



Annual Report for RECOCA

RECOCA

Reduction of Baltic Sea Nutrient Inputs and Cost Allocation within the Baltic Sea Catchment

January 2009

Period covering 1 January 2009 to 31 December 2009

Co-ordinator:

Prof. Fredrik Wulff

Stockholm University

SE-10691 Stockholm

Sweden

Tel. +46707310026

Email: fred@mbox.su.se

1. Overall Objectives and Scientific Achievements:

The overall objective of RECOCA is (i) to simulate possible future riverine nutrient loads to the Baltic Sea, (ii) to estimate cost functions for reductions in these loads and for improvements in ecological indicators and (iii) to suggest cost allocation schemes for riparian countries.

This report refers to the first 12 month period of the RECOCA project. The key objective of this project phase was the successful completion of a common data base and the conceptual set up of the hydrological and economic models.

Overall scientific achievements:

RECOCA has finished a very successful first year. An extensive data base holding all necessary statistical data for the coupled hydrological-biogeochemical models and the economic models has been established. Model set ups and parameterizations of the coupled hydrological-biogeochemical models CSIM, SWAT and DAISY as well the economical models COST and the regional economical models have been performed and the models are currently calibrated for type watersheds of the various spatial scales. As a first major result, Net Anthropogenic Nitrogen Inputs have been calculated for all major watersheds around the Baltic Sea and the results suggest that i) N fluxes have increased by a factor 2-4 compared to pristine loads ii) between 60-80% of all N loading to the watersheds is retained in the catchments before reaching the Baltic Sea and finally iii) that the sensitive watersheds are those with high specific discharge and low lakes area in their watersheds such as at the western Swedish Coast, in Germany and Denmark and the small costal watersheds in south-western Finland, i.e. all these watersheds have a naturally low nutrient retention.

Socio-economic relevance and policy implications: The socio-economic and policy implications of RECOCA are under progress. We anticipate that, RECOCA will allow decision makers to evaluate how changes in land use will affect nutrient loads to the Baltic Sea. Most importantly the CSIM model that will be developed and supported by the SWAT, DAISY and NANI models will be used during the update of the eutrophication section of the BSAP; the COST model further developed in RECOCA and supported by the regional economical models is a corner stone of the Baltic Stern Initiative as initiated by the Swedish Finnish and Danish EPAs. Both platforms (HELCOM, Baltic Stern) will allow that RECOCA results will be disseminated and applied in an optimal way to achieve and plan Ecosystem Based Management Strategies for the Baltic Sea

Conclusions: RECOCA has had a very successful first year scientifically and is on the right track to make an important contribution to the management of coastal ecosystems. In general we are following the original research and financial plan. No adaptation on the research plan and schedule of deliverables were necessary, except that the deliverables D 6.2 (Assessment of retention and uncertainty) will be late by about 6 month. This can be explained by the later start of this partner (Bioforsk) due to a delay in the contract

negotiations. Deliverable D 7.2 (Report on costs estimates for different measures, regions and locations) will be ready in month 24 instead of in month 12 due to changes in the work plan of WP 7. However, in general there are no major changes expected for tasks and we expect to achieve all deliverables in a timely fashion. Third parties will not have any substantial influence on the RECOCA working program.

2. Gained scientific results during the reporting period

2.1 Work Package 1 – Management and Dissemination

Lead Partner: Fredrik Wulff, SU-BNI

Researchers involved in the current work:

SU-ITM : Christoph Humborg

ÅU: Berit Hasler

2.1.1 Objective

Overall scientific management of RECOCA, establishment of a Project Advisory Board and Regional Liaison Groups and dissemination via NEST.

2.1.2 Methodology and scientific achievements

Task 1.1 Review project implementation and set annual work plans

The project implementation and a set up of annual work plan have been presented and discussed during the kick-off meeting in February 2009 (Stockholm) and during the first annual meeting in December (Silkeborg). Moreover, meetings of the natural scientific (Oslo) and economic subgroups (Roskilde) in June 2000 have set up more specific working plans of the individual disciplines.

