LAQUAN

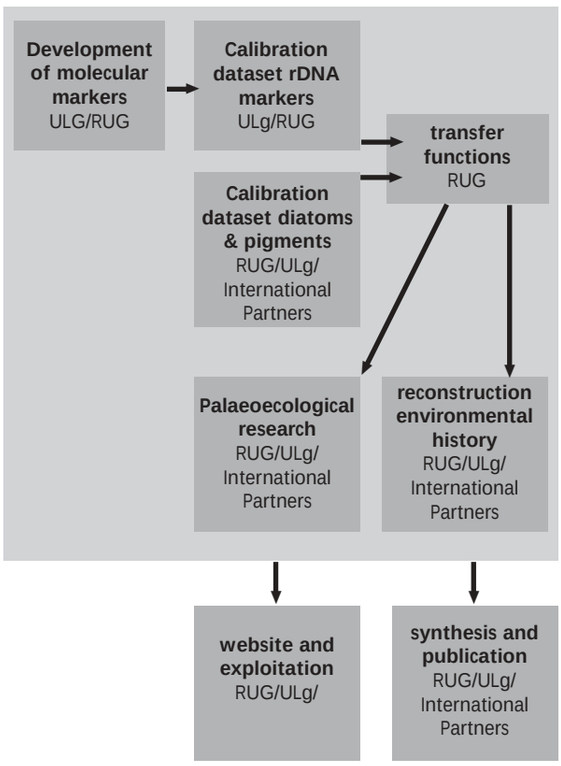
LATE QUATERNARY CLIMATE HISTORY OF COASTAL ANTARCTIC ENVIRONMENTS: A MULTI-PROXY APPROACH

Duration of the project: 01/12/2000 – 28/02/2005
Budget: € 545.787,18
Keywords: Antarctica, Larsemann Hills, Molecular Markers, Diatoms, Lake Sediments

CONTEXT

LAQUAN aims to maintain and develop Belgium's role as an integral part of two international research programmes. Both are core projects in the British Antarctic Survey (UK) 2000-2006 five year science programme "Signals in Antarctica of Past Global Changes (SAGES), which combines lake, ice and marine sediment cores in an integrated study of past environments.
The project contributes to the SPSD II objectives "Atmosphere and Climate", by developing new methodologies, which will allow a better understanding of past climate change in Antarctica. It also will contribute to the development of datasets for the validation and calibration of climate and ice sheet models.

Methodology



PROJECT DESCRIPTION

LAQUAN aims to contribute to the study of the Late Quaternary climate history of two contrasting Antarctic environments (Larsemann Hills and Alexander Island), by a multi-proxy, multi-site research of sediment cores from coastal lakes.

Objectives
The specific objectives of the project are:
1) The further development and testing of molecular tools (based on rDNA) for palaeoenvironmental reconstruction.
2) The development of calibration datasets of fossilizable protists and biomolecules representing current environmental variability in contrasting maritime and continental Antarctic coastal regions.
3) The construction and validation of interference models and indices to reconstruct environmental conditions based on fossil assemblages of a range of micro-organisms and biomolecules.
4) The application of these multiple proxies in the analysis of sediment cores from coastal lakes in continental and maritime Antarctica.
5) The participation in the integrated analysis of multiple biological, physical and chemical proxies and in the formulation of regional reconstruction of climate change in Antarctica during the past 30.000 years.

Link with international programmes
LAQUAN is an integral part of two international research programmes, "Palaeolimnological investigations of coastal continental lakes in the Larsemann Hills" and "Millennial-scale History of the George VI Sound Ice Shelf and Palaeoenvironmental History of Alexander Island, Antarctic Peninsula".

Expected results
1) The project and its integration in international research programmes will be presented in a website that will be updated regularly to include a summary of major findings and the final results and will provide access to the database containing the calibration datasets and image databases.
2) We anticipate that the project will spawn primary research papers, which will appear in front-line journals and that these will be used in major review and synthesis papers. In addition, the project will present data to the scientific, political and public communities at the occasion of international and national meetings.
3) The image database will contain new digital images of lacustrine and marine microfossils, taxonomic descriptions and autoecological and distribu-

tional data. This database will provide an important tool to both palaeoecological and taxonomic research in polar environments.
4) The new rDNA sequences will be deposited in international databases.
5) The project will contribute to work tasks set by the Past Global Changes (PAGES) component of the International Geosphere Biosphere Programme (IGBP) and by projects of the Scientific Committee for Antarctic Research (SCAR) Global Change and Antarctica Programme (GLOCHANT). Specifically, it will contribute to PAGES Stream 1 (last 2000 years) and stream 2 (late Quaternary), and to the GLOCHANT projects (also adopted by PAGES): International Trans-Antarctic Scientific Expedition (ITASE), Antarctic Ice Margin Evolution (ANTIME) Stream 1 (last 20 000 years), and Palaeoenvironments from Ice Cores (PICE).
6) Data from our major activities will be deposited with the PAGES International Palo-Data System at the World Data Centre-A for Palaeoclimatology (WDC-A) in Boulder, Colorado.
7) This project will contribute to the further development of the Belgian expertise in Antarctic research and to the realisation of the responsibilities and role of Belgium in the Antarctic Convention.
8) The development of new biological proxies to reconstruct climate-induced environmental changes in Antarctica will provide an important tool for future international research and is a distinguishing feature of Belgium's role in this project.

PARTNERS

Activities

RUG
Development of calibration dataset for lacustrine diatoms from Continental and Maritime Antarctica. The construction of inference models on the basis of the calibration datasets and on the basis of the calibration datasets constructed by ULg. The application of the transfer functions on sediment cores from the Larsemann Hills and Alexander Island. Integration of the biological (microfossils, molecular markers, pigments) and the sedimentological proxies in the reconstruction of climatic and environmental changes in the two Antarctic regions.

ULg
Testing and development of molecular methodologies for the reconstruction of past environments. Construction of a calibration dataset of rDNA markers from continental and maritime Antarctica. Participation in the construction of inference models and the integration of the different proxies.

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CLIMLAKE

CLIMATE VARIABILITY AS RECORDED IN LAKE TANGANYIKA

Duration of the project: 01/12/2001 – 28/02/2005
Budget: € 1.236.984,29
Keywords: Climate Change, Palaeoclimate, Limnology, Modelling, Tanganyika

CONTEXT

Many changes in the climate in the recent years affect the life of millions of people in the world (increase of air temperature, droughts or intense rainfalls...). For the humankind, it is important to understand the causes of those changes to either act directly upon them (by reducing CO_2 emissions and decrease the greenhouse effect for example) or to develop methods that will help to foresee and mitigate the type of climate changes expected. Information is needed on the natural variability of the climate on earth. One of the ways to reach this objective is to study sediments of lakes. The sediments of Lake Tanganyika are among the oldest on earth (10-20 millions years old). They contain remains of algae assemblages that developed in various lake and climate conditions. Information on the earth's climate history can help to forecast future change of the earth climate.

PROJECT DESCRIPTION

Objectives

The first objective of CLIMLAKE is to collect data for quantifying pelagic communities changes (bacteria, phytoplankton, protozoa, metazooplankton and pelagic fishes). It is aimed at relating these data to the physical and chemical variables, hydrodynamics and climate variability. These relationships should help to interpret changes in sediments and in some algae (diatom) assemblages in sediment cores, thereby providing insight on past climate at different time scales. A model (ECO-HYDRO) linking the lake movements with the changes in organisms in the lake during the 3 annual cycles will be developed.

The second objective of CLIMLAKE is to relate the local climate and changes of the lake characteristics with remote variations in oceanographic and climatic conditions. This objective should be achieved by coupling the eco-hydrodynamic model of Lake Tanganyika with a local and regional climate model.

The third objective is to use the coupled model ECO-HYDRO and the sediment proxies of the lake for investigating the environmental and climate changes that occurred during the past 1500 years at Lake Tanganyika and to compare this to the climate variability studied in other areas of the world during the same period.

Methodology

1 Set-up of a new programme for data acquisition, consisting of meteorological measurements (continuous) and limnological sampling (biweekly) at two stations of Lake Tanganyika during 3 years (2002 – 2004).
2 Development of an hydrodynamic model for predicting upwelling and internal waves from wind pattern and velocity and other relevant variables available from existing data sets of previous studies; validation of the model will be carried out with the new data acquired in the study.
3 Use of trace elements indicators (Sr, B, Ba, Mn, Rare Earth Elements, Cd, Zn, Pb, Cu) in order to quantify the water movements.
4 Test a bivalve mollusc (Pleiodon spekii) as a recorder for environmental change using microdrill and laser ablation with ICP-MS to perform reliable weekly to daily trace element distributions in chemically marked shells. After validation, we hope to use these shells to study past changes during the instrumental period (last 100 years) and tune the model.
5 Use a new isotopic indicator (based on silicon isotopes) to track changes of diatom production in the surface waters by calibration against primary production measurements and other productivity proxies (e.g. Ba excess).
6 Use of limnological indicators, in particular phytoplankton composition, which responds in the short term (days, weeks) to fluctuations of various factors (light, temperature, mixing regime, nutrient inputs to surface layers).
7 Continuation of analysis of sediment cores addressing environmental change in Lake Tanganyika during the past 1500 years using diatoms, sedimentology and other proxies.
8 Development of a descriptive lake model integrating climate and weather data, hydrodynamics, nutrient availability, primary production, plankton community structure and geochemical indicators.
9 Development of a predictive model to relate climate change and ecosystem function.

Interaction between the different partners

During a first period of 3 years, three teams (Namur-FUNDP, Gent-RUG and Tervuren-MRAC-KMMA) are developing a monitoring (in partnership with Zambian and Tanzanian colleagues) collecting and analysing data in several fields (limnology, plankton and geochemistry mainly). During the first 2 years, a fourth team (UCL) is developing a hydrodynamic model based on previous observations. This information will be updated and tuned at the end of the second year of monitoring with recent data. Ecological

information will then be implemented with the hydrodynamic model to constitute a multidisciplinary tool to be used for sediment interpretation and obtaining past climate information. The model will finally be used in the frame of climate change scenarios to forecast possible environmental changes.

Link with international programmes

- The project fits the objectives of IGBP's Core Project PAGES ("Global Palaeoclimate and Environmental Variability"). It aims to study the past climate variability (Timestream 1: Holocene with special emphasis on the last 2000 yr.) in a site along the PEP-3 (Pole-Equator-Pole (Afro-European) Transect. – The project is closely collaborating with IDEAL (International Decade for the East African Lakes), a program that is part of PAGES.

- The project meets also the aims of WCRP/CLIVAR as it will improve the understanding of decadal to century scale climate variability, especially as relevant to improving predictability, through the use of high resolution palaeoclimatic data as well as building a model dealing with the impact of the actual climate variability and changes on a great lake ecosystem.

- The project also corresponds to the themes defined in Key Action 2 "Global change, climate and biodiversity" of the "Energy, Environment & Sustainable Development" Programme of EC DG XII.

- The CLIMLAKE project works in close collaboration with two African research institutes: TAFIRI (Tanzanian Fisheries Research Institute) in Tanzania and DOF (Department of Fisheries) in Zambia.

Expected results

- The project is presented in a web site that is updated every 6 months (http://www.fundp.ac.be/urbo/climlake.html).
- Beside the international peer review publications, the project will present data adapted to diverse types of audiences (scientific, politics, general public...).
- An interdisciplinary database will be made available to the climate modellers. It will hold three types of information: (a) Lake Tanganyika information (limnology), (b) regional data on climate, (c) global data indices.
- The results of the project (palaeoclimate series) will be made available to the international research community. This is a participation of Belgium researchers to important international climate research program such as IGBP/PAGE.
- This research is part of the international effort dealing with the global warming issue. The records of global signals and their comparisons, particularly for the recent Holocene is a key point to understand actual climate changes.
- An international symposium will be organised on "The African Rift Great Lakes as recent and past climate impacts recorders".
- Climate-fisheries relationships will help to support the fisheries management and its sustainability at Lake Tanganyika.

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PARTNERS

Activities

FUNDP
Limnological sampling (temperature, light, dissolved oxygen, conductivity, pH, nutrient, metazooplankton, elemental analysis, pigments,...).

MRAC-KMMA
- Diatom productivity (silicon isotopes) and geochemistry of water, particles and mollusc shells.
- Database (climate, limnology...).

RUG
- Study of the present phytoplankton (distribution, dynamics).
- Palaeolimnological analysis of fossil diatoms in sediment cores.

UCL
- Building a 3D hydrodynamic model from wind pattern, velocity and other variables.
- Coupling to an ecological model in collaboration with all the teams.

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ESAC II

EXPERIMENTAL STUDIES OF ATMOSPHERIC CHANGES II

Duration of the project: 01/12/2001 - 28/02/2005
Budget: € 1.049.308,49
Keywords: Stratospheric Ozone, Climate Change, Air Pollution

CONTEXT

ESAC II is a collaboration between four Belgian teams in a national effort to investigate the Earth's atmospheric variability and changes. It started in 2001, for 4 years, and it is the continuation of a former project, ESAC I (1997-2000), involving the same research consortium. The project contributes to the worldwide effort of monitoring the atmosphere's state and evolution, for acquiring a better understanding of the controlling processes, among others, in support of regulations for protection, like the Montreal and the Kyoto Protocols. Time series of observational data on the chemical composition of the atmosphere will be extended, studies of atmospheric processes relevant to global change will be expanded and the results will be disseminated to a larger public, including environmental authorities or policy makers who are concerned with sustainable development.

PROJECT DESCRIPTION

Objectives
The main objectives of ESAC II are:
- to extend and improve the internationally recognised extensive Belgian contribution to atmospheric research that started in the fifties;
- to investigate, mainly with experimental means, the chemical composition of the atmosphere, to detect and understand its evolution. Special attention will be paid to the evolution of the ozone layer and chemical species and processes with an impact on climate change;
- to support the Belgian policies and decisions regarding the Amendments to Montreal and Kyoto Protocols.

Methodology
In ESAC II, regular surveillance of the atmosphere is achieved with continuous measurements from ground-based instruments at four European stations: Ukkel (Belgium, 50.5°N, 4.3°E), Harestua (Norway, 60.2°N, 10.7°E), Jungfraujoch in the Swiss Alps (46.5°N, 8°E), and Observatoire de Haute Provence (France, 44°N, 6°E). These remote sensing instruments target key atmospheric components that play a role in ozone depletion, the increase of UV radiation at the Earth's surface, or climate change. At Ukkel, the monitoring techniques include regular ozone balloon soundings. In addition a few measurement campaigns are programmed to contribute to instrument intercomparisons and particular more local studies. Among the selected campaign sites is Ile de la Réunion (22°S, 55°E) in the subtropics. Laboratory measurements of the spectroscopic properties of atmospheric species are carried out in support of the field observations. Finally, numerical modelling activities contribute extensively to the interpretation of atmospheric observations. The data are analysed, validated and "translated" into information that will be valuable for various bodies interested in the variability of the Earth's atmosphere and its long-term evolution.

Interactions between the different partners
The partners involved are: the Belgian Institute for Space Aeronomy, the Royal Meteorological Institute of Belgium, the Groupe Infra-Rouge de Physique Atmosphérique et Solaire of the University of Liège and the Laboratoire de Chimie Physique et Moléculaire of the University of Brussels. They work in close collaboration with international partners. The groups share manpower and instruments for performing observations and they exchange data and expertise for the analysis and interpretation of measurements.

Link with international programmes
The observatories involved in ESAC II are part of the Network for the Detection of Stratospheric Change (NDSC) and the results of the observations will be archived in the NDSC database. NDSC is a major component of the international effort of monitoring and investigating the atmosphere. It has been endorsed by national and international scientific agencies, including the International Ozone Commission (IOC), the United Nations Environment Programme (UNEP), and the World Meteorological Organization (WMO). ESAC II research objectives are also in line with several other international programmes such as the research project on Stratospheric Processes and their Role in Climate (SPARC) that is part of the World Climate Research Programme (WCRP).

Expected results and/or products
The ESAC II results will be of interest for both the scientific community and the larger public audience:
- ESAC II will provide 4-years extended time series of ozone and key ozone-related chemical compounds, radioactively active gases, source gases, tropospheric species and spectral UV irradiance measurements, at the 4 stations involved.
- The data and the coupling of them with model

studies provide new insights in the chemical composition and behaviour of the atmosphere.
- Investigations of the tropical atmosphere will be initiated with observations at Ile de la Réunion.
- New observational techniques and data analysis methods are adjusted, e.g., for the determination of the tropospheric concentrations of key species, and for improving the precision of spectroscopic laboratory measurements.
- Geophysical and spectroscopic data are submitted to international databases for further exploitation by modellers, satellite validation teams, etc... ESAC I and ESAC II are providing very valuable independent data for satellite validation.

Results will be disseminated regularly via the project website (http://www.oma.be/ESACII/Home.html) and publications, and through participation of the consortium to international assessments and/or press releases. The goal is to inform decision-makers and environmental authorities at regional, national, European and worldwide levels on the progress and findings of the project, in particular issues of relevance to the Montreal and the Kyoto Protocols.

PARTNERS

Activities

All partners participate in atmospheric monitoring with specific instruments, as well as in data analysis, validation, interpretation and archiving, and information exchanges with dedicated users.
In particular:

BIRA-IASB
The Belgian Institute for Space Aeronomy co-ordinates the project and related webpage, and the campaign-based activities. It operates instruments at all 4 stations.

KMI-IRM
The research group 'Ozone' of the Royal Meteorological Institute of Belgium co-ordinates the dissemination of information. It is responsible for the O_3 data at Ukkel.

ULg
The University of Liège co-ordinates all activities concerning the long-term surveillance of the atmosphere and related data analysis, validation and interpretation. It performs measurements at the Jungfraujoch since the early 50s.

ULB
The University of Brussels co-ordinates the laboratory measurements and the collection of supporting data.

