Abschlussbericht

ERANET BONUS: Verbundprojekt BONUS-125: ECOSUPPORT – Leistungsfähiges Modellsystem der Ostsee für Szenariensimulationen zur Unterstützung von Entscheidungsfindungen

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ECOSUPPORT

(Advanced modeling tool for scenarios of the Baltic Sea ECOsystem to SUPPORT decision making, http://www.baltex-research.eu/ecosupport)

Final report 2009-2011 (including annual report Y3: 2011-01-01 – 2011-12-31)

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1. Summary of Deliverables

1.1 Deliverables for the Y1 reporting period

WP no	No	Title	Due	Status
1	1	Reconstructed atmospheric forcing fields 1850-2007, riverborne nutrient loads including diffusive and point sources , airborne nutrient loads	Month 12	Delivered
1	2	Model data of the first transient simulation to force hydrological models of the catchment area and BS models 1960-2100	Month 6	Delivered
1	3	Model data sets of the whole ensemble 1960-2100	Month 12	Delivered
1	4	River flow data, river- and airborne nutrient loads and CO2 emissions 1960-2100	Month 12	Delivered
2	1	Unified high quality initial, forcing and validation data sets, model data sets 1961-2004	Month 6	Delivered
2	2	Detailed assessment of model skills	Month 9	Delivered
3	1	Unified validation data sets	Month 9	Delivered
5	1	Organisation and meeting minutes kick-off, annual GA, final conference	Month 2	Delivered
5	2	ECOSUPPORT webpage for internal and external information and data exchange, afterwards continuously updated	Month 3	Delivered

1.2 Deliverables for the Y2 reporting period

WP no	No	Title	Due	Status
1	5	Quantification of forcing biases, analysis of causes of biases in reconstructed and simulated forcing fields	Month 24	Delivered
2	3	Model data sets 1850-2007, understanding and quantification of the models capability to simulate perturbations in climate and nutrient loads	Month 24	Delivered
2	4	Model data of first transient simulation with BALTSEM and RCO-SCOBI 1960-2100	Month 18	Delivered
2	5	Model data of all transient simulations	Month 24	Delivered
2	8	Calculation of nutrient load reductions necessary to meet the BSAP targets	Month 24	Postponed to Y3 Completed in Y3
3	2	Food web model and BEM simulation results 1961-2004	Month 24	Completed
5	1	Organisation and meeting minutes kick-off, annual GA, final conference	Month 13	Delivered
5	4	ECOSUPPORT mid-term report	Month 19	Delivered

1.3 Deliverables for the Y3 reporting period

WP no	No	Title	Due	Status
2	6	Analysis of simulated changes (maps, transports, integrated budgets) of biogeochemical variables and ecological quality indicators in future climate and with altered nutrient loads	Month 30	Delivered
2	7	Uncertainty assessment of future projections, results of the analysis of various time horizons, e.g. 2010-2030, 2050-2070, output of the cause-and-effect studies	Month 36	Delivered
3	3	Output of the assessment of model skills, and analysis of regime-shifts in the food web	Month 30	Delivered
3	4	Food web and fish population model simulations for 1960-2100, assessment of impacts of ocean acidification effects on the key functional groups of organisms in the Baltic Sea ecosystem , cause-and-effect studies of simulated changes and analysis of scenarios	Month 33	Delivered
3	5	Probabilistic uncertainty assessments of biological responses (e. g., populations, food web structure) to model structure and forcing scenarios	Month 33	Delivered
4	1	Model simulations of present and future climates in the Gulf of Finland	Month 30	Delivered
4	2	Uncertainty estimates of the Gulf of Finland model output fields	Month 33	Delivered
4	3	Distribution maps of water quality indicators in the coastal zone and open Gulf of Finland	Month 33	Delivered
4	4	Recommendations for future country-wise actions on achieving and preserving good water quality of the Gulf of Finland and management its marine resources	Month 33	Delivered
4	5	Model data sets of hydrography and water quality indicators in Vistula Lagoon	Month 30	Delivered
4	6	Uncertainty estimates, and assessment of socioeconomic impact on Vistula Lagoon	Month 33	Delivered
4	7	Economic assessment of ecosystem goods and services of key ecosystem/habitats on the Polish Economical Zone based upon biological valuation maps in present and future climates	Month 33	Delivered
4	8	A cross-country analysis of stakeholder perceptions of climate change in the BS region	Month 36	Delivered
5	1	Organisation and meeting minutes, final conference	Month 25-36	Delivered
5	3	Publicly available web based DSS	Month 36	Delivered
5	5	ECOSUPPORT final report	Month 37	Delivered

