

# 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 Haptophyceae *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 *Oikoploira 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 radio-tracer 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 CO<sub>2</sub> 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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