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CALMARS

VALIDATION OF MARINE CALCAREOUS SKELETONS AS RECORDERS OF GLOBAL CLIMATE CHANGE

Duration of the project: 01/12/2001 - 28/02/2005
Budget: € 1.112.025,56
Keywords: Palaeoclimate, Carbon Cycle, Climate Change, Sea Surface Temperature

CONTEXT

Five Belgian Institutions (the Royal Belgian Institute of Natural Sciences: Department of Invertebrates (RBINSc); the Royal Museum for Central Africa, Section of Mineralogy, Petrography and Geochemistry (MRAC); Université Libre de Bruxelles, Laboratoire de Biologie Marine (ULB); Vrije Universiteit Brussel, Laboratory of analytical Chemistry and Laboratory of Isotope Geochemistry (VUB); University of Antwerp, Ecophysiology, Biochemistry and Toxicology Unit, Department of Biology (UA)) have set up a project to validate the use of CALcareous MARine Skeletons as recorders of global climate changes.
Potential recorders have been selected among three taxa: sclerosponges, bivalves, and echinoderms, for their contrasted characteristics: lifetime, growth rate, and mineralisation features. Areas of interest spread from the North East Atlantic Ocean to the Caribbean.

PROJECT DESCRIPTION

Objectives
The potential as environmental recorders of sclerosponges, bivalves, and echinoderms is well known, and the originality of CALMARS rather resides in three new perspectives.
- the comparative analysis of contrasted taxa will sustain the validity of the recorded global changes;
- laser ablation technology will ensure day to seasonal resolution depending of the taxon used;
- focus will go to a better understanding of the pathways of proxy incorporation and on the relative controls by environmental and physiological conditions, emphasising on reconstruction of sea surface temperature (SST), salinity, phytoplankton biomass and productivity, and trace metal content.

Methodology
CALMARS approach is based on a combination of field and laboratory work. Field work consists in regular samplings of each group at a few selected sites in both tropical and temperate settings (North Sea & Scheldt, Norway, Jamaica and Kenya) where long-term monitoring of environmental conditions is carried out to follow up the recording of seasonal variations in the skeleton. Single samplings along environmental gradients are also performed in order to assess the recording of latitudinal variations. Specimens preserved in museums will help to extend data in time and localities. Proxies studied are Mg, Sr, Ba, Cd, Mn, U, B, Pb, Zn and O13Ccarb, O18Ocarb, using laser ablation ICP-MS in order to gain a high time resolution. Effects of environmental parameters are tested for each group under experimental conditions (in situ with incubation chambers or in aquarium). Impact of ambient substrate concentrations and physico-chemical conditions are also studied in controlled in-vitro experiments, during which incorporation of proxy are followed after radioactive and stable isotope spiking to ascertain results obtained along naturally occurring gradients.

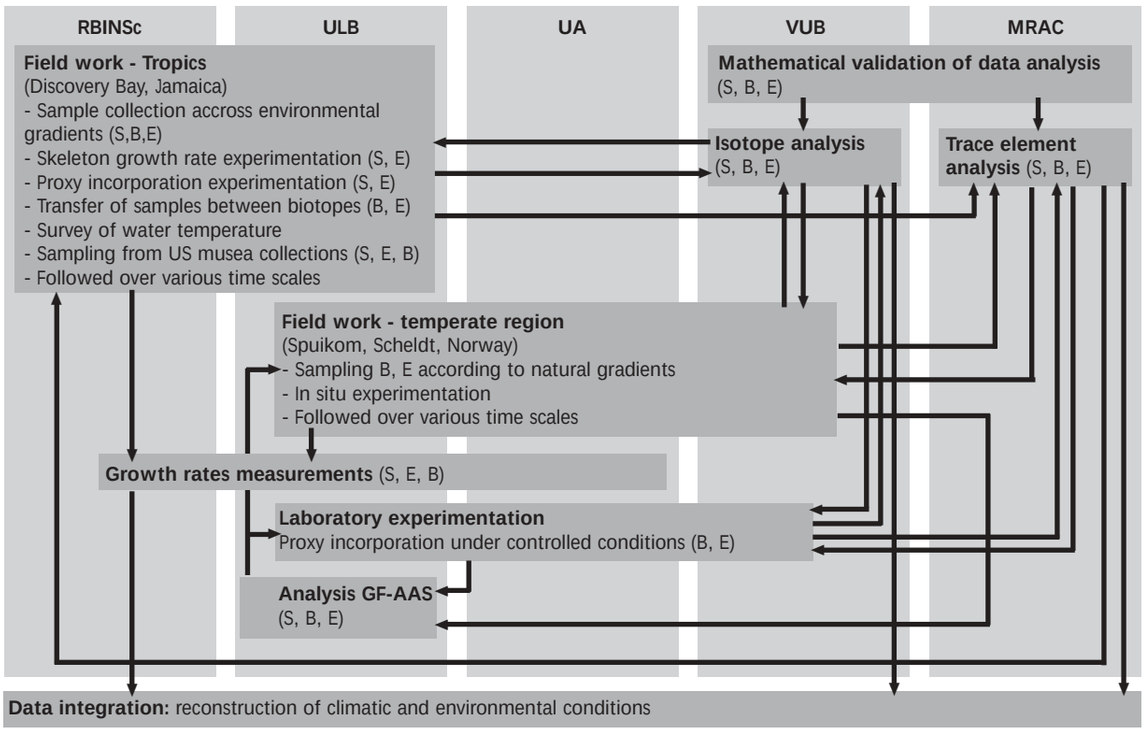
Interaction between the different partners
See reverse side

Link with international programmes
Palaeo-oceanographic studies of climate change to modern-day analyses of pollution impacts.

Expected results and/or products
CALMARS aims at improving and extending the records of global change in the oceanic domain with a peculiar interest for the climate databases. Through a network of biologists and geochemists of complementary experience, CALMARS intends to:
- better validate the existing proxies by a thorough experimental investigation of the physiological and environmental factors that interplay to control the proxy incorporation within the various existing mineralogical types of biogenic carbonates;
- refine the existing records by improving the recently developed analytical tools and generating very-high resolution records of the validated proxies;
- greatly enlarge the application scales of these proxies by a direct comparison of different biological taxa under contrasted tropical and temperate settings from the North Atlantic ocean. From this, CALMARS expects to generate robust high-resolution time series of several tracers which are of prime importance to better simulate the carbon cycle and will therefore be used by other research networks to understand present day global change and predict future changes;
- develop algorithms for climatic and environmental change from proxy records.

Development of educational aspects from this research is planned by creating and regularly updating a website, describing the main lines of the research. A scientific film and/or a didactic CD-ROM produced by the pedagogic staffs from the two involved federal scientific institutions (RBINSc and MRAC) are also planned.

Interaction between the different partners



S= sclerosponges; B=bivalves; E=echinoderms

PARTNERS

Activities

RBINSc has a long experience on Caribbean sclerosponges (ultra-structure and in situ growth rate measurement). Fieldwork is conducted at the Discovery Bay Marine Laboratory, Jamaica.
ULB has a large experience in biomineralisation processes of echinoderms through morphological, biochemical, physiological and environmental approaches, both in the field and in the laboratory.
UA performs research on bioavailability, bioaccumulation and effects of metals in aquatic organisms and studies effects of environmental conditions on kinetics of metal accumulation.
MRAC and VUB-ANCH have developed together expertise for trace element analysis by ICP-MS and Laser Ablation ICP-MS.
VUB-GISO has a long-standing experience in stable isotope geochemistry as applied to climate change.

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CCCC

ROLE OF OCEANIC PRODUCTION AND DISSOLUTION OF CALCIUM CARBONATE IN CLIMATE CHANGE

Duration of the project: 01/12/2000 – 28/02/2005
Budget: € 718.593,75
Keywords: Global Change, Carbon Dioxide, Production and Dissolution of Calcium Carbonate, Coccolithophorid, Marine Inorganic Carbon Cycle

CONTEXT

The ocean constitutes a large sink for anthropogenic CO_2 and thus plays a significant role in the global biogeochemical cycle of carbon and its perturbations. There remain, however, large uncertainties concerning the uptake of anthropogenic carbon by the ocean, mainly due to insufficient knowledge of biological processes controlling the CO_2 concentrations in surface waters.

In particular, little attention has been paid to the role of precipitation of calcium carbonate by calcifying organisms and the re-dissolution of their skeletons in marine carbon cycle. These processes play, however, a significant role in the buffering capacity of seawater and its potential to act as a sink or a source of CO_2 for the atmosphere. Their quantifications are therefore fundamental not only for the understanding of the present-day situation but also for the predictive studies in the context of global warming.

PROJECT DESCRIPTION

Objectives
The present research project (www.ulb.ac.be/sciences/dste/ocean/carbonate/frame.html) contributes to a better understanding of the oceanic inorganic carbon cycle and its role in climate change. We aim at studying the processes associated with the oceanic production and dissolution of calcium carbonate in order to quantify the role of calcifying phytoplanktonic organisms in sequestering CO_2.

Methodology
The objectives of our study will be achieved by combining field investigations, laboratory experiments and modelling efforts.

Our field of study concerns the area of La Chapelle Bank (about 47°30'N, 7°30'W) in the Gulf of Biscay (Northeast Atlantic Ocean). This site has been regularly visited since more than one decade in the framework of Belgian (Global Change) or European (OMEX) research projects, and a good knowledge of the physical processes occurring in the region has been obtained. In addition, coccolithophorid blooms have been frequently observed in the Gulf of Biscay. Previous measurements of the vertical distribution and fluxes of calcium carbonate ($CaCO_3$) indicate a rapid dissolution of the skeletons during settling even in the upper water column over-saturated with respect to $CaCO_3$. This site is thus a suitable location for studying the oceanic inorganic carbon cycle.

Field investigations, supported by remote sensing data, will provide basic, physical, chemical (nutrients, organic and inorganic carbon species), biological (phytoplankton and zooplankton) information. Suspended matter will be collected by continuous centrifugation, in situ filtration of large volumes of water and short-term deployments of sediment traps.

Process-oriented studies of the production of organic and inorganic particulate carbon and the dissolution of calcium carbonate will be conducted both in the field and during laboratory assays, using 14C and 45Ca incorporation experiments. The influence of zooplankton grazing and of microbial degradation of organic matter on the dissolution of $CaCO_3$ will be investigated in detail.

Particulate material collected in the Gulf of Biscay will be studied from a physical and chemical point of view using modern microscopic and spectroscopic methods for their composition, morphology and dissolution features.

The data acquired during this project will be used to formulate and to parameterise the rate equations for the production and dissolution of calcium carbonate. They will also be used for validation purposes and/or as input variables of the ocean carbon cycle (OCC) models.

Interaction between the different partners
The co-ordinator, the Laboratory of Chemical Oceanography and Water Geochemistry at the University of Brussels (ULB-LOCGE), is responsible for quantifying the production of organic and inorganic carbon and for studying the dissolution mechanisms of biogenic $CaCO_3$ related to microbial respiration.

The Laboratory of Ecology and Systematics at the Free University of Brussels (VUB-ECOL) will investigate the role of zooplankton grazing in the dissolution of $CaCO_3$.

The Micro and Trace Analysis Centre at the University of Antwerp (UIA-MiTAC) will contribute to the physical and chemical characterisation of suspended matter in relation to the $CaCO_3$ cycle.

Link with international programmes

The link with existing international programmes will be made via the members of the Users Committee.

- Dr. C. Sabine (University of Washington) is involved in the global estimations of the natural and anthropogenic reservoirs of carbon in the WOCE and JGOFS programmes.
- Dr. R. Francois (Woods Hole Oceanographic Institution) will contribute to a more complete description of the transfer of carbon between the atmosphere and the ocean interior within the framework of his project at WHOI.
- Our project can be linked with the GAIM-IGBP programme via Dr. O. Marchal (Woods Hole Oceanographic Institution) who will simulate $CaCO_3$ fluxes in the global ocean models developed within the framework of the Ocean Carbon-Cycle Model Inter-comparison Project.
- The present research is also linked with the "seatruthing" of remote sensing data collected by SeaWiFS and MODIS through our collaboration with S. Groom (Plymouth Marine Laboratory).

Expected results and/or products

- The mechanisms and rate of individual processes of calcium carbonate production and dissolution will be clarified.
- The integrated production and fate of calcium carbonate in the euphotic zone will be evaluated for the area under investigation.
- The fluxes of organic and inorganic carbon at a larger spatial and temporal scale may be described using coupled 1-D hydrodynamic and biological models.

PARTNERS

Activities

ULB

The Laboratory of Chemical Oceanography and Water Geochemistry (LOCGE), headed by Prof. Lei Chou, has a long standing experience in the study of the biogeochemical processes and their perturbations affecting the cycle of various elements such as carbon, nutrients, major, minor or trace elements either on a local or global scale in the coastal seas and the ocean margins.

VUB

The Research Group Ecology and Systematics (ECOL), headed by Prof. Marie-Hermande Daro, is specialised in zooplankton trophodynamics. Its research focuses on the ecological functioning of marine ecosystems with special attention to the first tropic levels (phyto- and zooplankton).

UIA

The Micro and Trace Analysis Centre (MiTAC), headed by Prof. René Van Grieken, has extensive experience in micro and trace analysis applied to environmental studies. The principal area of research concerns the evaluation of atmospheric deposition of nutrients and heavy metals to the North Sea and the study of aerosols in remote areas and their influence on the global climate.

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ANTHROPOGENIC AND BIOGENIC INFLUENCES ON THE OXIDISING CAPACITY OF THE ATMOSPHERE

Duration of the project: 01/12/2001 - 28/02/2005
Budget: € 1.167.900,77
Keywords: Atmosphere, Tropospheric Chemistry, Human Impact, Vegetation, Hydrocarbons

CONTEXT

Human activities induce large changes in the composition of the atmosphere. For example, industrial activities, the burning of fossil fuels, agricultural practices and vegetation fires release large amounts of gases and particles to the atmosphere. Chemical processes in the troposphere determine the fate and role of many of these pollutants. They are responsible for pollution (smog) episodes, and they control the abundance of greenhouse gases (ozone, methane) and aerosols. However, they are still poorly quantified, to a large extent because of their interaction with biogenic compounds (hydrocarbons) released by vegetation.

PROJECT DESCRIPTION

Objectives

- To better understand the processes controlling the distribution of chemical species in the troposphere, in particular oxidants and chemically controlled greenhouse gases (methane, ozone).
- To determine the human influences on the chemical composition of the troposphere, and provide estimates of its possible future evolution.
- To determine the impact of biogenic hydrocarbons on the tropospheric composition.
- To elucidate the oxidation mechanism of important biogenic hydrocarbons (terpenes) using laboratory (fast-flow reactor), theoretical and modelling studies.
- To generate the mechanistic data needed by atmospheric chemistry models in order to estimate the effect of terpenes on the composition of the atmosphere.

Methodology

- Use of the fast-flow reactor technique for the simulation of atmospheric chemistry processes at a laboratory scale.
- Development and application of new analytical techniques for the determination of the terpenes oxidation products.
- Development and application of theoretical techniques (quantum calculations, Structure-Activity Relationships, etc.) for the determination of the terpenes oxidation products, including aerosols.
- Development of a comprehensive chemical mechanism for the oxidation of terpenes in atmospheric conditions and validation of this mechanism by confrontation with laboratory results.
- Determination of the global emissions of biogenic hydrocarbons, and investigation of their uncertainties.

Interactions between the different partners

- Close collaboration between the teams of Christiaan Vinckier (KULeuven) and Etienne Arijs (BIRA-IASB) for the application of the fast-flow reactor technique to the terpenes oxidation.
- Close collaboration between the teams of Jean-François Müller (BIRA-IASB) and Jozef Peeters (KULeuven) for the development and validation of the terpenes oxidation mechanism.
- The mechanistic data obtained from the laboratory and theoretical studies will be integrated in a chemical model of the troposphere by the team of Jean-François Müller in order to determine their impact on the tropospheric composition.

Link with international programmes

- EUROTRAC2: contributions of the KULeuven teams to the subproject CMD (Chemical Mechanism Development);
- IPCC (Intergovernmental Panel on Climate Change) : contribution of Jean-François Müller to e.g. the 3rd Assessment Report IPCC/TAR;
- Integration in European research networks of the 5th Framework Programme.

Expected results

- New laboratory and theoretical techniques for investigating the oxidation of biogenic hydrocarbons (monoterpenes).
- New comprehensive mechanisms representing the oxidation of several important biogenic hydrocarbons (monoterpenes) in laboratory as well as in atmospheric conditions.
- Better assessment of the role of these hydrocarbons on the global troposphere, in particular regarding the production of aerosols.
- Better assessment of the impact of anthropogenic emissions on the composition of the global troposphere.

PARTNERS

Activities

The groups of Vinckier and Arijs conduct laboratory studies of the oxidation of several monoterpenes by OH in the presence of NO. They benefit from the experience gained by Vinckier's team during the previous SPSD programme. In addition, Arijs and Peeters's teams investigate other selected organic reactions.
The groups of Peeters and Müller combine theoretical and modelling studies in order to construct an oxidation mechanism for monoterpenes in general conditions. Peeters's team focuses on the gas-phase reaction steps, while Müller's group works at their integration in a model that includes gas/particle-partitioning effects. The latter group also assesses the biogenic emissions as well as global impacts using a three-dimensional chemical model.

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ATMOSPHERE AND CLIMATE
MARINE ECOSYSTEMS AND BIODIVERSITY
TERRESTRIAL ECOSYSTEMS AND BIODIVERSITY
NORTH SEA - ANTARCTICA - BIODIVERSITY

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BELCANTO II

ASSESSING THE SENSITIVITY OF THE SOUTHERN OCEAN'S BIOLOGICAL CARBON PUMP TO CLIMATE CHANGE

Duration of the project: 01/12/2000 – 28/02/2005
Budget: € 1.466.414,14
Keywords: Southern Ocean, Climate Change, Air-Sea CO_2 Fluxes, Biological Carbon Pump, Coupled Hydrodynamic-Biogeochemical Modelling

CONTEXT

Because of unique hydrodynamic and ecological features the Southern Ocean plays a key role in the global air-sea exchange of CO_2. A sustained supply of essential nutrients (N, P, Si) through deep-water upwelling ensures the potential of the SO to further enhance CO_2 uptake via the biological pump. However, in the High Nutrient Low Chlorophyll waters of the modern Southern Ocean this does not occur because biological production is iron limited. Future climate-driven changes in water circulation, eolian transport of continental dust, sea ice extent and lithogenic matter input from Antarctic continent, shelf and slope areas will modify the natural fertilisation patterns of the Southern Ocean. This together with changes in stratification of the upper ocean will impact on ecosystem structure and function, export production and air-sea CO_2 flux, with a feedback to climate.