Task 1.2 Receiving strategic advice from Project Advisory Board and stakeholder advice

In the original proposal it has been suggested to establish an official advisory board where HELCOM should be the given partner, because the CSIM and COST model are already and will be a corner stone in the formulation of the final Baltic Sea Action Plan. A letter has been formulated in this matter and addressed to the HELCOM executive officer and was responded negatively; HELCOM decided in general not to act in advisory boards within the BONUS project, simply due to the fact that all of these project have by definition a strong link to the HELCOM activities. However, Fredrik Wulff and Christoph Humborg are both members of the implementation group of the BSAP eutrophication segment and the advice from HELCOM on which processes should be parameterized in the NEST CSIM model are given throughout the BSAP implementation process, because the BSAP follow up will be built on CSIM results. Moreover, the Swedish EPA established in 2009 the Baltic Stern

Secretariat at the Stockholm Resilience Centre with the aim to coordinate the economic analyses within Sweden, Denmark and Finland concerning cost allocation schemes, cost minimization models and cost/benefit analyses towards the ecological targets as set by the actual and revised BSAP. Berit Hasler coordinating within RECOCA the development of the NEST Cost model is affiliated to the Stern secretariat. Advice for the development of COST is given both by the Stern staff and the economic scientists in the other northern countries. Thus, we regard the BSAP implementation group and the Baltic Stern secretariat as valuable Liaison groups for the overall advice on the implementation of RECOCA overall aims.

Finally, the RECOCA web page (<http://www.balticnest.se/>) has been established and we are continuing to update and improve the project website (deliverable 1.1).

2.2 Work Package 2 – Data base and river basin nutrient budgets

Lead Partner: Christoph Humborg, SU-ITM

Researchers involved in the current work:

ÅU: Hans Estrup Andersen, Hans Thodsen

Bioforsk: Per Stålnacke

LLU: Viesturs Jansson

WEEC: Tomasz Zylicz

SGGW: Adam Was

Informal contribution from Dennis P. Swaney and Bonghi Hong (Cornell University, US) and from Erik Smedberg (SU)

2.2.1 Objective

Forming a common data base for river basin models and economic models and analyses.
Calculating Net Anthropogenic Nutrient Inputs

2.2.2 Methodology and scientific achievements

Task 2.1 Estimate land use patterns and level of economic activities in all riparian countries and

Task 2.2 Detailed estimate of land use patterns and level of economic activities for type river basins

Land use patterns and level of economic activities have been compiled during the first year of RECOCA using GIS technique and are stored in the major RECOCA data base. Data on

animal numbers for the EU countries have been obtained from Eurostat on cattle, pigs, sheep and poultry and have been assembled on a data set on a Baltic Sea catchment scale. Following an earlier agreement of data exchange with the EU Joint Research Centre, spatially distributed data on a Baltic Sea catchment scale of crop types have been received and added to the comprehensive GIS base already containing N and P fertilizer use and manure applications (JRC data base), population data (HYDE data base) data on land cover (CORINE) and hydrological and climatic forcing data (MARS data base). All these data have been compiled for the 117 watersheds (82 major watersheds and 35 coastal areas) and also for 8 type watersheds. This extended data compilation (deliverable 2.1 and 2.2) is available to all other partners within RECOCA.

Task 2.3 Calculating Net Anthropogenic Nutrient Inputs for 82 main river basins by means of atmospheric deposition, fertilizer use and foot and feed spreadsheets