Overall ECOSUPPORT conclusions:

1. **Climate change may have considerable impact on the marine environment with socioeconomic implications**
2. **Nutrient load reductions and sustainable fishery may even be more important in future climate than in present climate**

2. Executive summary

Today the Baltic Sea suffers from severe environmental problems due to eutrophication, e.g. large cyanobacteria blooms and dead sea beds. To overcome these problems it is of vital importance to reduce nutrient loads from the atmosphere, point sources and rivers with the help of international policies, e.g. HELCOM's Baltic Sea Action Plan (BSAP). The BSAP includes the load reductions necessary to obtain good water quality as well as nutrient load abatement strategies based upon a country-wise allocation scheme. The BSAP is currently under revision, i.e. new environmental targets were recently proposed by the TARGREV project and based on these targets revised maximum allowable loads and country allocations are under development.

ECOSUPPORT was designed to play a role by supplying decision makers with sound, scientific knowledge of results of actions on water and land. During 2009-2011 research at 11 institutes from seven Baltic Sea countries contributed to the understanding what effects different mitigation measures will have on the marine ecosystem. For this purpose, a multi-model system tool was developed to support decision makers to assess the anthropogenic impact on the Baltic Sea environment. The advanced modelling tool produces scenario simulations of the whole marine ecosystem that underpin and inform design strategies to ensure water quality standards, biodiversity and fish stocks.

As the response of the Baltic Sea system to changing nutrient loads from land is slow (we found that it will take at least 30 years approximately to see significant improvements of the environmental status in case of nutrient abatements), long scenario simulations are needed that take also the effects of changing climate into account. Hence, within ECOSUPPORT a new modelling approach was developed to calculate the combined effects of changing climate and changing nutrient loads on the Baltic Sea ecosystem. As models have biases due to our limited knowledge of climate and ecosystem processes, uncertainties were quantified using a multi-model ensemble approach for all components of the Earth system, i.e. models for the atmosphere, ocean and land surface including biogeochemical cycles and marine food webs. For coupled climate-environmental modeling the ensemble approach is novel and such a comprehensive downscaling approach has never been applied before.

To evaluate the models' sensitivity to changing drivers on long time scales we reconstructed atmospheric surface fields, runoff, nutrient loads from land and atmospheric deposition for the period 1850-2006. From the reconstruction of the past 150 years we learned about eutrophication, warming trends due to anthropogenic influences, and decadal variations (such as stagnation periods) helping to understand expected future changes. We found that all three Baltic Sea models applied in ECOSUPPORT are capable of simulating past climate variations and eutrophication since 1850 building confidence that the models are able to simulate future changes. Further, we found that nutrient loads increased with a noteworthy acceleration from the 1950s until peak values around 1980 followed by a decrease continuing up to present. However, modeled eutrophication is delayed and shows its largest expression during the 2000s at the end of the simulation period. The simulation results indicate that despite decreased nutrient loads in recent decades no improvement in water quality compared to the present state can be expected for the coming years.

For projections of future environmental status we applied a hierarchy of existing state-of-the-art sub-models of the Earth system. The "work horse" is a regional coupled atmosphere-ocean model which is used to generate the atmospheric and hydrological forcing for three oceanographic-biogeochemical models to calculate the impact of changing climate. It was found that a coupled atmosphere-ocean model is indeed necessary for the ECOSUPPORT applications because biases of simulated present