PROJECT DESCRIPTION

This project focuses on the role of the Southern Ocean in Global Change. The research is conducted by BELCANTO (BELgian research on Carbon uptake in the ANTarctic Ocean), an interdisciplinary network of biologists, geochemists, physical and ecological modellers. Focus is on the development of geochemical proxies and numerical tools for understanding the present-day functioning of the biological carbon pump in the iron-limited Southern Ocean and predicting its evolution in response to increasing atmospheric CO_2. The research methodology will combine collection of historical and new field data, laboratory process-level studies and numerical work in order to improve our understanding of the mechanisms controlling the production of bloom-forming phytoplankton groups, their sinking rate and biodegradation when exported to the intermediate and deep waters (100-1000 m).

Objectives
The general objective is to develop a 3-D ocean - sea-ice - biogeochemical model for the Southern Ocean south of 30°S, in order to budget the present-day CO_2 uptake and predict the ocean's response to doubled atmospheric CO_2, scheduled for the second-half of the 21st century.

Specific objectives are: (1) the set-up of in-vitro process studies to achieve a mechanistic understanding of (i) the different factors that control growth, sedimentation of Antarctic phytoplankton and its bacterial breakdown and (ii) the potential proxies of these processes; (2) to complete existing databases for carbon fluxes; (3) to develop a realistic ocean - sea-ice - biogeochemical model for the region south of 30°S; (4) to simulate the situation at doubled atmospheric CO_2.

Methodology and interaction between the different partners
1 In-vitro experiments with phytoplankton cultures (ULB-VUB-MRAC) to study the factors controlling (i) growth, sedimentation and decay of phytoplankton (diatoms and Phaeocystis) under saturating and non saturating conditions of light, iron and Si (ULB) and (ii) new production (VUB) and the expression of proxy signals such as Ba, barite (VUB-MRAC), 15N (VUB), 30Si (MRAC).

2 Composing a database for carbon fluxes (ULg-VUB-MRAC)
pCO_2 (ULg): (1) Collection of data for under-sampled regions and seasons; (2) Construction of an autonomous pCO_2 analysis system for use on board supply ships; (3) Elaboration of algorithms for the reconstruction of pCO_2 distribution fields based on satellite observation (SEAWIFS) of SST and Chl a. (4) Deduce atmosphere-ocean CO_2 fluxes using ERS wind speed data and pCO_2 distribution fields.

Carbon export and mineralisation flux (VUB – MRAC): Estimation of the carbon export flux and the POC mineralisation profile in the mesopelagic water column (100-1000m) using proxies (new production, f-ratio; 234Th-deficit; 30Si of biogenic silica; 15N of suspended organic matter; Ba-barite). These export fluxes are compared with POC and proxy fluxes in sediment traps, sediments and with model results.

Optimisation of the Ba-barite proxy (VUB-MRAC): (1) The co-variation of mesopelagic Ba and POC export is verified; (2) Identification of the different factors that control the Ba-signal; (3) Comparison of export production based on mesopelagic Ba with export production based on POC flux in sediment traps; (4) Reconstruction of the POC mineralisation flux and mineralisation profile for the mesopelagic water column; (5) Optimisation of existing algorithms relating the mesopelagic Ba signal to export production and develop new ones.

3 Numerical experimentation: Construction of a 3-D Ocean-Ice-Biogeochemical model (ULB-UCL)
Coupling of a biogeochemical model (SWAMCO) to a 3-D ocean - sea-ice model: (1) Optimisation of the 3-D ocean – sea-ice model; simulations for the modern ocean (1988-2000) and for the future ocean under doubled atmospheric CO_2 (UCL); (2) Aggregation and optimisation of the existing 1-D biogeochemical SWAMCO model (ULB); (3) Elaboration of an integrated ocean – sea-ice – biogeochemical model (UCL-ULB).
The validated integrated model is used for the estimation of the CO_2 mass balance on global, regional and seasonal scales. Sink and source regions are identified as is the sequestration of organic carbon in the deep sea. The model is used to simulate the situation at atmospheric CO_2 redoubling.

Expected results
A better evaluation of the role of the Southern ocean in Global Change. This will be achieved as a result of the development and improvement of complementary proxy approaches contributing to the understanding of the biological carbon pump functioning in an iron-limited Southern Ocean. Simulation of the Southern Ocean's carbon pump functioning at CO_2 redoubling.

PARTNERS

Activities

VUB-ANCH
Has expertise for (i) the determination of new production based on 15N isotope dilution methods and the modelling of nitrogen fluxes related with uptake and release; (ii) the application of proxies of new production and export production (Ba-barite; 234Th-deficit; 15N).

ULB-ESA
Has expertise in the field of phytoplankton processes (growth, sedimentation, grazing, bacterial breakdown) and the development of biogeochemical models.

MRAC-KMMA
Has expertise in the field of trace element and isotope proxy analysis and interpretation.

UCL-ASTR
Has expertise with hydrodynamic modelling coupled ocean – sea-ice models.

ULg-GHER
Has expertise in the field of ocean – atmosphere CO_2 exchange and physicochemistry of oceanic inorganic carbon.

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AMICS

ANTARCTIC ICE SHEET DYNAMICS AND CLIMATIC CHANGE: MODELLING AND ICE COMPOSITION STUDIES

Duration of the project: 01/12/2000 – 28/02/2005
Budget: € 774.816
Keywords: Glaciology, Glacier Modelling, Ice Composition, Climate, Antarctica

CONTEXT

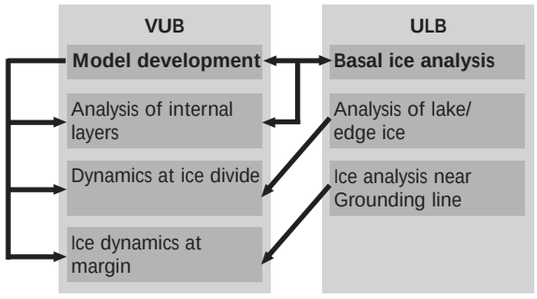
Over the last decades, a number of deep ice-core drillings were carried out in Antarctica, such as Vostok, Dome Fuji and more recently Dome Concordia. Analysis of these cores provides the scientific community with a continuous record of ice composition, which makes it possible to reconstruct climate and its variability over more than 500,000 years back in time (and possible to 800,000 years). These data are necessary to understand the variability and stability of climate (both from the past as for the future) and the associated environmental change. A central role is played by the Antarctic ice sheet and its relation with sea level.

PROJECT DESCRIPTION

Objectives
The main objective of AMICS (Antarctic Ice Sheet Dynamics and Climatic Change: Modelling and Ice Composition Studies) network proposal is to contribute to the international research effort leading to an improved understanding of the dynamic behaviour of the Antarctic ice sheet resulting from climatic change and its composition. More specifically it aims at a better knowledge of the internal dynamics of the Antarctic ice sheet and to a better assessment of the interactions of the ice sheet with its boundary conditions. The major components of this interdisciplinary research objective are modelling and ice composition studies.

Methodology
The aim of this research network is to clarify the dynamic interactions between the ice sheet and its boundary conditions, such as the substratum, based on analysis of ice from the basal part of the Antarctic ice sheet and ice sheet modelling. Results from the analyses will put constraints on the basal boundary conditions of the numerical model and will make validation of the model possible with regard to the melting and refreezing processes at the base. Further constraints come from radio-echo sounding (RES) surveys and SAR interferometric applications. For this purpose, the high-resolution numerical model of complex ice flow will be adapted to three-dimensions and refined. With the numerical model we will translate the results of the ice composition analyses into physical processes, hence providing the scientific community with a model tool of complex basal interaction. As basal processes play an important role in the onset of fast-flowing areas such as ice streams, the role of ice streams, outlet glaciers and ice shelves in the stability of the Antarctic ice sheet and their influence on the variability of the ice sheet with changing climate will be investigated.

Interaction between the different partners



Link with international programmes
Both teams are involved in the EPICA project (European Project on Ice Coring in Antarctica, ESF) and are the only Belgian teams that carry out field work and co-operative research on the interior ice sheet of Antarctica. There is a close collaboration with the Vostok Project, the National Institute of Polar Research (Japanese Antarctic Research Expedition), and the New Zealand Antarctic Project, besides the collaboration with a large number of foreign scientific research institutes and groups.

Expected results and/or products
We expect to obtain analytical results from basal ice of Antarctic deep drillings, which will allow investigating the basal ice and allow specifying the dynamical behaviour of the ice sheet during past and future climatic changes, providing constraints to modellers. It is envisaged that the research on the basal mechanics as well as the numerical improvement of the models will add significant knowledge to the results already obtained in this field.

Results of this research will be circulated through publications in high-ranking international scientific journals (peer reviewed). They will be represented at international symposia and workshops, with emphasis on those workshops dedicated to Antarctic glaciology. A website is started to provide the community with the project results:
http://www.vub.ac.be/DGGF/amics

PARTNERS

Activities

The two research teams of this network are the only ones in Belgium that carry out both field work and research regarding the Antarctic inland ice sheet. Both are involved in the ongoing EPICA project (European Project for Ice Coring in Antarctica). The VUB team has a long-standing experience in modelling of ice sheets and glaciers and model development for studying ice dynamics. The ULB team is specialised in the study of ice composition, as a tool for understanding the formation and deformation of basal ice retrieved either from major deep ice-core drillings or from natural outcroppings in both Greenland and Antarctica

CONTACT INFORMATION

Website of the network:
www.vub.ac.be/DGGF/amics

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MILMO

MODELLING THE EVOLUTION OF CLIMATE AND SEA LEVEL OVER THE THIRD MILLENNIUM

Duration of the project: 01/12/2001 - 28/02/2005
Budget: € 970.255,26
Keywords: Climate, Sea Level

CONTEXT

A large number of modelling studies have addressed the likely effects of greenhouse gas induced climate change over the 21st century, but the longer-term effects have received much less attention. Yet these effects could be very significant, as a persistent increase in global mean temperature may ultimately influence the large-scale processes in the Earth system that play a central role in determining global climate. The aim of MILMO is to provide decision-makers with long-term projections of climate and sea level changes with increased confidence.

MILMO consists of Belgian scientists who are deeply involved in the IPCC (Intergovernmental Panel on Climate Change) and in international research programmes on climate change such as IGBP (International Geosphere and Biosphere Programme) and WCRP (World Climate Research Programme). This ensures that the results will be widely disseminated both to scientists involved in studying climate change and the communities involved in impact studies.

PROJECT DESCRIPTION

Objectives

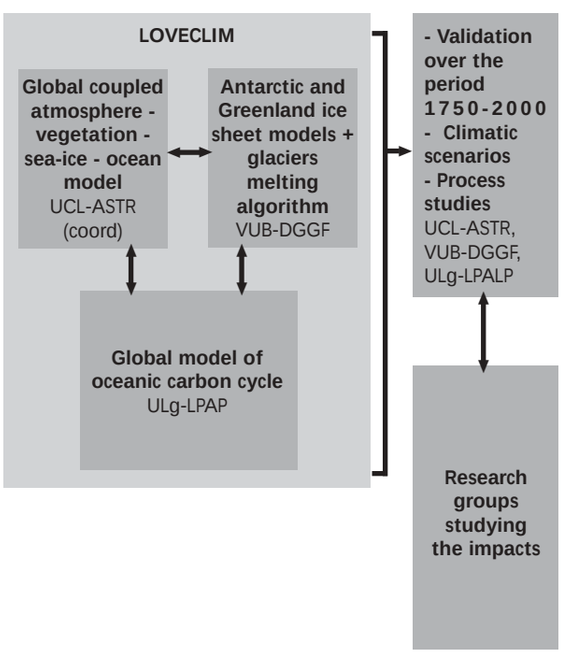
The overall objective of MILMO is to improve projections of global and European climate and sea level changes for the 21st century and to profoundly investigate processes and dynamic feedback in the climate system as well as the likelihood of abrupt climate and sea level changes during the 3rd millennium. The approach is to implement and use an efficient three-dimensional atmosphere–vegetation–sea-ice–ocean model coupled with a model of the oceanic carbon cycle and improved thermo-mechanical models of the Greenland and Antarctic ice sheets. With the coupled model, we will study climate and sea-level changes for the periods 1750–2000, 2000–2100, and 2000–3000. A series of sensitivity experiments will assess the importance of including interactive ice sheet, land-vegetation, and carbon cycle representations in the model.

Methodology

Investigating the long-term response of climate and sea level to human activities requires the operation of global three-dimensional models, which encompass all relevant components of the climate system (i.e., the atmosphere, the oceans, the ice masses, the upper Earth's mantle, and the living world). But most importantly, these models must be computationally fast enough so that integration of longer duration and a larger number of sensitivity experiments can be performed than is usually the case with climate general circulation models. To achieve this requires some simplifications in the most CPU-time demanding model component, which is usually the atmospheric component.

Models of this type do not yet exist but are being developed in several European and American research laboratories. Here we propose to build such a model (LOVECLIM) by coupling an efficient three-dimensional atmosphere–vegetation–sea-ice–ocean model with a model of the oceanic carbon cycle and with thermo-mechanical models of the Greenland and Antarctic ice sheets. All three model components were partly developed within the First Multi-annual Scientific Support Plan for a Sustainable Development Policy (SPSD I). We will also implement a global algorithm for calculating the melt from glaciers and small ice caps and a scheme for deriving thermal expansion from the ocean model to be able to assess all major contributors to global sea level changes.

Interactions between the different partners



Link with international programmes
MILMO's objectives are along the lines of those of the CLIVAR (Climate Variability and Predictability) and ACSYS/CliC (Arctic Climate System Study/Climate and Cryosphere) programmes of the World Climate Research Programme (WCRP), the International Geosphere and Biosphere Programme (IGBP) and the 6th Framework Programme of the European Union.

Expected results and/or products
Once validated, the model will be utilised to advance our understanding of interactions in the climate system, to improve climate change projections at the century time scale and beyond, and to explore the threat of possible rapid climate and sea level changes during the 3rd millennium. Dissemination of results will take place via the training of young researchers, participation in and presentations at national and international scientific meetings and publication of results in international, peer-reviewed scientific journals. As far as possible, workshops will be organised with other Belgian teams involved in the Second Multi-annual Scientific Support Plan for a Sustainable Development Policy (SPSD II) to inform them about our results. A specific website will be created on the server of the co-ordinator. This website will provide full information about the objectives, the models, and the progress of the project. Furthermore, it will include a database with the relevant model outputs. It is also planned to incorporate the outcomes of MILMO's projections of climate and sea level changes in international climatic databases such as the IPCC's one. So that a public as large as possible can know about the research results, members of MILMO will engage in vulgarisation activities such as (1) publication of documents to be used by policy makers, the OSTC, non-governmental organisations, enterprises, and the general public, (2) conferences in universities, schools, and societies, (3) press releases, and (4) printed press, television, and radio interviews.

PARTNERS

Activities

UCL
Over the last 30 years, UCL-ASTR has gained a worldwide reputation for the study of climate, climatic changes, and mesoscale meteorology. In particular, it has a great deal of expertise in three-dimensional global climate modelling.

VUB
Since more than 15 years, VUB-DGGF is deeply involved in ice-sheet modelling. It has developed three-dimensional thermo-mechanical models for the Greenland and Antarctic ice sheets that were amongst the first of their kind, and which are widely regarded as state-of-the-art.

ULg
Research activities at ULg-LPAP cover two distinct areas: (1) modelling of biogeochemical cycles in connection with global change and sustainable development, and palaeoclimate studies; (2) physics of the Earth's upper atmosphere and study of giant planets' auroras with the Hubble Space Telescope.

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ENSO-CHILI

A CONTINUOUS HOLOCENE RECORD OF ENSO VARIABILITY IN SOUTHERN CHILE. A CLUE TO A BETTER UNDERSTANDING OF INTERHEMISPHERIC CLIMATE TELECONNECTIONS

Duration of the project: 01/03/2001 – 28/02/2005
Budget: € 585.003,93
Keywords: Palaeoclimate, Climate Change, El Niño Southern Oscillation, Lake, Chile

CONTEXT

In recent years it has become increasingly clear that the Earth's climate system is influenced by a whole series of natural variations, which operate on different time scales - from years to several thousands of years - and which may have different effects in different regions. Moreover, climate processes in one place appear to be able to interact with climate processes elsewhere, by means of so-called teleconnections.
One of these "rapid" climate processes is "El Niño Southern Oscillation" (ENSO). This is an oceanographic and atmospheric climatic disturbance, which originates in the southern Pacific Ocean, but influences weather patterns and climate in many regions of the world.
A better understanding of the natural dynamics of the ENSO phenomenon - studied in detail in one of the ENSO key areas, i.e. the Chilean Lake District - and of its evolution through time is indispensable for improving our knowledge of the functioning of the climate processes in Europe, and of the natural evolution of the climate in the past, and possible also in the future.

PROJECT DESCRIPTION

Objectives
The aim of this project is to provide a new, detailed sedimentary record of changes in precipitation and temperature in the Chilean Lake District (SW South America) for the last 10.000 years, in order to define the regional impact of ENSO.
Attention will also be paid to identifying millennium-scale abrupt climate changes (such as the "Little Ice Age") in the area and to how they affect the ENSO-system, but also to the study of pluri-decadal cyclicity (i.e. 50-60 years) overprints on ENSO-intensities, as recent studies highlight their possible global impact through oceanic circulation anomalies.
Finally, the observed characteristics of the ENSO-system will be compared with well-documented European climate records, in order to detect possible similarities, interactions or differences.

Methodology
The project is based on a multidisciplinary analysis of long sediment cores from two selected lakes in the Lake District. A detailed reconnaissance will allow to select the most suitable lakes and to locate in these lakes the most appropriate sites for coring. Fieldwork around the lakes will allow defining the sediment source characteristics, the present-day vegetation and the geomorphology of the drainage basins. Multidisciplinary analysis of the cores will include physical properties, sedimentary structures, mineralogy, age dating, tephrochronology and pollen studies. The final result will be a well-dated, high-resolution, mullet-proxy record of palaeoenvironmental and/or palaeoclimate changes that affected the lakes and their drainage basins, and this in terms of precipitation and temperature variations. Special analysis techniques will be applied to analyse the variability of this multi-proxy record, and to highlight the ENSO-cyclicities and the occurrence of decadal to millennium-scale climate variations. The results will be confronted with existing climate models, in order to recognise possible long-distance interactions, as well as the evolution of climate responses to natural and/or anthropogenic perturbations.