Net Anthropogenic Nutrient Input (NANI) calculations have been expanded from comprising only Swedish catchments to include the whole Baltic Sea drainage basin and are now calculated for 117 catchments in the Baltic Sea drainage basin. To facilitate the data extraction and the calculation processes two tools have been developed (one ArcGis-based and one Excel-based). NANI correlates well to observed drainage basin nutrient losses. The NANI calculations are still in a preliminary stage, because all N and P conversion coefficients have to be checked. However, we are on the right track and NANI will tell us about overall nutrient retention, the background loads and indicate sensitive watersheds, i.e. these watersheds that export a high proportion of their nutrient loading to the Baltic Sea. The first results suggest that i) N fluxes have increased by a factor 2-4 compared to pristine loads ii) between 60-80% of all N loading to the watersheds is retained in the catchments before reaching the Baltic Sea and finally iii) that the sensitive watersheds are those with high specific discharge and low lakes area in their watersheds such as at the western Swedish Coast, in Germany and Denmark and the small costal watersheds in south-western Finland, i.e. all these watersheds have a naturally low nutrient retention.

2.3 Work Package 3 – Farm Scale Model

Lead Partner: Hans Estrup Andersen, ÅU

Researchers involved in the current work:

ÅU: Hans Estrup Andersen, Gitte Blicher-Mathiesen, Peter Mejlhede Andersen

LLU: Viesturs Janssons

Bioforsk: Johannes Deelstra, Per Stålnacke

SU-IGG: Erik Smedberg, Magnus Mörth, Christoph Humborg

Informal contribution from Tallinn Technical University (Arvo Iital and Peeter Ennet) and Water Management Institute of the Lithuanian University of Agriculture (Aušra Šmitienė)

2.3.1 Objective

Provide type concentrations for nutrients in surface and ground waters to be used in CSIM. Describe the effects of changes in agriculture including mitigation measures for type river basins on a farm scale. Supply the natural scientific inputs to WP 7 and 8.

2.3.2 Methodology and scientific achievements

Task 3.1 Compilation of hydro-meteorological, physiographical, and statistical forcing data was achieved and delivered in month 6 (deliverable 3.1) and is available to all RECOCA partners via the RECOCA data base located at BNI.

Task 3.2 Defining type farms as a function of regional climate, soils, and agricultural management has been achieved and has been delivered in month 12 (deliverable 3.2) as a word document describing the methodology used. Briefly, we have divided the Baltic Sea Drainage Basin into climate zones based on temperature and precipitation regimes and identified dominant soil types. For each climate zone we have defined four different agricultural management strategies. Prior to running the rootzone N leaching model DAISY the management strategies are currently being parameterized using various data sources: national statistics, the data compiled in task 3.1 at a 10 km grid level for the entire Baltic Sea drainage basin, and data compiled for type watersheds (achieved in WP4).

2.4 Work Package 4 – Type river basin models

Lead Partner: Hans Estrup Andersen, ÅU

Researchers involved in the current work:

ÅU: Hans Estrup Andersen, Hans Thodsen

Bioforsk: Johannes Deelstra, Per Stålnacke

LLU: Viesturs Janssons

SU-IGG: Magnus Mörth, Christoph Humborg

Informal contribution from Tallinn Technical University (Arvo Iital and Peeter Ennet) and Water Management Institute of the Lithuanian University of Agriculture (Aušra Šmitienė)

2.4.1 Objective

Describe the effect of measures on point and diffuse sources for meso-scale type river basins. Provide estimates of ground water retention of nutrients to be used in CSIM. Provide type concentrations for nutrients in surface and ground water to be used in CSIM. Supply estimates of uncertainties in river basin data to be used in the cost model.

2.4.2 Methodology and scientific achievements

Task 4.1 Compilation of hydro-meteorological, physiographical, and statistical forcing data was achieved and delivered in month 6 (deliverable 4.1) and is available to all RECOCA partners via the RECOCA data base located at BNI.

Task 4.2 Model calibration and validation for type river basins is ongoing. We are currently working on two river basins (Odense and Plonia) and will start up further two river basins in February 2010 (Nevezis and Berze). A validated model is available for one river basin (Norrström).

The deliverables scheduled for month 12: Estimates of ground water retention has been handed in timely (deliverable D 4.2). The form of the deliverable is a word document describing the methodology. Briefly, ground water retention is calculated within catchments as the difference between rootzone N leaching calculated in WP3 and measured riverine N load corrected for surface water retention (WP 6). Quantitative estimates will be calculated between month 18 and 24 when the upscaling of the rootzone N leaching calculations in WP 3 has been finished.

