technology and explosion safety, and platform technology. To this end it has unique experimental facilities, for ballistic and pyrotechnic research and extremely toxic substances.

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The Marine Biology Section of the University of Gent is specialized in the ecology and the systematics of the benthos of the North Sea, and the assessment of sedimentological and chemical environmental parameters.

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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 analysed 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 (= monitoringstrategy 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 Antarctic meiobenthos, Ecology of tropical estuaries and lagoons, Population dynamics of macrobenthos of coastal sandbanks and several Ph.D. studies.

### PARTNER 1

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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, bed-forms, 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.

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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).

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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.

### COORDINATOR

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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).

### PARTNER 1

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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 macrobenthos-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 investigate 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.

#### **PARTNER 1**

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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 management

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 developing a general strategy ready for BEL-TEST 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 ( $^{13}C_{12}$ ).

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 MAN- AGEMENT 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, iii) 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](http://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 cooperates with other European and non-European oceanographic laboratories and governmental institutions.

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