Interaction between the different partners
The project tasks will be executed jointly by the three project partners, in close concert with the main subcontractors and the Chilean collaborators.

Link with international programmes
- The project fits the objectives of Focus 1 ("Global Palaeoclimate and Environmental Variability") of IGBP's Core Project PAGES. It aims to study the past climate variability (Timestream 1: Holocene with special emphasis on the last 2000 yr.) in a site along the PEP-1 (Pole-Equator-Pole) transect of the Americas.
- The project also corresponds to the themes defined in Key Action 2 "Global change, climate and biodiversity" of the "Energy, Environment & Sustainable Development" Programme of EC DG-XII.
- To a certain extent, the project will also answer to some of the objectives of WCRP's CLIVAR-DecCen Component Programme aimed at "...describing and understanding the patterns of global decadal-to-centennial climate variability in the instrumental, palaeo-climatic, and model records...".

Expected results and/or products
The expected outcome of the project will be a well-dated, high-resolution, multi-proxy record of variations in precipitation and temperature in southern Chile during the last 10000 years, and of the effects and evolution of the ENSO-system during this time period. Such a record will be instrumental in improv-

ing our knowledge of the natural cyclicities of a number of basic components of the world climate system and on how and how fast specific climate changes may have a global impact. As such, the project may produce results that are useful for outlining the climatic boundary conditions to be taken into account by future policies on sustainable development.

PARTNERS

Activities

RUG
The Renard Centre of Marine Geology (RCMG) will be involved with the reconnaissance of the study area, with the regional study of the different lakes, with the actual sediment coring (subcontract to Université de Savoie) and with the development of an age model for the different cores.

ULg
Three laboratories of the ULg will closely collaborate in the multidisciplinary analysis of the sediment cores (sedimentary structures, mineralogy, dating, tephrochronology and pollen-analysis) and of the characteristics of the drainage basin.

UCL
The 'Institut d'Astronomie et de Géophysique Georges Lemaître' will focus on the mathematical analysis of the sedimentary signal and on the climate modelling.

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CHARACTERISATION AND SOURCES OF CARBONACEOUS ATMOSPHERIC AEROSOLS

Duration of the project: 01/12/2000 – 28/02/2005
Budget: € 757.438,67
Keywords: Carbonaceous Atmospheric Aerosols, Climate, Chemical Characterisation, Aerosol Sources

CONTEXT

The project deals with the theme "Atmosphere and Climate". Atmospheric aerosols play an important role in climate and they have effects on human health. Some parts of the project are carried out in the context of the AEROSOL subproject of EUROTRAC-2, which is a EUREKA project on the transport and chemical transformation of trace constituents in the troposphere over Europe. Other parts of the project are done within the context of the International Global Atmospheric Chemistry (IGAC) project, which is a core project of the International Geosphere-Biosphere Programme (IGBP).

PROJECT DESCRIPTION

Objectives

The aims of the project are: (1) to implement improved collection procedures for carbonaceous aerosols, whereby the sampling artefacts are better controlled or can be corrected for; (2) to develop improved methods for the characterisation of the carbonaceous atmospheric aerosol, going from a better discrimination between organic and elemental (black) carbon over separation into a number of main classes to a more complete molecular characterisation; (3) to identify new organic compounds that can be used as markers for specific sources, source types or processes, and/or atmospheric processes; (4) to use already existing and newly developed samplers and analytical methods for a detailed characterisation of the carbonaceous aerosol in Europe and (5) in tropical and equatorial regions; (6) to employ the data sets on the carbonaceous aerosol, on inorganic aerosol constituents and on the particulate mass for source identification and apportionment and for aerosol chemical mass closure work; and (7) to examine the relationships between the carbonaceous aerosol chemical characteristics and the physical and optical/radiative aerosol properties in order to assess the contribution of the carbonaceous aerosol to the direct and indirect effects of aerosols on climate.

Methodology

Two approaches are employed to correct for the artefact collection of gaseous organic compounds in aerosol sampling. In the first approach use is made of filter holders that contain two filters in series. In the second approach, a denuder is placed upstream of the aerosol collector. Improved methods are developed for the differentiation between organic and elemental carbon. For this, one resorts to a thermal-optical transmission technique. This technique is evaluated by participating in intercomparison studies with foreign research groups. Methods are also developed for the determination of the water-soluble organic carbon (WSOC) in the aerosol. A "Total organic carbon" analyser is used for this work. For the fractionation of the WSOC, one resorts to anion exchange with high-performance liquid chromatography. Methods based on ion chromatography are used to measure low-molecular weight water-soluble organic compounds. For a whole series of other water-soluble and apolar organic compounds, one utilises capillary gas chromatography/mass spectrometry (GC/MS) in combination with appropriate derivatisation methods. The source identification and apportionment work is done with the aid of receptor models.

Interaction between the different partners

The RUG team performs the aerosol collections and the work for the development and implementation of improved sampling procedures. It also performs the analyses with the thermal-optical transmission (TOT) technique, with the "Total organic carbon" analyser and with ion chromatography. On the basis of the TOT results, samples are selected for the fractionation of the WSOC and for the extensive GC/MS analyses. These two activities are carried out by the UIA team. The source identification and apportionment is a joint activity of the RUG and UIA teams, whereby chemical analysis results of both teams are being used.

Link with international programmes

The development of improved collection and analytical procedures and the aerosol studies in Europe are carried out within the framework of the EUROTRAC-2 AEROSOL subproject. The aerosol studies in tropical and equatorial regions fit in IGBP-IGAC activities and in components of it, such as the "Southern African Regional Science Initiative" (SAFARI 2000) and the "Large Scale Biosphere-Atmosphere Experiment in Amazonia" (LBA). Part of the research in Brazil is linked with the EC-funded project SMOCC ("Smoke Aerosols, Clouds, Rainfall and Climate: Aerosols from Biomass Burning Perturb Global and Regional Climate"). Finally, our studies in Europe are also utilised to contribute to the 2003 revision of the EU "Particulate Matter Directive".

Expected results and/or products
The project will give rise to publications in international journals with peer review. In addition, it will result in communications at international and national conferences, symposia or workshops. The project and its results will be presented on a website, which will be set up by us. Furthermore, pertinent data, data summaries and information will be made available for use in national and international databases and websites. It is expected that many of our results will be of value for modellers and for environmental policy makers and advisers.

PARTNERS

Activities

RUG
This team has many years of experience in atmospheric aerosol research and in aerosol collections and analyses. It was an active participant in several international field campaigns. It has a large expertise in the inorganic analysis of aerosol samples and performs analyses for organic and elemental carbon, water-soluble organic carbon and low-molecular weight water-soluble organic compounds.

UIA
The UIA team has a very large experience in mass spectrometric methods for the characterisation of biomolecules and complex organic compounds. It has a great expertise in capillary gas chromatography/mass spectrometry and in derivatisation techniques, which aim at structure determination or sensitive analysis. It is an essential partner for the detailed organic analyses of the aerosol samples.

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CASTEC

CARBON SEQUESTRATION POTENTIAL IN DIFFERENT BELGIAN TERRESTRIAL ECOSYSTEMS: QUANTIFICATION AND STRATEGIC EXPLORATION

Duration of the project: 01/12/2000 – 28/02/2005
Budget: € 1.366.091,63
Keywords: Global Change, C-Sequestration, Arable Land, Grassland, Forests

CONTEXT

The CASTEC project is situated within the framework of the Kyoto Protocol and the Belgian Federal Plan for Sustainable Development (2000-2004). The Kyoto Protocol determines emission reductions for a basket of 6 greenhouse gases. During the first commitment period (2008-2012) Belgium has to reduce its greenhouse gas emissions by 7,5% in comparison to the level of 1990 (baseline year emission). Articles 3.3 and 3.4, of the Protocol offer an opportunity to demonstrate CO_2 reduction/removal through C-sequestration via afforestation, reforestation and deforestation and forest management and additional human-induced activities (e.g. in agriculture).
The project also falls within the scope of the Belgian Federal Plan for Sustainable Development. The purpose of this plan is, partly, to formulate a coherent policy of sectoral and transsectoral measures to realise the emission reductions of the Kyoto Protocol by means of a new Belgian climate plan.

PROJECT DESCRIPTION

Objectives
The main objective of this project is to produce a reliable quantification and to perform a strategic exploration of the C-sequestration potential of Belgian forests, plantations, arable lands and grasslands to demonstrate atmospheric CO_2 removal via terrestrial sinks. The data in the Belgian national greenhouse gas inventory communications to the United Nations Framework Convention on Climate Change (UNFCCC), indicate a large uncertainty and a clear lack of information concerning the size and nature of these reservoirs for CO_2 reduction in Belgium. Modern environmental policy and decision-making need a multidisciplinary approach and more than one solution. Therefore, the main objective is split into several specific objectives, which will be covered in different Task Forces (TF):
TF1: Determination of the C-sequestration potential of arable land by exploring different soil management scenarios.
TF2: Determination of the C-sequestration potential of grassland and urban land.
TF3: Determination of the C-sequestration potential of forests and biomass/bio-energy plantations.
TF4a: Determination of nitrous oxide (N_2O) and CO_2 emission and methane (CH_4) uptake as a result of the management scenarios of TF1, TF2 and TF3.
TF4b: Establishment of methods for quantification/verification of annual new soil C accumulation.
TF5: Optimisation of an existing Dynamic Vegetation Model to predict C storage and C uptake in the ecosystems of TF2 and TF3.

The baseline C storage for the reference year 1990 for arable land (TF1), grassland/urban land (TF2) and forests/plantations (TF3) will be determined by using historical data sets.

Methodology
The following methods will, amongst others, be used during the course of the project:
- Collection of historical data sets for the calculation of the 1990 baseline.
- Re-sampling of a large number of locations for which the soil organic carbon content is already known for at least 2 points in time.
- Establishment of a plantation and other field trials to investigate the effect of ecosystem management on C-sequestration.
- Flux measurements (CO_2, N_2O, CH_4).
- Process studies using stable isotopes.
- Modelling.

Interaction between the different partners
The interaction between the different partners and the different task forces is shown in Fig. 1. For more information, we invite you to visit our website at: http://fltbwww.rug.ac.be/CASTEC.

Expected results and/or products
The direct exploitation of the CASTEC project is situated on a national level and within the international scientific community. Through a reliable quantification and the strategic exploration of the possibilities of C sequestration in terrestrial ecosystems in order to meet the Belgian greenhouse gas emission targets, this project will contribute to quality assurance, quality control and completeness of the Belgian greenhouse gas inventory. Moreover, it can offer policy options to reduce greenhouse gas emissions.
Within the Intergovernmental Panel on Climate Change (IPCC), however, many questions exist on reporting, exploration, monitoring and verification with regard to the application of articles 3.3 and 3.4 of the Kyoto Protocol. This project can contribute in solving these international problems.
In order to be successful, a modern environmental

policy should rely on scientific analysis and a broad partnership. Therefore, the most important element of a successful environmental policy is bringing together all parties necessary for the correct implementation of potential measures. With this in mind, an integrated assessment of the scientific research results will take place during a two-yearly workshop. The purpose of such a workshop is therefore not purely scientific. It is our intention to communicate the obtained scientific results as soon as possible to: scientists of related disciplines, policy makers, actors involved (e.g. farmers organisations, foresters, ...) and the media.

PARTNERS

Activities

RUG- Laboratory of Applied Physical Chemistry
Research at this laboratory deals with the biogeochemistry of C and N in terrestrial ecosystems, using flux measurements and stable isotopes to unravel relevant processes.

RUG-Department of Soil Management and Soil Care
This department focuses on the determination of the C-sequestration potential of Belgian cropland by exploration of different soil management scenarios, using existing data sets and modelling.

RUG-Laboratory of Plant Ecology
Research at this laboratory is focused on the carbon and water cycle of terrestrial ecosystems, including the up scaling by an experimental or a modelling approach.

RUG-Laboratory of Forestry
This laboratory is responsible for the carbon pools inventory of Belgian forests and biomass plantations and established a 1 ha short rotation plantation for research on the changes in above- and belowground carbon pools.

CLO
The Department of Crop Husbandry and Ecophysiology conducts research concerning the impact of agricultural practices on yield and quality of crops and plants and environment in the frame of the multi-functionality of a sustainable agriculture.

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INVASION AND BIODIVERSITY IN GRASSLANDS AND FIELD BORDERS

Duration of the project: 01/12/2000 – 28/02/2005
Budget: € 604.711,47
Keywords: Biological Invasion, Biodiversity, Climate Change, Grassland, Field Borders

CONTEXT

Biological invasions are considered an increasing threat to biodiversity, but the underlying principles are poorly known. Also the way changes in the global climate will affect invasions is not well understood. The aim of the current project is to develop an improved mechanistic framework to (a priori) establish which communities are most susceptible to being invaded ('invasibility') and which species are expected to become invasive ('invasiveness') under given conditions. The overall goal of the project is to provide a better scientific foundation for protective strategies towards biological invasions in grasslands and field borders, so that management policies can eventually become proactive rather than curative today.

PROJECT DESCRIPTION

Objectives

- Identify factors critical to invasion, in order to a priori monitor highly invasive species, to characterise ecosystems most susceptible to and conditions most conducive to invasion, and to develop protective strategies.
- Identify interactions with climate change, by simulating invasion in grassland patches damaged by climatic extremes. Explain the underlying basis of sensitivity to climatic extremes in different species.
- Evaluate techniques to locally maximise diversity in plant communities, in casu field borders. Assess effects of realised diversity in field borders on neighbouring crops. Devise management options to minimise risks of invasion into field borders, and from field borders into arable land.

Methodology

UIA:

1) Underlying mechanisms of establishment of invading species

Eight grass species acting both as invader and as invaded system. One monoculture per species, each with 8 predetermined gaps to insert seeds of the 8 possible invaders. Measurements on invaders: germination; survival; growth rate etc. Measurements on invaded monocultures to determine invasibility (e.g. photosynthetic active radiation (PAR) in the gaps).

2) Effect of species diversity and climatic extremes on invasion

24 Different synthesised plant communities with species number varying from 1 to 8. Three replicate sets develop undisturbedly; the 3 others are exposed to a simulated heat wave. The 3 most aggressive species of Exp 1. are inserted as invaders in gaps. Measurements: gap conditions; invader survival/ growth; critical traits for invasiveness/ invasibility; changes in ecosystem processes.

3) Predicting which grasslands are sensitive to climatic extremes

Species are experimentally exposed to heat/drought stress in the field (FATI-system), to investigate the physiological/morphological basis of sensitivity to climatic extremes.

RUG:

1) Creation of diversity reservoirs in field borders

Four different plant communities are installed under 3 managements (2 cuts with no, 1 time or 2 times removal of the cuts):
a) spontaneous vegetation;
b) commercial blend of grasses, leguminous plants and field flowers;
c) same as b) but covered with the mown and chopped product from a botanically species-rich roadside in the neighbourhood;
d) locally bred grasses and dicots assembled in the neighbourhood.
Measurements: characterisation of the seed bank; seed rain captation and determination; biomass production and quality; species presence, abundance and shifts; PAR; mineral status of soil and vegetation; incidence and development of weeds, pests and diseases in the crops.

2) Effect of light and disturbance on invasion

Field border plots are installed along a tree lane consisting of 2 rows of very uniform 50- year-old beeches, east-west oriented offering a sunny and a shady side. Investigated factors: light effect and disturbance effect (passage of a tractor in the middle of the plots) on selected invaders inserted in the border plots.

Interaction between the different partners

The research teams study different aspects of diversity and biological invasion: UIA the theoretical ecological foundations and RUG the application in field borders in order to optimise diversity management. The interaction will focus on the integration of the more artificial detail experiments of UIA with the information from the field experiments of RUG.

Expected results and/or products

- Publication in peer-reviewed international journals.
- Presentation of results on national and international fora (conferences, ...).
- Construction of a website describing the objectives and results of the project.
- Contribution to databases (IWETO, OSTC, the database 'Understanding and Conserving Biodiversity in Europe').
- Submission of the project as Core Project of IGBP-GCTE Focus 4.
- Participation to the Global Invasive Species Programme (GISP).
- Development of a mathematical model.

PARTNERS

Activities

UIA

The research group of Plant and Vegetation Ecology conducts research in plant ecophysiology, physical ecology, crop micrometeorology, ecosystem physiology, plant sociology, and landscape ecology. Over the past decades the group has been involved in impact studies on acid rain, elevated CO_2 concentrations, global warming, ultraviolet-B, changes in biodiversity and biological invasion. Experimental research is often coupled to existing or newly developed models.

RUG

The department 'Plant Production' focuses its research into plant breeding; farming systems: monocultures versus crop rotation; research into grassland and forage crops; extensivation of grassland systems. The objective trough out all research items is the development of a sustainable agriculture, supported by divergent research activities and concepts.

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METAGE

ESTIMATING GREENHOUSE GAS FLUXES FROM BELGIAN ECOSYSTEMS UNDER GLOBAL CHANGE SCENARIOS

Duration of the project: 01/12/2000 - 28/02/2005
Budget: € 704.215,92
Keywords: Global Change Scenarios, Greenhouse Gas Fluxes from Terrestrial Ecosystems, Carbon Sinks, Emission Factors, IPCC Guidelines

CONTEXT

Numerous studies have achieved a detailed understanding of the processes determining greenhouse gas (GHG) fluxes both at the global and local scale. However, policy-makers require information at intermediate scale levels (i.e. the national scale) in order to make informed judgements about the effectiveness of different strategies for sustainable development. Currently, the inventory of the fluxes of the major GHG: CO2, N2O and CH4, emitted by agriculture, land use change and forestry is carried out for the regions of Belgium under its obligations to the Kyoto Protocol using a standard methodology (IPCC, 1996). These guidelines have unfortunately a number of limitations and uncertainties due to aggregated national scale, default value parameters, calculations based on simple empirical expressions and insensitivity to changes arising from climate and land use.

PROJECT DESCRIPTION

Objectives
The overall aim of the project is to develop a Geographical Information System (GIS) to estimate greenhouse gas fluxes from terrestrial ecosystems in Belgium under global change scenarios.

