AMORE III

Combined Effect of Changing Hydroclimate and Human Activity on Coastal Ecosystem Health

CONTEXT

As EU member and Contracting Party of the OSPAR Convention for the Protection of the Marine Environment of the north-east Atlantic, Belgium has the obligation to take measures to protect its maritime area against the adverse effects of eutrophication. Eutrophication in Belgian coastal waters results from climate-driven transboundary (SW-Atlantic waters, Rhine) and local (Ijzer, Scheldt) inputs of land-based unbalanced nutrients (excess of N over Si and/or P) and manifests as high-biomass algal blooms (mainly the Haptophycea *Phaeocystis*) that impact the ecosystem function and services. An increased understanding of the links between changing nutrient loads and ecosystem response is needed to guide formulation of EU regulations for the reduction of nutrient inputs to the North Sea and the optimisation of goods and services such as offshore mussel farming.
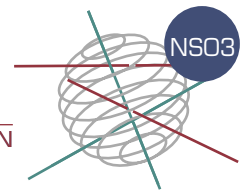
PROJECT DESCRIPTION

Objectives

AMORE III address the dual role of changing human activity and climate on eutrophication in the Belgian coastal zone (EEZ.be) and the feedback effect on goods (newly-deployed offshore mussel farming) and services (atmospheric CO2 absorption).
As a scientific contribution towards the sustainable use of EEZ.be, AMORE III aims to provide new ecological knowledge, develop new technology and upgrade the existing 3D-MIRO&CO ecological model to:
- Assess the dual role of changing hydro-climate and nutrient river loads in determining the geographical spreading and the magnitude of *Phaeocystis* blooms in EEZ.be as well as the role of the coastal area as buffer of increased atmospheric CO_2; predict how these features might change in the near future (2015) based on realistic scenarios of changing climate and river nutrient loads;
- Assess the impact of *Phaeocystis* colony spreading on offshore mussel farming and make recommendations for an optimized management;
- Define ecological quality criteria for measuring ecosystem changes and the effectiveness of management and policy applications.

Methodology

Recognizing the multiplicity of processes, changes and forces behind the dynamic of coastal ecosystems, the AMORE research methodology involves and combines field observation, laboratory-controlled experiments, and mathematical modelling in an iterative way. The coupled hydrodynamical ecological model 3D-MIRO&CO plays a central role as integrator of new knowledge gained from experimental studies and as a tool for eutrophication assessment and prediction as well as decision support. Results gained during AMORE I and II revealed some weaknesses that have to be solved before transferring model results to end-users. Therefore:
Laboratory and field experiments focus on mechanisms controlling the inception, magnitude and extent of blooms in North Sea with particular attention to further understanding the:
- *Phaeocystis* origin and mechanisms triggering colony formation
- Sensitivity of diatoms and *Phaeocystis* to expected temperature and light changes
- Impact of *Phaeocystis* blooms on offshore mussel farming
- Spatio-temporal distribution of diatom and *Phaeocystis* blooms throughout the development and application of a real-time digital imaging flow cytometry (Flow CAM).

Numerical experimentation will provide an improved version of the 3D-MIRO&CO model in order to increase its capability to predict bloom spreading in response to changes in land-based nutrients and climate. This includes the increase of the grid size resolution, the explicit resolution of temperature, the coupling with the RIVERSTRAHLER model calculating land-based nutrient loads and the upgrading of the biological MIRO code based on new experimental results. The validated model will be used to understand the past (back to 1950), present and future role of changing climate

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and human activity on the North Sea coastal ecosystem and assess the effect of nutrient reduction policy on algal bloom mitigation.

INTERACTION BETWEEN THE DIFFERENT PARTNERS

Experiments in phytoplankton ecophysiology are conducted by ULB. ULB is responsible of phytoplankton cultures and assists ILVO and UMH for respectively mussel bioassays and Flow CAM application. UMH is in charge of the development of software for digital image analysis. MUMM is in charge of upgrading and managing the numerical code of the 3D-MIRO&CO model and is responsible of upgrading the hydrodynamical model. MUMM is assisted by ULB for the ecological parameterisation, interpretation of model simulations and formulation of scenarios for model exploitation.

Frequent joint meetings of modellers and experimentalists are planned to secure relevance of biological parameterisation and evaluate the capability of the model to simulate ecological trends in the Belgian coastal zone.

LINK INTERNATIONAL PROGRAMMES

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

EXPECTED RESULTS AND/OR PRODUCTS

- Peer-reviewed papers describing scientific achievements.
- First estimate of the impact of *Phaeocystis* blooms on offshore mussel farming.
- Open source software (PHYTOImage) freely available to the whole scientific community and other experts.
- Optimised 3D ecosystem model of Belgian and adjacent waters (Southern North Sea, English Channel), suitable for scientific understanding of the ecosystem dynamics and for application to eutrophication management.
- Website (www.ulb.ac.be/assoc/esa/AMORE/amore.htm) for communicating between and outside AMORE partners

PARTNERS - ACTIVITIES

The coordinator, ULB (Ecologie des Systèmes Aquatiques, ESA) focuses research on the study and modeling of the functioning of aquatic systems. It is recognized expert in *Phaeocystis ecophysiology and the developer of the MIRO model.*

UMH (Numerical Ecology of Aquatic Systems) develops biostatistical tools and software for ecology. It is leader in the development of Open source software for the automatic analysis of plankton digital images (Zoo/PhytoImage) and for the analy-

sis of space-time series (PASTECS).

ILVO (Institute for agricultural and fisheries research) – fisheries conducts research on fish biology and aquaculture.. ILVO supports the offshore mussel farming in the North Sea.

MUMM's research aims to provide a scientific basis for marine environmental management, e.g. using 3D modeling and remote sensing to understand eutrophication processes.

CONTACT INFORMATION

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Follow-up Committee

For the complete and most up-to-date composition of the Follow-up Committee, please consult our Federal Research Actions Database (FEDRA) by visiting http://www.belspo.be/fedra or http://www.belspo.be/ssd

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