2.5 Work Package 5 – Baltic Catchment Model

Lead Partner: Carl-Magnus Mörtz, SU-IGG

Researchers involved in the current work:

ÅU: Hans Estrup Andersen

Bioforsk: Per Stålnacke

LLU: Viesturs Jansons

SU-ITM: Christoph Humborg

Informal contribution from Cornell University, US (Dennis P. Swaney and Bonghi Hong)

2.5.1 Objective

Up scaling the effect of measures as gained from Daisy and SWAT models runs for the type river basins by using type concentration libraries (simulations).

2.5.2 Methodology and scientific achievements

Task 5.1 Compilation and updating of hydro-meteorological and statistical forcing data and

Task 5.2 Model calibration and validation for 117 river basins

During the first year of the project major changes have been made to the CSIM model to achieve the goals and deliverables specified in the project. These deliverables are to be delivered later on in the project, but major milestones have been achieved. These milestones that are substantial regarding the model set up and capabilities are:

- 1) The possibility to change individual countries WWTP (connection degree and emission per person) and getting the individual response from such a change. Although this is not requested in the project this feature has been added to answer questions about trans boundary loads,
- 2) Automatic calibration of hydrology or whatever parameter chosen using the Solver engine.
- 3) Implementation of retention calculation using the hydraulic load concept.
- 4) Accept type concentrations inputs from database connections. How the structure of that database should look like is not clear yet (this will dependent on how the data output looks like for DAISY and SWAT and the structure of these matrices). This is done to provide the user with the possibility to run scenarios where changes in agricultural practice can be tested.
- 5) The possibility to aggregate data in any possible way; for example, Baltic Sea sub basins, EU water districts or just individual river basins. This has been done by using a shell where individual river basins are set to 'belong' to a region.

2.6 Work Package 6 – Nutrient Reduction Effectiveness and Potential of Measures

Lead Partner: Per Stålnacke, Csilla Farkas, Johannes Deelstra, BIOFORSK

Researchers involved in the current work:

LLU: Viesturs Jansons, Kaspars Abramenko, Latvia University of Agriculture, Latvia

SU-IGG Carl-Magnus Mörth, Stockholm University, Sweden

ÅU: Hans Estrup Andersen and Hans Thodsen, Århus University, Denmark

SGGW: Adam Waś, Warsaw University of Life Sciences, Poland

Informal contribution from Tallinn Technical University (Arvo Iital and Peeter Ennet), Water Management Institute of the Lithuanian University of Agriculture (Aušra Šmitienė) and Erik Smedberg (SU).

2.6.1 Objective

Quantification of retention from source emissions to river mouth. Estimation of impact of mitigation measures in regional and Baltic-wide models on coastal loads

2.6.2 Methodology and scientific achievements

Task 6.1 Assessment of retention by using the developed retention software in the FP5-funded project EUROHARP plus data from the type catchment, experimental data hold by the consortium and modelling results (input from WP3, 4)

The NutRet software has been tested and applied for calculating the retention of nutrients (N and P) in surface water bodies (streams, rivers, lakes and wetlands) in four type catchments. An Excel sheet for transferring input data into the requested NutRet input file format has been created and utilised. The list of input data, required for calculations of various levels of complexity has been prepared and sent to the consortium partners. An intermediate report has been prepared and uploaded to the Project website (Deliverable 6.1, Data set of regional retention characteristics for the various sources).

Task 6.2 Regional retention characteristics for the various sources in the various river basins

A meta database has been constructed containing all the necessary information for the assessment of nutrient retention. Data, available for the type watersheds have been incorporated in the meta database and uploaded to the Project website (NutRet_input_database.xls). Data from the 117 studied watersheds has been compiled. Nitrogen and phosphorus retention calculations for these catchments have been started, using the NutRet model.