The specific objectives are:
- to construct an operational GIS defining the parameters required to estimate GHG fluxes from agriculture and forestry for landscape units of Belgium;
- to implement the IPCC emission inventory models for the main greenhouse gases (CO2, N2O and CH4) with respect to fluxes from agriculture, land use, land use change and forestry for the landscape units;
- to improve the parameters of the IPCC models and develop ecosystem specific emission factors;
- to develop a spatially explicit model of land use and management change for Belgium and to implement this model within the GIS framework;
- to construct a range of plausible scenarios of environmental change and evaluate their impacts on GHG emissions.

Methodology
The integration of the work packages is illustrated in the project diagram.

Work package 1: Construction of the GIS framework
The GIS system consists of polygons derived from an overlay of the CORINE land cover map and the soil association map (Tavernier and Maréchal, 1972). Soil data (e.g. the 'Aardewerk' data base; Van Orshoven et al., 1993), climate data and miscellaneous data such as fertiliser use, livestock numbers and cultivated area per crop type are geo-referenced to the polygons.

Work package 2: Implementation of the IPCC greenhouse gas inventory models for the landscape units within the GIS framework
N2O and CH4 fluxes from agriculture and livestock husbandry are calculated from national statistics available at the district level. A rule-based approach allows the conversion from the district level to the landscape polygons. Carbon stocks are calculated for the landscape polygons from soil data and regional forest inventories. As a first approach, CO2 fluxes as a result of land use/management change will be estimated by comparison of carbon under similar environmental conditions.

Work package 3: Improvement of IPCC model parameters
A database containing results of experimental work regarding fluxes of GHG from agriculture and forestry will be compiled. The database will be analysed in order to develop so-called pedotransfer and ecosystem response functions relating IPCC model parameters to the landscape attributes available in the GIS database.

Work package 4: Land use change modelling
The approach to modelling agricultural land use change will be based on the use of optimisation techniques that simulate the decision-making process of land users given a type of land use. A number of different models will be used based on the approaches developed within the ACCELERATES project financed by the EU.

Work package 5: Construction and evaluation in terms of greenhouse gas fluxes of a range of plausible global change scenarios
The estimates of land use change will be driven by global change scenarios. These scenarios will include estimates of changes in climate and socioeconomics. An important benefit of the scenario approach is that these allow direct comparison of changes arising from either climate or socio-economic change. Thus, the relative importance of socio-economic and biophysical drivers can be assessed, and the policy implications can be highlighted.

Interaction between the different partners
The GIS, constructed by the KULeuven team is a focal point ensuring integration of the results. The FUSAGx and the UCL teams will at first concentrate on the development of spatially variable model parameters reflecting variability in soil and climate conditions. At a later stage the UCL team will provide the land use change model for Belgium. Finally, all teams will be involved in the formulation of scenarios and evaluating the fluxes of greenhouse gases.

Link with international programmes
The approach to land use change modelling will be based on previous projects financed by the EU (IMPEL). The results of a case study for Belgium constructed in current EU financed project (ACCELERATES) will be used to simulate the impacts of global change scenarios. Expansion factors applied to forest inventories are calculated in consultation with European initiatives within the COST E21 project.

Expected results and/or products
- A spatial representation of baseline carbon stocks in soil and biomass for Belgium.
- CO2 fluxes from forest soils under baseline conditions.
- Improved emission factors for N2O from soils related to environmental conditions.
- Estimates of uncertainty for N2O emissions from soils.
- Scenarios for future land use change.
- Future stocks and fluxes in response to land use and climate change scenarios.

PARTNERS

Activities

UCL
The Geography department has a strong background in ecological and land use change modelling. The UCL team is involved in several EU projects and the land use change modelling part of the METAGE project will be developed in close collaboration with these EU projects.

KULeuven
The research focus of the department of Land Management is on biophysical land process studies, spatio-temporal land modelling and decision support regarding land use and management. Basic research tools are empirical and process-based models, geomatics and earth observation. Knowledge is developed in numerous projects funded by regional, national and international authorities.

FUSAGx
The group Forest Tree Ecophysiology has developed from 1987 onwards several field experiments and models related to the physiological responses of forest trees to elevated CO2 concentrations in open top chambers. At present, these experiments focus on root dynamics and forest soil respiration in order to elaborate long term scenarios of plant response to global change.

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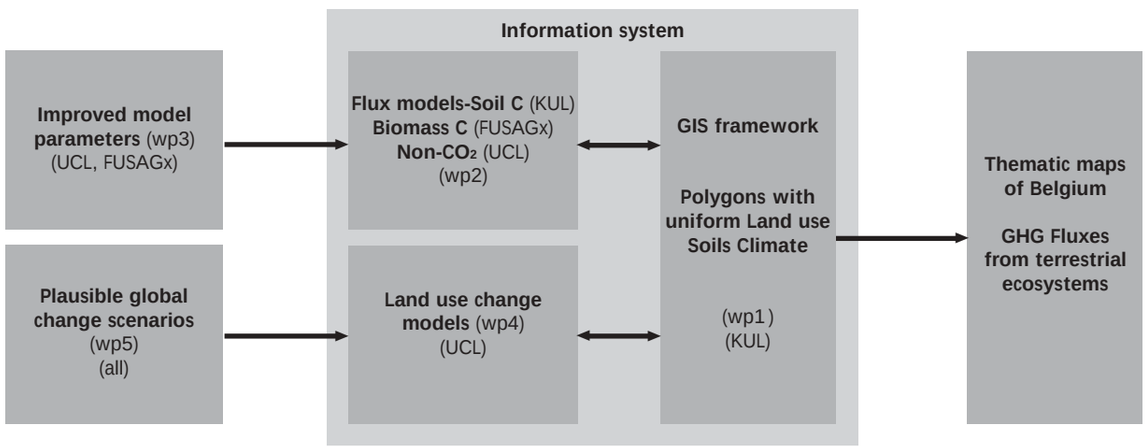
METAGE Project diagram



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XYLOBIOS

DIVERSITY, ECOLOGY AND ROLES OF SAPROXYLIC ORGANISMS IN BELGIAN DECIDUOUS FORESTS

Duration of the project: 01/12/2000 – 28/02/2005
Budget: € 810.611,83
Keywords: Deciduous Forest, Coarse Woody Debris, Biodiversity, Saproxylic Insect, Wood Decomposition

CONTEXT

Saproxylic organisms depend during some part of their life cycle upon wood substrates or wood-inhabiting fungi. They account for as much as 25% of all forest-dwelling species, including specific and species-rich fungi and invertebrate communities. Saproxylic organisms play a critical role in forest soil fertility and ecosystem functioning since they recycle considerable amount of nutrients through multitrophic interactions. Most of the species, however, have undergone dramatic declines throughout Europe, mainly as a result of large-scale intensive forest management and fragmentation. Moreover a few saproxylic insect species have been identified as a major cause of tree damage and significant economical losses once their populations increase above some abundance threshold.

PROJECT DESCRIPTION

While an increasing number of studies dealing with the conservation of saproxylic organisms have been carried out in several European countries, mainly based on recommendations by the Council of Europe to retard the loss of species, there is a clear lack of information on their taxonomy and ecology in Belgian deciduous forests.

Objectives
Based on recommendations from the European Council, the project, named XYLOBIOS, aims to develop a national expertise in the study of diversity, ecology and roles of saproxylic organisms living in beech and oak forests. Besides increasing public awareness for their importance in forested habitats and the identification of biodiversity hotspots, the main objective of the project is to address simultaneously and to link both ecological and economical issues raised by forest management, with beech mortality in southern Belgium as a study case.

Methodology
- Enquiries sent to foresters to identify forest areas as habitats for diversified saproxylic communities, with tree species (oak/beech), availability of woody debris, and dead wood continuity in relation to past forest management history as the main criteria of selection.
- Enquiries sent to naturalists to gain better knowledge on the current distribution of flagship species, indicators of microhabitats and succession processes found in natural and poorly managed forests.
- Development of an insect sampling methodology based on a comparative analysis of capture efficiency among different kinds of traps used during the first year.
- Study of relationships between the number of saproxylic species and their abundance in forest with local (soil properties, vegetation structure and composition, climate, altitude, woody debris availability) and regional (landscape properties) ecological conditions.
- Bark sampling on recently logged beech trees to identify the main insect species and functional groups involved in their colonisation after death.
- Building of a website to ensure accessibility and readability of the information for a larger audience, in particular regarding the importance of dead wood and saproxylic organisms in forest ecosystem functioning.
- Simulation of different management strategies and their effects on the economical value and multifunctional use of the forest.

Interaction between the different partners
The main objective of the project is to provide a global and multifunctional analysis of the results. This implies from the different partners to work in close co-operation during the whole research period, whether they are working on the field, identifying organisms at the Natural History Museum of Belgium, etc.

Link with international programmes
The research project does not fit into larger international programmes, although it benefits from continuous and dynamic exchanges with researchers from well-known European forest research institutes (Finland, France, Ireland, Portugal, Slovakia, Sweden).

Expected results and/or products
Besides a better understanding about the role that biodiversity plays in the recycling of organic matter in forest soils, this project aims to clarify the national distribution of saproxylic insects, to quantify their impacts in deciduous forests, and to identify the main determinants of their diversity. Results will be made available through national and international publications, a website, and build-up of a centralised data bank from national biological inventories.

PARTNERS

Activities

CRNFB
Contact: Philippe Fayt, Biologist. Co-ordinator of the project, involved in the different steps, including information systems, enquiries and publications for a larger audience.

FUSAGx
Unité de Gestion et Economie Forestières. Contact: Jean-Marc Henin, Forest Engineer, PhD student. Sampling, identification, analyses and writing. Study mainly the diversity and succession of insects which colonise dying and dead beeches (i.e. bark beetles and associated fauna).

UCL
Unité d'Ecologie et de Biogéographie. Contact: Christophe Pontégnie , Forest Engineer, PhD student. Sampling, identification, analyses and writing.

KBIN-IRSNB
The department Entomology-Insects of the Royal Belgian Institute of Natural Sciences. Contact: Veerle Versteirt, Biologist, PhD student. Sampling, identification, analyses and writing.

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CADILLAC

LINKING DISPERSAL, CONNECTIVITY, AND LANDSCAPE STRUCTURE TO PRODUCE HABITAT EVALUATION / RESTORATION GUIDELINES

Duration of the project: 01/12/2000 – 28/02/2005
Budget: € 579.822,96
Keywords: Biodiversity, Conservation Biology, Land Use Management, Habitat Fragmentation, Population Viability Modelling

CONTEXT

Species go extinct enormously faster now than in the last few million years. This dramatic reduction of Earth's biodiversity is mainly attributable to habitat loss and isolation due to human activities. The severity of the threat, largely ignored some decades ago, is now a major concern for scientists, managers, and governments. (The latter have undertaken actions: SPSD II is an example).
Conservation biology has shifted from local (focal area or species) towards landscape level approaches, including ecological networks. But the management, restoration, or re-creation measures are still rarely based upon ecological knowledge of (target) species and their associated habitats.
There is an urgent need for sound, scientifically based procedures to evaluate the conservation efficiency of different network scenarios for a series of (target)-species and their habitats.

PROJECT DESCRIPTION

Basing upon (1) long-term studies in regions with various degrees of landscape fragmentation, (2) precise descriptions of the population dynamics, in those regions, of several animal species with contrasted ecological requirements, (3) estimates of dispersal rates between habitat patches, (4) evaluations of the connectivity and of habitat quality through GIS-based models, this project aims at building spatially explicit models of population viability as a function of landscape structure. This should enable us to estimate the time to metapopulation extinction, the probability of survival over long periods (100 years) and the risk of genetic loss under various scenarios of habitat restoration, in order to provide guidelines and criteria to evaluate the "quality" of a landscape in conserving biodiversity.

Objectives
This project aims at modelling population dynamics of several functionally different species as a function of the structure of the landscape, in order to help decision-makers to forecast the consequences of different habitat restoration scenarios on the evolution of biodiversity.

Methodology
1 Population dynamics: Standard capture-mark-recapture methods are applied, with technical adaptations specific to each target species.
2 Description of population dynamics: Demographic parameters (survival rates and recruitment) of populations inhabiting local habitat patches are estimated using «high-tech» methods (constrained linear models), based on probabilistic models describing the outcomes of capture-mark-recapture experiments.
3 Estimation of dispersal rates: For some species (butterflies) direct observation of movements between habitat patches is possible. For mammals, radio-tracking may occasionally reveal such movements; but we mainly rely upon molecular methods to identify immigrants by comparing their «genetic signature» to the profile of genotypes in the local population.
4 Evaluation of connectivity and of habitat quality: Physical and vegetal characteristics of the target regions are mapped. Using GIS tools and models of habitat patch occupancy and of «cost distance», maps of habitat quality and of resistance (against movement between habitat patches) are produced for the focal species and used in spatially explicit models of the dynamics of these species over the target regions.

Interactions between the different partners
This project is clearly interdisciplinary. UIA and UCL teams have recognised expertise in complementary fields, which they share in the frame of this project (including mutual training sessions). Specific UIA expertise is in molecular methods and in cost distance modelling. UCL expertise is in the estimation of demographic parameters and in population viability analysis. Both teams have long-term data on several species (butterflies, rodents) in different regions, which are used in the present project.

Expected results and/or products
The expected output of this project is a tool to estimate the time to metapopulation extinction, the probability of survival over long periods (100 years) and the risk of genetic loss under various scenarios of habitat restoration, in order to provide guidelines and criteria to evaluate the "quality" of a landscape in conserving biodiversity.
The proposed methodology does not provide a global solution to the problem of biodiversity conservation at the scale of a landscape. A landscape must support a sustainable ecosystem, and not merely be viable for some emblematic species. The exercise must be performed for an array of species, hopefully encompassing all functional compartments of the ecological web. The best scenario for one species may be a bad scenario for another species. The globally

optimal scenario necessarily will be a compromise. A perspective towards such a compromise may be to try to apply the concept of desirability functions used in the statistical problem of finding experimental conditions that optimise a multivariate response. Our proposal is the first necessary step towards this direction.

PARTNERS

Activities

UCL-ENGE
The Environmetry and Geomatics Unit aims at understanding and modelling processes underlying (meta)population dynamics. We specialise upon demographic parameter estimation, experimental planning, analysis methods, and field techniques.

UCL-ECOL
Since 1994 we initiated several projects on population ecology and genetics of different taxa in their natural habitats. The general aim is to investigate mechanisms responsible for the adaptation of populations to selective pressures of a changing, heterogeneous environment.

UIA
The Laboratory of Animal Ecology investigates the functioning of animal populations, focusing on interaction between individual and population processes. Fundamental questions concern adaptation in behavioural and ecological traits, and micro-evolutionary processes. Applied ones concern the impact of environmental changes on natural populations.

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SISCO

SILICA RETENTION IN THE SCHELDT CONTINUUM AND ITS IMPACT ON COASTAL EUTROPHICATION

Duration of the project: 01/02/2002 – 30/04/2006
Budget: € 727.000
Keywords: Coastal Eutrophication, Biogenic Silica, Scheldt Estuary, North Sea, Biogeochemical Cycle of Silica

CONTEXT

Anthropogenic activities have significantly increased the riverine fluxes of N (nitrogen) and P (phosphorous) to the coastal zones. In contrast, the major land source of dissolved Si (silicon) is through chemical weathering of silicate minerals and dissolved Si inputs to aquatic systems have barely been altered. The excess delivery of N and P, compared to Si, has led to profound modifications of the phytoplankton succession and has thus perturbed significantly many coastal ecosystems.

The Si retention in the river-estuary-coastal zone continuum, a selective and efficient filter for nutrients, is poorly known at present time owing to our insufficient understanding of the processes affecting the biogeochemical cycling of Si. The processes controlling the Si riverine flux deserve thus a better quantification in order to evaluate its impact on primary production and on the further alteration of the marine food web.

PROJECT DESCRIPTION

Objectives
The overall objective of the project is to elucidate the biogeochemical cycling of Si and its anthropogenic perturbations in the river-estuary-coastal zone continuum of the Scheldt. We aim, in particular, at identifying the sources and sinks of Si in the aquatic continuum, and at quantifying the major processes controlling the biogeochemical behaviour of Si in the water column and in the sediments. The results will be used to assess the budget of Si and its fluxes carried by the Scheldt to the Southern Bight of the North Sea.

Methodology
In order to achieve the aims, the present research will be carried out by combining 1) analyses of historical data, 2) field surveys and laboratory investigations, and 3) model developments.

A Si database will first be constructed and its analysis will allow the evaluation of the historical evolution of the concentration of this nutrient along the Scheldt continuum. A series of fundamental physico-chemical and biological parameters will be measured in the dissolved and particulate phases along the continuum during the first two years. Pore water profiles of dissolved Si (DSi) and biogenic Si (BSi) contents in sediments will be determined to quantify the transformation of Si occurring during early diagenesis.

In addition to field surveys, biogeochemical processes controlling the production, regeneration and retention of BSi will be studied both in the field and in the laboratory using natural samples and cultured diatoms. Incorporation experiments of ^{14}C and ^{32}Si will be conducted to estimate the primary production versus diatom production. Dissolution assays of BSi will be carried out to evaluate the regeneration rate of this biogenic element. The diagenetic processes will also be studied to assess the DSi fluxes across the sediment-water interface.

Finally, a Si module will be developed and implemented within an existing coupled hydrodynamic and biogeochemical model (CONTRASTE), originally developed to estimate long-term fluxes of reactive species in strong tidal estuaries. The improved model will allow us to assess the reduction in Si fluxes along the Scheldt continuum and to evaluate its impact on coastal eutrophication by modifying the marine food web in the Southern Bight of the North Sea.

Interaction between the different partners
The co-ordinator, the Laboratory of Chemical Oceanography and Water Geochemistry at the University of Brussels (ULB-LOCGE), will focus its efforts on studying processes controlling the production, regeneration and retention of BSi in the water column and in the sediments.

The Laboratory of Protistology and Aquatic Ecology at the University of Gent (RUG-LPAE) is responsible for investigating diatom dynamics and the role of microbial activity on the regeneration of BSi. It will also be in charge of the diatom culture collection and its maintenance.

The department of Geochemistry at the Utrecht University (UU-GEO) is the European collaborator in the project. It is the leading partner for the modelling of Si biogeochemical cycle in the Scheldt continuum.