Expected changes in future working plans: A delay with the NutRet input dataset for the 117 catchments and the type watersheds caused a 6 months shift in tasks submission. No overall changes in tasks and working plan are foreseen.

Expected changes in deliverables: The expected deliverable 6.2 (Assessment of retention and uncertainty) will be delivered within the project time frame, but most probably with a 6-months shift compared to the original timing. This has been caused by the substantial delay (6 month) in the contract negotiations with BONUS EEIG and Bioforsk.

2.7 Work Package 7 – Regional cost effectiveness models

Lead Partner: Tomasz Zylicz, WEEC

Researchers involved in the current work:

WEEC: Mikolaj Czajkowski

SLU: Katarina Elofsson

ÅU: Berit Hasler, Maria T.H. Konrad, Sisse L. Brodersen, K. Munck

SGGW: Adam Waas

2.7.1 Objective

Develop regional cost effectiveness models with higher spatial resolution than the Baltic-wide model. Analysis of cost-effective reduction scenarios taking into account uncertainty. Development of methods for linking regional and Baltic-wide cost minimization models.

2.7.2 Methodology and scientific achievements

The aim of Work Package 7 (WP7) is to develop regional cost models for nutrient reduction measures that can later be aggregated and used for developing cost minimizing allocations for Baltic-wide nutrient reduction scenarios. All major tasks will be addressed during the RECOCA project, however we decided to restructure the time plan of addressing the individual tasks that deviate from the numerical order given in the original proposal.

Task 7.1 Baseline scenario is constructed in cooperation with WP 2 and

Task 7.2 Calculation of cost functions. This task includes collection of cost data and estimation of cost functions for different measures in the agricultural, energy and transports sectors, for wastewater treatment and for different eco-engineering methods. Similar methodological approaches will be used for all regional model and

Task 7.3 Integration of impact coefficients estimated in WP 6. This task is carried out in collaboration with WP 6, and consists of the integration of the catchment model into the cost models. This integration will be made for both non-random and random estimates of the impact of measures on coastal load. The latter will be made using stochastic programming methods and

Task 7.4 Analysis of cost-effective nutrient reduction scenarios. Cost-effective reduction scenarios will be analyzed for different regional reductions in nutrient loads based. The results from different models will be compared. Uncertainty is analyzed through stochastic programming and

Task 7.5 Development of consistent methods to link regional and Baltic-wide cost models.

Expected changes in future working plans: In order to address the second part of the tasks, and to make the results of WP7 usable for WP8 (Cost Minimization Model) we have started to develop a theoretical cost minimization model (Objective 3, Task 7.5 of WP7). In 2009 we have successfully developed the model, set up a list of possible abatement measures, and identified data requirements for the cost functions. This allows us to start the work on Tasks 7.1-7.3. We have also started working with linking watershed models and economic models in one of the type catchment, Odense Fjord catchment, in 2009 and this work will be finalised in 2010. In 2010 we plan to calibrate the regional Baltic wide COST model using the cost data (Task 7.2) and data provided by the other WPs (Tasks 7.1 and 7.3). In 2011 we will finish developing the model, analyze scenarios and incorporate uncertainty in the model (Task 7.4).

The proposed model structure is as follows – the model scale covers in principle 117 regions reflecting all major Baltic watersheds. The nutrient reduction measures that were identified and can be used in the model include sectors of agriculture (manure storage, manure management, livestock, fertilizer use, border zones, buffer strips, and catch crops), energy (NOx emissions), transport (NOx emissions), municipal (wastewater treatment, P free detergents) and wetland restoration. We have identified the methods appropriate for estimating cost functions for the measures include: general equilibrium analysis, partial equilibrium analysis, econometric analysis and engineering methods. Even if approximate data is used, the development of the model provides a great advancement in the COST component of the NEST model and hence allows us to achieve Objective 1 of WP8 – an improvement of existing COST model w.r.t. measure coverage and data quality.