Link with international programmes
The link with international programmes will be made through our collaboration with the foreign members of the Users Committee:

- Prof. Hamborg is co-ordinating a EU project "SIBER" on the Si biogeochemical cycle in the Baltic

Sea Ecosystem. He is also actively involved in SCOR and IGBP-LOICZ who recently stressed the important role of Si in regulating coastal food webs.

- Dr. Conley, also a partner in SIBER, has the expertise in Si biogeochemistry and coastal eutrophication. He is participating in a EU funded research training network "Si-WEBS" to which the present network will be associated.
- Dr. Garnier has been actively involved in the French PIREN programme of the Seine basin on nutrient biogeochemistry and will provide knowledge in the diatom and Si dynamics.
- Dr. Middelburg will collaborate in the framework of a Dutch-Flemish project, aiming at studying the carbon and nitrogen dynamics in the Scheldt estuary.

Expected results and/or products

The following research results are expected from the project:

- A database of existing historical data on dissolved Si, other nutrients and related parameters incorporating the results acquired in the present project.
- A comprehensive understanding of the Si biogeochemistry in the Scheldt continuum.
- Parameterisation of rate constants for processes controlling the production, regeneration and retention of Si in the Scheldt continuum.
- A Si diagenetic model for the quantitative assessment of the recycling efficiency, the burial flux and thus the retention of Si in contrasting estuarine sediments.
- An improved transport-reaction model with the implementation of a new Si module, allowing the prediction of Si fluxes delivered by the Scheldt to the Southern Bight of the North Sea.

PARTNERS

Activities

ULB

The Laboratory of Chemical Oceanography and Water Geochemistry (LOCGE) has focused its research activities on studying the biogeochemical processes affecting the carbon cycle and associated elements in aquatic systems. Its expertise includes kinetics of mineral weathering and developments of methodologies in the field of aquatic and sedimentary geochemistry.

RUG

The Laboratory of Protistology and Aquatic Ecology specialises in protist biodiversity and their role in aquatic ecosystem functioning. Relevant expertise includes diatom culturing and a range of techniques to study natural protist and bacterial communities.

UU

The department of Geochemistry emphasises the study of biogeochemical complexity in earth surface environments combining field-, laboratory and modelling work. The partner of the present project, Prof. P. Regnier, is the co-ordinator of the modelling group and is the originator of the coupled transport-reaction model CONTRASTE.

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MAREBASSE

MANAGEMENT, RESEARCH AND BUDGETING OF AGGREGATES IN SHELF SEAS RELATED TO END-USERS

Duration of the project: 01/02/2002 – 30/04/2006
Budget: € 970.000
Keywords: Marine Aggregates, Environmental (Impact) Assessment, Sediment Transport Modelling, Geo-acoustical Techniques, Seafloor Classification

CONTEXT

The research project frames into the strategic research on marine ecosystems and the sustainable management of the North Sea with priority towards the theme 'Evaluation of sedimentary systems and the development of new evaluation technologies within the view of a sustainable management of the Belgian exclusive economic zone (EEZ)'. An evaluation of sedimentary systems calls for the development of appropriate tools and strategies that are efficient and flexible enough to meet future needs regarding the exploitation of the EEZ. Within the concept of a 'sustainable management', the research proposal is relevant towards different uses of the sea such as marine aggregate extraction, dredging/dumping operations and the implantation of windmill farms, however, with the main emphasis on the sediments themselves.

PROJECT DESCRIPTION

Objectives
The MAREBASSE project is essentially meant to set up an integrated assessment framework for marine sediments. This framework is regarded necessary to be able to answer management/policy questions on how a sustainable exploitation of marine resources should be viewed and what approaches should be envisaged. This implies that essentially an increase of knowledge is necessary on the level of the sediments themselves and their distribution, but also on the dynamical environment. Ideally, this calls for a holistic approach, but it is clear that time and resources impose constraints. Still, nowadays instrumentation and techniques in combination with the necessary 'know-how' can largely overcome this discrepancy.

The project is structured around a three-tiered approach encompassing three spatial scales: broad-based, regional and site-specific. Fieldwork programmes will be the focal point of the regional and site-specific research, however with a coupling towards the broad-based approach.

An overview of the different project components is further schematically represented including the interaction between the different partners.

Link with international programmes
On an international level, the project is complementary to the Fifth Framework Research Training Network EUMARSAND (European Marine Sand and Gravel Resources). The project is set-up to address, on a European level, the urgent need for integrated and coherent approaches regarding marine aggregates. However, the main objective of the programme is to train young European researchers, to a high level, in the individual research approaches needed and to provide them with an integrated and balanced view of the diverse and difficult issues involved. Partnership: Fundacion AZTI, Spain; University of Southampton, United Kingdom; University of Gent, Belgium; National & Kapodistrian University of Athens, Greece; University of the Aegean, Greece; Maritime Institute in Gdansk, Poland; Université du Littoral Côte d'Opale, France; Universiteit Twente, The Netherlands and Christian-Albrechts-Universitaet zu Kiel, Germany.

Expected results and/or products
As the integration and the valorisation/exploitation of the research results are an inherent component of the MAREBASSE project, high-quality end products and strategies are aimed at. The main deliverables can be summarised as follows:
- Review of existing knowledge on marine sediments taking into account the marine aggregate needs, dredging issues and a European review on environmental (impact) assessments.
- 2-D sediment transport model of the Belgian continental shelf (BCS) as an evaluation tool for the sustainable management of the EEZ.
- Definition of optimised environmental assessments.
- Development of environmental assessment evaluation tools and strategies (the definition of unambiguous acoustical seabed classes for the range of sediment types found on the Belgian continental shelf; the set-up of a reference manual of the acoustic facies on a BCS level including their eco-morphological interpretation; 3-D sediment transport model).
- Definition of optimised environmental impact assessments.
- Set-up of an integrated assessment framework for marine aggregates including a mapping of the distribution of the surficial sediments of the Belgian continental shelf.
- Targeted resource mapping according to end-users' needs together with a multi-user GIS of Belgian marine aggregates.
- Development of targeted environmental assessments tools and strategies.
- Monitoring and research protocols and guidelines.

PARTNERS

Activities

RUG-RCMG
The research team of the Renard Centre of Marine Geology is specialised in the use and validation of geo-acoustical techniques (a.o. for the prospecting of marine aggregates and habitat mapping). For MARE-BASSE, RCMG has subcontracted the consultancy firm Magelas and the section Marine Biology of the University of Gent.

MUMM
The Management Unit of the North Sea Mathematical Models of the Royal Belgian Institute for Natural Sciences follows a Management-Monitoring-Modelling strategy. Management because of the impact of human activities. Modelling for operational forecasts and research. Monitoring as a basis of a good Management and for calibration and validation of models

KULeuven
The team of the Hydraulics Laboratory conducts research in the domain of hydrodynamics and mechanics of sediments. Applications related to wave and current modelling in coastal seas and estuaries, to erosion and sedimentation of (non-)cohesive sediments, to urban hydrology and river modelling.

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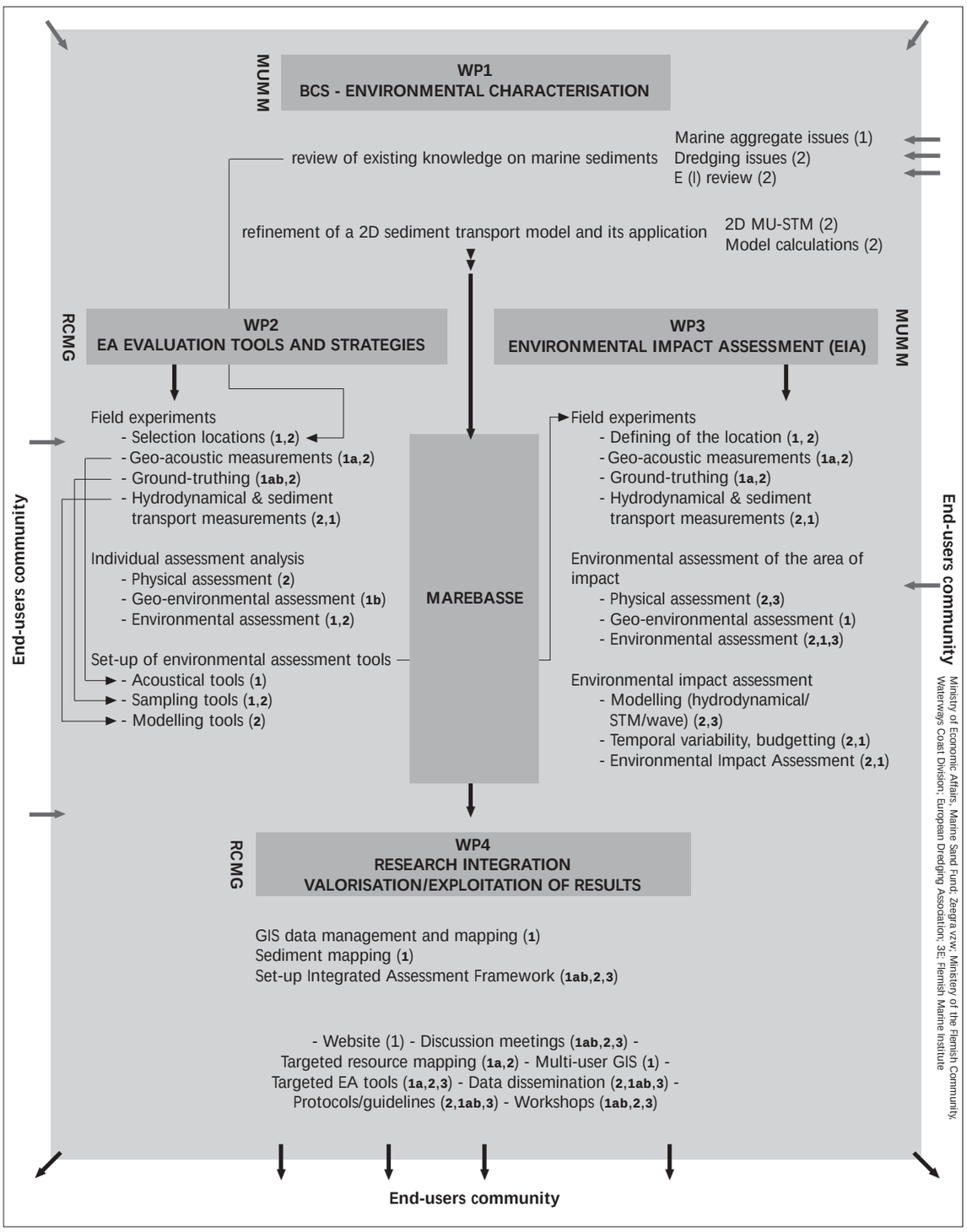
Schematic representation of the MAREBASSE research project



Ministry of Economic Affairs, Marine Sand Fund; Zeegra vzw; Ministery of the Flemish Community, Waterways Coast Division; European Dredging Association; 3E; Flemish Marine Institute

ATMOSPHERE AND CLIMATE
MARINE ECOSYSTEMS AND BIODIVERSITY
TERRESTRIAL ECOSYSTEMS AND BIODIVERSITY
NORTH SEA - ANTARCTICA - BIODIVERSITY

Partners:

1. Ghent University, Renard Centre of Marine Geology
a-subcontract Magelas
b-subcontract Ghent University, Section Marine Biology

2. Management Unit of the Mathematical Model of the North Sea

3. Catholic University of Leuven, Hydraulics Laboratory

AMORE-II

ADVANCED MODELLING AND RESEARCH ON EUTROPHICATION - LINKING EUTROPHICATION AND BIOLOGICAL RESOURCES

Duration of the project: 01/02/2002 – 30/04/2006
Budget: € 1.116.000
Keywords: Eutrophication, Biological Resources, Modelling

CONTEXT

As EU member and Contracting Party of the OSPAR Convention for the Protection of the Marine Environment of the Northeast Atlantic, Belgium has obligation of taking measures to protect its maritime area against the adverse effects of eutrophication. Eutrophication in Belgian coastal waters results from transboundary (SW-Atlantic waters, Rhine) and local (IJzer, Scheldt) inputs of land-based nutrients (N, P, Si) and manifests as huge algal blooms (mainly the Haptophycea Phaeocystis) that impact the ecosystem function. Despite a nowadays 50% reduction of P loads compared to 1990 no ecosystem improvement is discernible. Increased understanding of the links between nutrient enrichment and ecosystem response is needed to guide the implementation of European regulations for the reduction of riverine nutrient loads to the North Sea.

PROJECT DESCRIPTION

Objectives
AMORE-II research focus on establishing quantitative and qualitative links between nutrient enrichment, spreading of high-biomass algal blooms (*Phaeocystis globosa* but also the co-occurrent diatom *Guinardia delicatula*), presence of gelatinous zooplankton (the dinoflagellate *Noctiluca scintillans*, the appendicularian *Oïkoploira dioica*) and impact on ecosystem function.
In support to government policy, the overall objective is to provide new ecological knowledge and an upgraded version of the existing ecological model (3-D-MIRO&CO) to:

- predict the magnitude and geographical extent of undesirable Phaeocystis blooms in the Southern Bight of the North Sea in response to changing nutrient loads and climate conditions (North Atlantic Oscillation);
- trace the origin and fate of anthropogenic nutrients in the Belgian coastal zone distinguishing between in-flowing Atlantic waters, Scheldt, IJzer and Rhine river inputs, local pelagic and benthic recycling and the export to adjacent areas.

Methodology
AMORE-II research methodology involves and combines the collection of historical and new field data, process-level experiments and numerical tools.
Laboratory and field experiments focus on mechanisms controlling the inception, magnitude and extent of blooms in the Southern Bight of the North Sea with particular attention to further understanding the:

- life strategy of Phaeocystis blooms based on the identification of overwintering forms and complete life cycle making use of high-resolution microscopic techniques and molecular probes;
- competitive strategy among algal blooming species *(P. globosa, G. delicatula)* and bacteria for P acquisition during bloom events based on culture work with pure freshly-isolated species making use of radiotracer and immunofluorescence techniques;
- trophic role of gelatinous zooplankton based on quantitative and qualitative determination of key organisms and their diet and feeding function.

Numerical experimentation will provide an improved version of the existing 3-D-MIRO&CO ecological model in order to increase its capability to predict bloom spreading in response to changes in land-based nutrients and short-term climatic variations. It includes the extension of the geographical domain, better resolution of forcing functions, upgrading of the biological MIRO code based on new experimental results and data assimilation, addition of a module describing carbon speciation and air-sea CO2 exchange. The validated model will be used to assess the impact of nutrient reduction policy on algal bloom mitigation taking into account contrasted meteorological conditions.

Interaction between the different partners
Experimental studies are under full responsibility of ULB-ESA and VUB-ECOL. Experiments in microbial ecology (nutrient competition and Phaeocystis life cycle) will be conducted by ULB-ESA with assistance of Observatoire Océanologique de Banuyls for electronic microscopy. Beside, ULB-ESA will have responsibility of maintenance of phytoplankton cultures and assist VUB-ECOL for experiments on gelatinous zooplankton. MUMM will be in charge of upgrading and managing the numerical code of the ecological model 3-D-MIRO&CO and will be responsible of upgrading the hydrodynamical model. ULB-ESA and Oregon State University will assist MUMM for the optimised ecological parameterisation, interpretation of model simulations and formulation of scenarios for model exploitation. NIOO-CEME due to its recognised international expertise will provide the validated benthic diagenetic module while VUB-ECOL will assist in parameterisation of gelatinous zooplankton dynamics.
Frequent joint meetings of modellers and experi-

mentalists are planned to secure relevance of biological parameterisation and evaluate the capability of the model to simulate ecological trends in the Belgian coastal zone.

Links with international programmes

AMORE contributes to objectives of IGPB-LOICZ (Land Ocean Interactions in the Coastal Zone) and GEOHAB/EUROHAB (Harmful Algal Blooms).

Expected results and/or products

- Improved knowledge of the origin and determinism of Phaeocystis blooms in the Belgian coastal zone and their link with nutrient loads.
- First estimate of the trophic status of gelatinous in Belgian waters and their link with algal blooms.
- Optimised 3-D ecosystem model of Belgian and adjacent waters (Southern North Sea, Eastern English Channel), suitable for application to eutrophication management ('what-if?' scenarios), scientific understanding of the ecosystem and, thanks to addition of carbon cycle dynamics, future global change applications.

PARTNERS

Activities

ULB-ESA: Co-ordination, phytoplankton and bacterioplankton ecophysiology, ecosystem modelling
VUB-ECOL: Zooplankton ecology
MUMM: Modelling
NIOO-CEME: Benthic diagenesis modelling
Oregon State University: Inverse modelling and data assimilation
Observatoire Océanologique de Banuyls: phytoplankton taxonomy

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CANOPY

BIOGEOCHEMICAL CARBON, NITROGEN AND PHOSPHORUS FLUXES IN THE NORTH SEA

Duration of the project: 01/02/2002 – 30/04/2006
Budget: € 948.000
Keywords: Southern Bight of the North Sea, Carbon, Nitrogen, Phosphorus, Budgets

CONTEXT

The Southern Bight of the North Sea receives carbon and nutrients from wastewater discharges, river inputs and atmospheric deposition. Sources of nutrients and carbon are mostly linked to anthropogenic activities. The nutrient enrichment of aquatic systems, also called eutrophication, results in an increased productivity. The most recent QSR report (OSPARCOM, 2000) for the Greater North Sea highlighted very high inputs of nitrogen and phosphorus to the North Sea. These nutrients and carbon are subject to internal fluxes and processes within the North Sea ecosystem, but recent average data for the North Sea dealing with these internal N, P and C recycling processes are rather scarce.

PROJECT DESCRIPTION

Carbon and other nutrients are subject to internal fluxes and processes within the North Sea ecosystem, like internal recycling of organic and inorganic compounds, uptake by phytoplankton, mineralisation, atmospheric efflux, sedimentation, etc. Recent data for the North Sea, concerning this internal recycling are very limited. In this project we will reveal the relative importance of major processes involved in these internal carbon and nutrients cycles in the Southern Bight of the North Sea. These data will be integrated in box-models and compared to the input and output fluxes of C-N-P, in order to be able to visualise the global functioning of the concerned ecosystem. Furthermore, the significance of the main C-N-P compounds will be studied.

Objectives
The general objective of this project is to reveal the relative importance of major processes involved in the internal cycling of carbon and nutrients, in the Southern Bight of the North Sea. These data will be integrated in box-models and compared to the input and output fluxes of C-N-P, in order to be able to visualise the global functioning of the concerned ecosystem. Furthermore, the significance of the most important C-N-P compounds will be studied. Attention will be given to the improvement of analytical techniques, the validation of experimental protocols and the calculation of important ecosystem parameters.

Methodology
1 Workpackage Uptake: The goal of this workpackage is to quantify for the Southern Bight of the North Sea, on an annual basis, the importance of the transfer flux between the inorganic C-N-P pools and the living organic C-N-P pools (mainly phytoplankton). Experiments will be conducted in such a way that exactly the same conditions are valid for the 3 elements. This allows us to link the assimilation pathways of C, N and P.

2 Workpackage Regeneration: The goal of this workpackage is to quantify for the Southern Bight of the North Sea, on an annual basis, the importance of the transfer flux between the organic C-N-P pools and the inorganic C-N-P pools. For nitrogen, transformation rates will be calculated using a detailed 15N mass balance model (Elskens, 1999) allowing estimating the related uncertainties.

3 Workpackage Pools and Speciation: The first goal of this workpackage is to quantify, for the Southern Bight of the North Sea, the importance of the different pools of particulate/dissolved and organic/inorganic C-N-P, including their seasonal variability. This will be done by collecting data in existing databases and by implementing these by original measurements. Quality Assurance and quality control of the nutrient analysis is an essential requirement and therefore regular participation in the QUASIMEME nutrient inter-comparison exercises is necessary.

Interaction between the different partners
The 4 partners have each expertise in either the determination of N-fluxes (VUB), C-fluxes (ULB, VUB and ULg), P-fluxes (ULB) and in budgeting (RIKZ) so that they are complementary in the described workpackages.

Link with international programmes
This project is linked to the Dutch-Flemish collaboration project “The Balance between Heterotrophic and Autotrophic Processes in the Scheldt Estuary: Consequence for the Nitrogen Cycle”.

Expected results and/or products
We expect that the results of this project will be able to answer some fundamental questions about the functioning of a highly men-influenced marine ecosystem: (1) How does the productivity of the Southern Bight of the North Sea reacts to the huge inputs of nutrients (2) What is the faith of the synthesised biomass? (3) What is the net CO2 flux in the area? (4) What would be the possible result of a reduction of the nutrient supply?

PARTNERS

Activities

VUB
The department of Analytical and Environmental Chemistry (ANCH) has expertise in the determination of main fluxes concerning the nitrogen cycle in freshwater and marine systems.

ULB
The Laboratory of Chemical Oceanography has expertise in the determination of main fluxes concerning the phosphorus cycle in marine systems.

ULg
The Unit of Chemical Oceanography has expertise in the field of air-sea CO2 exchange and physico-chemistry of marine inorganic carbon.

RIKZ
Remi Laane has expertise in nutrient budgeting of marine systems and in data-bank management.

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BALANS

BALANCING IMPACTS OF HUMAN ACTIVITIES IN THE BELGIAN PART OF THE NORTH SEA

Duration of the project: 01/10/2002 – 30/09/2006
Budget: € 908.000
Keywords: Anthropic Activity, Ecotoxicology, North Sea, Ecological Indicators

CONTEXT

In the 5th North Sea Declaration (2002) Ministers stressed the need to establish an ecosystem based management of the North Sea in order to conserve biological diversity and ensure sustainable development. To reach the latter, integration of science based, environmental and socio-economic factors influencing the functioning of the North Sea ecosystem are essential. Various research activities in the Belgian part of the North Sea identified either ecological indicators without any link to socio-economical indicators or socio-economical indicators that are not linked to potential ecological indicators. At this stage, the absence of accepted systems and techniques for integrating, weighing and balancing social, economic and ecological indicators is an important lacuna.

PROJECT DESCRIPTION

Sustainable management of the North Sea is a complex theme due to interactions between the social, the economic and the ecological dimension. Five research disciplines (socioeconomics, ecology, ecotoxicology, modelling and fisheries) strive to develop a conceptual policy model, balancing ecological, economical and social indicators in an integrated approach, to support arguments and directions for policy makers to reach a more sustainable management of the Belgian part of the North Sea (BPN).

Objectives
The purpose of this project is to gain experience in correlating and balancing relevant social, economic and ecological data, through the elaboration of indicators, weighing these indicators and the development of a conceptual policy model "Sustainable Management of the North Sea". Following items will i.a. be examined: the reliability of the model, the reduction of uncertainty and error, the relevance of policy models in the argumentation for sustainable management of the sea and the effects of changing parameters of different indicators (social, economic and ecological). As this type of research is very complex and still in an embryonic phase for the marine environment, the project boundaries are limited to fisheries, sand and gravel extraction and related shipping.

Methodology & interaction between the different partners
In general all partners support the calculation of management scenarios.

RUG-Laboratory Marine Biology
- Selection and elaboration of relevant indicators for benthic en epibenthic ecology which reflect the impact of human offshore activities related to fisheries and sand/gravel exploitation, based on available literature. For fisheries special attention here will be directed to ecological impacts of the use of different types of fishing gear. For sand and gravel extraction, special attention will be given to disturbance and recolonisation of habitats.

CLO-Sea Fisheries Department
- Study of the ecological impact of sea fisheries based on own project research collected during the last 10 years and additional literature study. Special attention will be paid to the fishing techniques applied by Belgian fishermen.
- Synthesis of the available data sets and analysis of non-mined data in the Sea Fisheries Department concerning discarding in the Belgian shrimp and flatfish fisheries industry.

RUG-Laboratory Ecotoxicology
- Selection and elaboration of relevant ecotoxicological indicators, which reflect the impact of various industrial activities in the North Sea (fisheries, sand and gravel extraction and discharges of pollutants).
- Selection of indicators representative for the ecological quality status of the chemistry of the water-column and the seafloor, including ecological indicators of the toxicological quality and the effects of pollutants at the ecosystem level.

MUMM
- Data management within the project.
- Study of the feasibility of visualisation of the data and support in the visualisation of the dynamics of a first conceptual balancing model.
- Support of the development and selection of different types of ecological and ecotoxicological indicators.
- Support of the elaboration of ecotoxicological indicators by the use of modelling.

RUG-Maritime Institute & Ecolas
- Selection and elaboration of social and economic indicators for fisheries, sand and gravel extraction and related shipping.
- Development of the impact of the basic management scenario. Impact on socio-economic indicators and the relation to ecological reference points will be taken into account.
- Construction of a conceptual balancing model (BALANS). This model will, as much as possible, be build based on dynamic relationships between the differ-

ent indicators. Different methods and techniques of integration or balancing of social, economic, and ecological indicators will be analysed and compared.
- On the basic of management optimisation scenario's and making use of the conceptual balancing model in co-ordination with the administrations, new developments in international/national law and policy will be used to make short-term and long-term predictions of their socio-economical and ecological effects.

Expected results and/or products
- Detailed database of human activities and compiled database of the benthos of the BPN, evaluation of candidate indicators and selection of indicators related to this benthos.
- Development of ecotoxicological indicators of the watercolumn as a result of the focused activities.
- Application and validation of the developed indicators in a number of management scenarios.
- Identification of social and economical indicators for the focused activities.
- Relation between socio-economic indicators and ecological indicators based on a selection of indicator species derived from literature study and the database Macrodat.
- Relation between socio-economic indicators and ecological indicators based on a selection of ecotoxicological substances derived from literature and the databases.
- Comparison of methods for integration and balancing of social, economical and ecological indicators.
- A conceptual model balancing indicators for social, economical and ecological impacts of the focused activities.
- Relational database of the information relevant to the project.
- Synthetic analysis and dynamic visualisation of these data.

PARTNERS

Activities

RUG-Maritime Institute (MI)
The MI is a university based research institute advising and carrying out studies for governmental administrations, non-governmental organisations and private companies. The staff of the MI is i.a. specialized in research topics concerning international and national environmental law and policy, nature conservation and integrated coastal zone management, law of the sea, maritime law and shipping.

Ecolas N.V., AXE Group
Ecolas N.V. is a multidisciplinary environmental consultancy firm, active world-wide, which has gained its credits in policy supporting environmental studies. Highly trained multifunctional economists, engineers, biologists and geologists form the core of the firm. As such the company and its employees are used to solve problems where environmental, economical and social problems meet.

RUG-Marine Biology Section
The Marine Biology Section has been involved in ecological and systematic research of marine ecosystems from 1970 onwards, starting with the investigation of North Sea benthic communities, with special focus on the macro- and meiobenthos. Later on research was expanded to include the hyperbenthic and epibenthic compartments. Since about ten years, other geographical areas have been included. Next to the biological subjects geochemical characteristics are determined and analysed. 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.

RUG-Laboratory of Environmental Toxicology and Aquatic Ecology
The Laboratory of Environmental Toxicology and Aquatic Ecology has performed fundamental research on different aspects of aquatic toxicology (marine and freshwater environment), such as: development of toxicity tests with different marine and freshwater aquatic organisms; quantification of the toxicity of water sediments; development of Toxicity-Identification-Evaluation (T.I.E.) and Toxicity-Reduction-Evaluation (T.R.E.) techniques; development of biomarker techniques based on physiological and biochemical endpoints for a rapid evaluation of potential toxicity; research towards the endocrine disrupting potential of chemicals in vertebrates and invertebrates; development of (predictive) risk assessment models in freshwater and marine environment, ...

MUMM
Research at MUMMM focuses on providing the necessary knowledge and tools for scientific management of the North Sea ecosystem based on i.a. mathematical modelling. MUMM is the Belgian official body for the management of the marine environment and represents Belgium in various international organisations (e.g. OSPAR, ...). MUMM, as co-ordinator and leader of the IDOD project (Belgian federal oceanographic data centre), has recently gained a significant and professional experience in data management activities.

CLO
DvZ (Sea fisheries Department) is a multidisciplinary institute involved in research on: the rational and sustainable exploitation of living marine resources - the protection of the marine environment as a habitat for these resources - and the quality control of fishery products. The technical department of DvZ has over ten years of experience with national and international research projects. DvZ has good contacts with the fishing industry, fishermen's organisations and the fishery administration and worked closely together with fishermen in many project, such as: selectivity of existing fishing gears; development of alternative fishing techniques; discard monitoring and study of the environmental impact of fisheries.

CONTACT INFORMATION

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ENDIS-RISKS

ENDOCRINE DISRUPTION IN THE SCHELDT ESTUARY: DISTRIBUTION, EXPOSURE AND EFFECTS

Duration of the project: 01/02/2002 – 30/04/2006
Budget: € 1.314.000
Keywords: Endocrine Disruption, Scheldt Estuary, Distribution, Biomarkers, Mysid

CONTEXT

There is growing concern about the potential of various chemicals to produce changes in the functioning of the endocrine system of humans and animals. Known natural hormones as well as relatively unknown environmental pollutants seem to have the ability to potentially disrupt the endocrine system of man and animal in such a way that harmful effects on their development and reproduction can occur.
The first indications of possible effects of endocrine disrupting substances and the presence of these substances in the Scheldt estuary have recently been published. The industrial areas of Gent and Antwerp are to a large extent responsible for this pollution. Therefore, there is an obvious need to investigate the occurrence of endocrine disruption in the Scheldt estuary. In addition, a detailed knowledge of the distribution and long-term effects of these substances is needed in the framework of future-oriented policy measures at the national and European level.

PROJECT DESCRIPTION

Objectives
The major objectives within the project are:
- analyses of endocrine disrupters in water, suspended solids, sediment and biota (mysids, gobies);
- in vitro evaluation of the estrogenic and androgenic potency of samples of water, suspended solids and sediment;
- ecotoxicological and in situ evaluation of the effects on the resident mysid populations (short, intermediate and long-term);
- risk assessment of endocrine disrupters in the Scheldt estuary.

Methodology
The proposed project can be divided into four different research phases:

Phase I: Distribution of endocrine disrupting substances in the Scheldt estuary (chemical analyses, analyses on biota, in vitro analyses)

The Scheldt estuary will be sampled three times a year (spring, summer and winter) for the duration of the project. On each sampling date, sediment, water, suspended solid and biota (mysid shrimp and gobies) will be collected. An extended list of natural hormones and endocrine disrupting chemicals will be measured in these samples.

The different water, sediment and suspended solid extracts will be tested in vitro to assess their potential to bind with the (human) estrogen and androgen receptor. The results of these analyses will allow an identification of the estrogenic and androgenic potency in different environmental matrices of the Scheldt estuary.

Phase II: Evaluation of the exposure of biota from the Scheldt estuary to endocrine disrupting substances

Based on the results of the first sampling campaigns priority substances will be selected. These priority endocrine disrupting chemicals will be used in laboratory experiments with mysid shrimp to assess acute and chronic effects (Phase III).

Phase III: Ecotoxicological evaluation of the effects of endocrine disrupting substances occurring in the Scheldt estuary on resident mysid shrimp populations (laboratory and field studies)

Acute and chronic laboratory tests with mysid shrimps.
To evaluate the possible effects of the pollutants (retained in phase II) on mysid shrimp, acute and chronic test will be performed in the laboratory. Mysid shrimp will also be exposed in multi-generation experiments during two generations (until the first generation of juveniles produces juveniles again) to assess the effects of endocrine disrupters during prolonged exposure.

Population study of the native mysid shrimp in the Scheldt estuary.
The mysid shrimp population of the Scheldt estuary will be sampled and studied during one year. In this way, the present population dynamics can be compared with the available historical data and possible changes can be detected. In addition, a more in-depth field study on the possible endocrine disruption effects will be conducted based on the results of the laboratory toxicity experiments. Sensitive endpoints identified in the laboratory experiments will be validated in situ on the resident mysid shrimp population in the Scheldt estuary.

Phase IV: Risk assessment

In the last phase, the results of the previous phases will be incorporated into an integrated risk assessment for the Scheldt estuary with reference to endocrine disrupting substances. Moreover, an over-

all risk assessment for the Scheldt estuary will be conducted with these data in correlation with environmental concentrations of the tested endocrine disrupters. Recommendations for sustainable management and priority substances will be developed.

Expected results and/or products

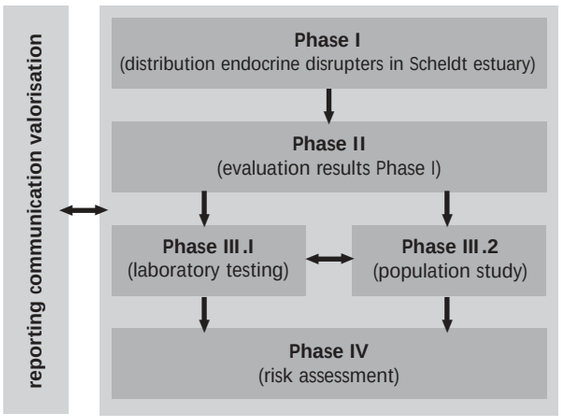
The results of this study on "endocrine disruption in the Scheldt estuary: distribution, exposure and effects" will be used at different levels and in different ways.

In order to ensure (rapid) dissemination and valorisation of the obtained results, the following actions will be undertaken:

- all results will be published in peer-reviewed journals;
- transfer (and discussion) of the obtained knowledge and insights to national and international representatives of policy making and policy supporting governmental services. This discussion will offer an essential contribution to the international contractual engagements of Belgium;
- diffusion of data and results through scientific databases;
- interactive communication forum during the project (project website);
- the results of the project will be brought together in a book, which will include the datasets on CD-rom and the main research results.

The diffusion and valorisation of the information as described above will be developed and maintained by the Flemish Institute for the Sea (VLIZ) (subcontracted) under supervision of the co-ordinator.

Overview of the interactions and different research phases in the ENDIS-RISKS project



PARTNERS

Activities

RUG-LMAE

The Laboratory of Environmental Toxicology and Aquatic Ecology belongs to the inter-faculty research group Endocrine Modulator Research Gent (EMRGent). This group investigates different aspects (environment and human) of endocrine disrupting substances. The recognised experience of the LMAE is in the field of ecotoxicology and risk assessment of endocrine disrupting substances and metals.

RUG-Marine Biology Section

This section is specialised in biological and ecological research in marine/estuarine ecosystems. This group has a long-standing and recognised expertise in the various research aspects of mysid shrimps in European estuaries, in particular the Scheldt estuary.

RUG-Laboratory of Chemical Analysis

This laboratory has an internationally recognised expertise, experience and technology for the identification, quantification and purification of endocrine disrupting chemicals (especially hormones).

MUMM

The Management Unit of the North Sea Mathematical Models has a crucial role in the preparation, performance and visualisation of the governmental policy concerning the marine environment. In addition, their laboratory is a recognised expertise centre for the analysis of micro-pollutants.

RIKZ

RIKZ has, in the Netherlands and in Europe, a central role in the research of endocrine disrupting substances in the marine environment. This institute recently performed (together with RIZA) the LOES-project (Research to the presence of estrogen-active substances in aquatic systems and wastewater in the Netherlands) and performs important policy supporting research on the Scheldt estuary.

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website of the network: www.vliz.be/projects/endis

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ECOTOX2

EFFECTS OF POLLUTANTS ON BENTHIC POPULATIONS AND COMMUNITIES OF NORTH SEA ORGANISMS

Duration of the project: 01/02/2002 – 30/04/2006
Budget: € 754.000
Keywords: Benthic Population, Benthos, North Sea, Pollution, Ocean Organisms

CONTEXT

Several classes of potentially toxic contaminants occur at high levels in the North Sea. These worrying contaminants include coplanar polychlorobiphenyls (cPCBs), polybrominated diphenyls ethers (PBDEs), dioxins, furans, polycyclic aromatic hydrocarbons (PAHs) and some metals (Cd, Pb, Hg, Zn). Tools for assessing the effects of these substances have been developed, the so-called biomarkers (biological responses indicating the exposure to or the effects of a contaminant in an organism). Most current biomarkers (as well as those in development) consist in responses at biochemical to individual levels of biological organisation. Actually, there are very few data to interpret the significance of the biomarker responses at the population or community level, which should be considered for the preservation of species and biodiversity.