Expected changes in deliverables: Due to reversing the structure of the work (as explained above) to better fit overall goals of the project and input requirements of WP8 (Cost Minimization Model) and WP9 (Country Allocation Schemes) we have not been able to provide deliverable 7.1 – ‘Report on costs estimates for different measures, regions and locations’. Instead, we expect deliverable 7.2 – ‘Report on the full regional cost model structure’ to be available sooner (month 18) and deliverable 7.1 in month 24 (depending on data availability). Finally, deliverable 7.3 is expected in month 30.

2.8 Work Package 8 – Cost Minimization Model

Lead Partner: Berit Hasler, ÅU

Researchers involved in the current work:

ÅU: Maria T.H. Konrad, Sisse L. Brodersen, K.Munck, B. Hasler

SLU: Katarina Elofsson

WEEC: Mikołaj Czajkowski

SGGW: Adam Waas

2.8.1 Objective

Improvement of existing COST model w.r.t. measure coverage and data quality. Analysis of cost-effective solutions on Baltic-wide level. Analysis of the informational situation for international and regional decision-makers

2.8.2 Methodology and scientific achievements

Following the project plan the deliverables of WP8 is not planned to be finished before months 30 and 36; as the improved COST model in the NEST should be delivered in month 30, and reports on the implications of uncertainty about nutrient transports for the cost-

effective solutions will be delivered in month 36. A report on the implications of the informational situation for central and regional decision makers with regard to policy choice and strategic interaction will also be delivered in month 36. The work has been started up in most of the WP tasks to accomplish all deadlines of the deliverables.

Taks 8.1 Baseline scenario establishment (same WP 7)

The COST model has been developed further and tested, new retention coefficients have been included, and they are currently tested. The nutrient transport coefficients between sea regions/basins have been tested as well. Links between models are tested in a small regional Danish catchment area with the intention to aid how we most effectively can link the models at the Baltic wide and regional levels and use data from the other WPs in the calibration of the COST model at national and regional scales. The Baseline scenario will be established using the new, improved Baltic wide model which is an updated version of the COST model fully integrated with the regional models developed in WP7.

Task 8.2 Improvement of cost functions and extended measure coverage, in particular for the new EU-member states and Russia

This work has been started and linked to WP7 by data collection delivered by the other WP's dealing with NANI, SWAT, DAISY and CSIM-modelling. The cost functions will be calibrated using data from model runs with these models. Cost-functions will further be estimated using national and regional technical and economic data, as well as farm optimisation models developed for Denmark, Finland and Poland as a source to estimate cost-functions for e.g. reductions in nutrient application. Models are a good tool to estimate these cost-functions as the data available for different crops and measures are hard to find. A cooperation involving the economic researchers from RECOCA and Finnish environmental economists is planned for in February 2010, with the aim to discuss model developments and cooperation on cost-functions and modelling.

Task 8.3 Integration of catchment model (same as WP 7)

This work has also been started by a pilot project in the Odense Catchment to test the link of the economic model with the other models within a catchment. The work involves the environmental economists, drainage basin modellers and marine modellers, i.e. it is linked to task 8.4.

Task 8.4 Integration of marine model, including the possibility to investigate cost-effective solutions to improvements in different ecological indicators.

This work is also ongoing, where the marine transport coefficients of nutrients has been tested. Work is ongoing investigating if transport coefficients should be revised.

2.9 Work Package 9 – Country Allocation Schemes

Lead Partner: Fredrik Wulff, SU

2.9.1 Objective

Investigation of the implications of different target formulation for the allocation of abatement and costs. Investigation of the role of uncertainty about catchment nutrient transports for the allocation of abatement and costs

2.9.2 Methodology and scientific achievements

Task 9.1 Different alternative targets, such as basin targets, coastal load targets and improvements in environmental indicators are analyzed in the COST model w.r.t. the cost-effective allocation of abatement resulting from these targets.

This WP is based on operational and updated models COST and CSIM and will be addressed in the later phase of RECOCA.