PROJECT DESCRIPTION

Objectives
To determine whether the effects of contaminants of high concern in the North Sea (cPCBs, dioxins, furans, PAHS, PBDE, and metals -Cd, Pb, Hg, Zn- with possible synergic effects due to increased levels of organic matter) monitored at the gene to individual levels result in significant impairments of populations or communities of benthic organisms and if the early signals provided by biomarkers can effectively predict these ecological effects.

Methodology
Considered organisms are marine benthic biota of great ecological and/or strategic importance, namely the starfish Asterias rubens, the mussel Mytilus edulis, and sediment-associated microbial communities (SAMC). The two first species are recognised bioindicators of contamination and provide validated biomarkers or biomarkers in development. They are studied at the population level. SAMC are key components of soft sediments but are poorly known from an ecotoxicological point of view. They are studied at the community level.

The strategy is to determine the effects of contaminants on population or community parameters of the selected organisms in mesocosms and/or in the field together with biomarker responses, environmental and contamination conditions being either imposed (mesocosm experiments) or determined simultaneously (field studies).

Analysed contaminants are cPCBs, dioxins, furans, PAH, PBDEs, and metals (Cd, Pb, Hg, Zn). Environmental conditions taken into account are salinity, temperature, organic load of the sediment, and food availability for starfishes and mussels. Considered biomarkers are, in starfishes and mussels, metallothionein induction, cytochrome P450-1A activity, immune activity, embryotoxic assays, differential gene expression analysis. In addition, a bacterial cell stress gene-profiling assay is used to detect and characterise the nature of the pollution in marine sediments and suspended matter. This is a newly developed assay whereby the status of gene expression is measured through specific reporter constructs.

In field experiments, the strategy is to determine in a limited number of well-contrasted sites (1) general environmental conditions (temperature, salinity, available food), (2) contaminant levels (in sediments, suspended organic matter, and the selected biota), (3) population/or community parameters of the selected organisms, and (4) responses of the selected biomarkers. Then, through multivariate data analysis, differences in ecological parameters will be linked with environmental conditions and/or contaminant levels. Finally, correlations between biomarker responses and impairment of populations or communities will be established. Selected sites include contaminated and background sites in the Southern Bight of the North Sea (from Pas-de-Calais to Grevelingenmeer with stations along the Belgian coast and in the Scheldt estuary) and a hot spot (and associated gradient of contamination) in a Norwegian fjord. The parameters of starfish and mussel populations that are characterised are population dynamics (cohort analysis of size class distributions, to determine growth, survival, and death rates), organ indices (to characterise resource allocation), gametogenetic cycle, and reproductive capacity. Parameters of SAMC are biodiversity and abundance of dominant species (determined by molecular biology techniques).

Mesocosms experiments will allow to separate effects of specific factors (environment and contaminants) on the population and community parameters in controlled conditions. For that purpose, selected environmental parameters and levels of contaminants are manipulated with other parameters maintained at background condition. Studied variables are growth of recruits (i.e. newly settled juveniles), growth and metamorphosis of larvae, and biodiversity and abundance of dominant species of SAMC.

Interaction between the different partners
Four biologist teams (UMH-Biomar, ULB-Biomar -with its subcontractant ULB-ESA-, and RUCA) are in charge of field and mesocosm experiments, and biomarker measures. Two chemist groups (UMH-ChOrg and ULg) will analyse, respectively, PAHs and cPCBs, PBDEs, dioxin and furans. Metals will be analysed by RUCA and ULB-Biomar.

Expected results and/or products
The main results expected are (1) an assessment of the impact of contaminants of high concern on populations of major invertebrates and communities of sediment-associated bacteria in the North Sea and (2) an evaluation of the ability of selected biomarkers to predict these effects. This will provide a case study in the field of ecotoxicology sensu stricto (i.e. at the level of population and community), a fundamental but rarely seeked objective in the marine environment.
The output of the project will provide both environmental agencies and industries with an assessment of the health status of coastal benthic communities of the Southern Bight of the North Sea and a determination of the factors of concern (these data can constitute the basis to decide if remedial actions are necessary or not - e.g. in recreational or shellfishing areas).
Results will also be used to raise the concern of the public and NGO for the protection of marine benthic ecosystems in general and of invertebrates in particular.

PARTNERS

Activities

ULB
The research activities of the Marine Biology Laboratory (Biomar) deal with the biology, ecology, ecotoxicology, and aquaculture of marine invertebrates, with a particular interest for echinoderms. The Laboratory of Ecology of Aquatic Systems (ESA) is specialised in the functioning of aquatic ecosystems and their responses to natural and man-induced changes.

UMH
The Marine Biology Laboratory (Biomar) focuses on the biology of marine benthic invertebrates, notably echinoderms. Main topics are adhesive properties, symbiosis, and larval development including metamorphosis. The Organic Chemistry Laboratory (ChOrg) is specialised in mass spectrometry applied to new reactive molecules, atmospheric and marine pollutants, and amino acid sequences in peptides.

RUCA
The research of the Ecophysiology, Biochemistry and Toxicology group is focused on biological availability and accumulation of contaminants in aquatic organisms and ecosystems, and on the effects of environmental conditions and pollution exposure on physiological condition and toxicological effects.

ULg
The Mass Spectrometry Laboratory research is focused on the development of analytical methods for micropollutants and on the study of molecular recognition between bio-molecules (proteins and DNA and complexes with xenobiotics).

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BIANZO

BIODIVERSITY OF THREE REPRESENTATIVE GROUPS OF THE ANTARCTIC ZOOBENTHOS

Duration of the project: 01/02/2002 – 30/04/2006
Budget: € 1.140.000
Keywords: Biodiversity, Antarctica, Amphipoda, Nematoda, Echinoidea

CONTEXT

The Convention on Biological Diversity has critically increased the awareness of the general lack of knowledge about the world biodiversity, especially the marine biodiversity. On the other hand, the implementation of the Madrid Protocol on Environmental Protection of the Antarctic requires a more comprehensive knowledge of Antarctic marine biodiversity and a better accessibility to the widely scattered biodiversity information.

Current research programmes in Antarctic biology focussed in particular on the structure and dynamics of coastal and shelf ecosystems in the perspective of global changes (SCAR-EASIZ), and on the biodiversity of the totally unknown deep-sea habitats (ANDEEP). Finally, several worldwide initiatives (like GBIF) have stressed the need for developing efficiently the biodiversity information management and promoted the development of comprehensive biodiversity databases.

PROJECT DESCRIPTION

Objectives
The main goal of this study is to investigate the biodiversity of the Antarctic benthos through three representative faunal groups of different size categories: the nematodes (meiobenthos), the amphipod crustaceans (macrobenthos) and the echinids (megabenthos).

The meiofaunal Nematodes are in terms of abundance the most important metazoan group in marine sediments. As their communities contain a large number of species, usually an order of magnitude greater than any other meiobenthic taxon, they are particularly suitable for tackling biodiversity and biogeography issues. Amphipods appear to be the most speciose animal group in Antarctic seas, and one of the most diverse in terms of modes of life, habitats, trophic types, and size spectra. Finally Echinoids constitute an often abundant and widely distributed component of the Antarctic communities, and offer important opportunities for symbiotic diversity.

Relying on the exploration of new or poorly known Antarctic regions, this study will first concentrate on the understanding of the nature and distribution of biodiversity, i.e. to take an inventory of the faunal components and to analyse their distribution with respect to several gradients (depth, latitude or differences between basin).

The second objective aims at better understanding the ecofunctional role of biodiversity by analysing different dynamic aspects such as niche diversity, trophic types and role in food webs, reproduction patterns or biomass turnover.

The third objective concerns the development of a Biodiversity Information System for the Antarctic benthos, to make more effectively available to the scientific community and other users, the biodiversity knowledge acquired during previous studies or newly gained from the proposed research. This information system will include mapping applications and will rely on the extant or development databases of the three benthic taxa.

Methodology
Field sampling of new material will benefit from different international Antarctic campaigns onboard RV Polarstern such as the ANDEEP or LAMPOS cruises in the Weddell Sea and along the Scotia Arc. Sampled material will be preserved for morphological and taxonomic purposes, for molecular approach, and for stable isotope analyses by mass spectrometry. It will also be compared to existing museum collections.

Living material will also be collected and kept in cold rooms, in order to analyse different ecological parameters such as food preferences, feeding or growth rates.

Interaction between the different partners
IRSNB-RUG-ULB will collaborate in field sampling and in the analysis and integration of data of common significance, each partner focussing on a different group of zoobenthos representative for a size class.

ULg will work together with the other three ones in analysing stable isotopes on collected material, in order to delineate carbon and nitrogen fluxes within Antarctic benthic ecosystems.
The four partners will collaborate in the creation of a web portal which will connect the databases developed by each partner, and eventually other existing databases about Antarctic biodiversity.

Link with international programmes
- SCAR-EASIZ, Ecology of the Antarctic Sea-Ice Zone;
- ANDEEP, ANtarctic benthic DEEP-sea biodiversity;
- LAMPOS, Latin-AMerica POlarstern Study;

- SCAR-EVOLANTA, EVOLution in ANTArctica;
- DIVERSITAS;
- CoML-OBIS, Census of Marine Life - Ocean Biogeographic Information System;
- GBIF, Global Biodiversity Information Facility.

Expected results

- An improved knowledge of the composition and biogeography of the three target benthic groups in some poorly known parts of the Southern Ocean shelf.
- A detection of potential cryptic species (through molecular analyses) which could conduct to revise our current estimations of Antarctic species richness and our concept of generalised circumpolar distribution.
- A discovery of the totally unknown deep-sea fauna from the continental slope and abyssal basins of the Scotia and Weddell seas.
- An improved knowledge of some ecological aspects useful to understand the role of biodiversity in ecosystem functioning, such as niche diversity, trophic roles.
- An improved knowledge of some biological aspects significant for the understanding of Antarctic biodiversity patterns: life styles such as symbiosis, size spectra in the deep sea, reproduction and development.
- New syntheses on taxonomy, faunistics, distribution and biogeography of selected groups of the Antarctic benthos through the development and concerted exploitation of comprehensive databases and mapping applications.
- An implementation of extant databases on the biodiversity of the 3 target groups.

PARTNERS

Activities

IRSNB
Will focus on different aspects of the biodiversity of Antarctic amphipods (morphological and molecular taxonomy, biogeography, ecofunctional diversity), and will implement the ANT'PHIPODA database (Biodiversity Reference Centre for Antarctic Amphipoda). It will also co-ordinate the project.

RUG
Will concentrate on biodiversity features of Antarctic nematodes (diversity of communities, depth gradients, density and turnover). It will implement the NEMASLAN database (Biodiversity of Antarctic Nematodes).

ULB
Will focus on the biodiversity of Antarctic echinoids, with a special interest for symbioses as a source of niches. It will also update its ANTARCTIC ECHINOID database.

ULg
Will perform isotope ratio mass spectrometry analyses on field collected material to delineate the food webs wherein the 3 groups of target organisms are involved.

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TROPHOS

HIGHER TROPHIC LEVELS IN THE SOUTHERN NORTH SEA

Duration of the project: 01/02/2002 – 30/04/2006
Budget: € 1.048.000
Keywords: North Sea Ecosystem, Benthos, Population Dynamics, Sampling, Food Web

CONTEXT

TROPHOS is a co-operation between five Belgian institutes (RUG–Marine Biology, KULeuven–Aquatic Ecology, Institute of Nature Conservation (IN), Management Unit of the North Sea Mathematical Models (MUMM) and Flanders Marine Institute (VLIZ)) and one Dutch institute (NIOO-CEME) and aims at a better understanding of processes structuring the higher trophic levels in the North Sea. As we will not ignore the link between ecosystem functioning and aquatic biodiversity, our results will also serve in aspects of sustainable management for those areas on the Belgian Continental Shelf (BCS) of the North Sea, which fulfil the criteria for protection status in marine reserves.

PROJECT DESCRIPTION

Objectives

Research within TROPHOS will focus on processes structuring the higher trophic levels in the North Sea ecosystem. Special attention will be given to:

- The food web interactions that shape the benthic communities. This will make it possible to unravel how food cascades into animal biomass. Detailed research on C-cycling within the benthic food web will be performed.
- The dispersal mechanisms on the BCS. This is mainly of importance for those species that have a pelagic life-style or have pelagic larvae. The impact of certain behavioural aspects (swimming, sinking,...) on the dispersal will be investigated as well.
- The importance of the benthic communities in the functioning of the total BCS ecosystem. It will be examined whether or not Phaeocystis can be used as a food source by the infauna of the benthos. In addition, sediment community oxygen consumption rates that will be performed in BCS sediments will shed light on total benthic metabolism.
- The Belgian coastal waters are internationally very important areas for a number of sea and coastal birds. Studying the distribution patterns of the possible food sources (i.e. pelagic fish) of these birds will lead to a better understanding of their spatial distribution patterns. Population dynamics of gulls and terns in the outer harbour of Zeebrugge will be studied as well.

Methodology

- Food web interactions: This task will be executed by RUG-Marine Biology Section and NIOO-CEME and is focussed on meiobenthos. Monthly sampling of two stations, showing a clearly different food web structure, will allow describing changes in the composition and densities of the meiobenthos when changes in the primary production in the water column will occur. The primary production will sink to the sea floor and acts as an important food source for the benthos. Possible consumption of phytoplankton can be studied by comparing the natural occurring stable isotopes of the meiobenthos with those present in the phytoplankton. Changes in bacterial diversity will be assessed by means of DGGE. The benthic response to the sedimentation of the spring phytoplankton bloom will be evaluated trough experiments with enriched and labelled (stable isotopes 13C and 15N) phytoplankton. Benthic food web flows and the benthic contribution to the metabolism of the ecosystem will be inferred from inverse modelling.
- Dispersal mechanisms of key species: This part of TROPHOS will be performed by KULeuven, RUG and MUMM. Larvae and post larvae of fish and Mesopodopsis, sole and gobies will be sampled using the appropriate sampling gear. Population-specific life history characteristics (e.g. fertility, survival, growth...) will be collected. Genotyping will be done with at least 8 DNA microsatellites per fish (KULeuven) or with SSCP combined with sequencing of variable nuclear and mitochondrial loci (Mesopodopsis (RUG) and Gyrodactylus (KULeuven)). The behaviour of the planktonic stages of the fishes and Mesopodopsis will be modelled with a combined 3-D hydrodynamic and particle tracking model by MUMM.
- Coastal and sea birds: This part of TROPHOS will be a combined effort of RUG and IN. Pelagic fish will be collected monthly at 7 locations on the BCS by means of a MIC-net at the surface and near the bottom. Frequency of sampling will be diminished towards the end of the project. Species composition, length distribution, abundance, zooplankton density and a number of environmental variables will be measured. Distribution patterns of Common Tern, Sandwich Tern, Auk, Common Guillemot and Great Crested Grebe will be compared with the horizontal distribution of their prey fish. An analysis of the content of the stomach will be performed on fresh corpses of Guillemot, Auk and Great Crested Grebes found during beach bird surveys along the coast and birds accidentally caught in fishing nets. Population size of seabirds nesting in Zeebrugge will be determined. Laying date, clutch size, predation rate, hatching success, chick growth and survival will be measured. Nest attendance and prey specific foraging time will be established. Food intake and diet composition of Sandwich and Common Tern chicks will be measured from a hide. Food composition of adult terns will be identified by means of otholits

and other food remains found in faeces and pellets. Variation in food composition will be compared to fluctuations in food availability. Reading of ringed Sandwich Tern, Common Tern, Herring Gull and Lesser Black-backed Gull will be analysed and migration between colonies will be assessed.

Interaction between the different partners

Strong interactions between the various partners in this project are foreseen. The bentho-pelagic coupling theme will be a result of a strong co-operation between RUG and NIOO-CEME, while VLIZ offers ship time on their research vessel Zeeleeuw. Sampling campaigns will be a joint effort and researchers belonging to both institutes will conduct the experiments. KULeuven and RUG will work together on the theme covering the dispersal mechanisms of species having pelagic life stages. These mechanisms will be modelled as a result of collaboration between the KULeuven and RUG teams and the modellers at MUMM. IN and RUG will be the partners tackling the problems relating to the causal aspects of the distribution of seabirds: RUG will work on the pelagic fish data, while bird data will be analysed at IN.
Data management and dissemination of results: VLIZ will be responsible for the data management, valorisation and exploitation. By developing databases and websites, data gathered in the framework of TROPHOS will be made available to the public. VLIZ will also develop and implement modalities and technical solutions for data-exchange between the partners within TROPHOS.

Link with international programmes

- DIVERSITAS (ICSU, SCOPE, IUBS, IUMS, UNESCO-MAB).
- IGBP (International Geosphere – Biosphere Programme).
- LOICZ (Land Ocean Interactions in the Coastal Zone, IGBP, ICSU).

Expected results and/or products

- Scientific results will be published in peer-reviewed journals.
- Data of the benthos and seabirds on the BCS will be made public through the website. An atlas with distribution maps will be provided as well.
- Monitoring designs for the follow-up of nature conservation will be developed (potential Marine Protected Areas).
- Bio-indicator species and bio-indicator communities for anthropogenic threats will be identified and tested.
- Detailed food web interactions will be identified for the first time in the higher trophic levels of the North Sea.
- Coupling between hydrodynamic models and dispersal mechanisms of selected species will be explained.
- Population dynamics of gulls and terns will help in setting the criteria for protected areas, habitats and species.
- Results will be made available to the public, end-users, governmental bodies.

PARTNERS

Activities

RUG
The Marine Biology Section is responsible for the overall co-ordination, diversity, density and biomass of meiobenthos, diversity of bacterial communities, stable isotope work.

NIOO-CEME
The Centre for Estuarine and Marine Ecology of the Netherlands Institute for Ecology focuses on experimental work using stable isotopes, modelling of food-web flows.

KULeuven
The Laboratory of Aquatic Ecology works on the life history and dispersal of organisms with pelagic life stages.

MUMM
The Management Unit of the North Sea Mathematical Models will be in charge of the development of a dispersion model for organisms with a pelagic life stage.

IN
The Institute of Nature Conservation focuses on causal aspects of seabird distribution.

VLIZ
The Flanders Marine Institute is responsible for the data management, valorisation and exploitation of results.

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website of the network: www.vliz.be/projects/trophos

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