# Annual Report for RECOCA

## RECOCA

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

**January 2011**

**Period covering 1 January 20010 to 31 December 2010**


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## 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 second 12-month period of the RECOCA project. The key objective of this project phase was the successful completion of a common data base and to get the hydrological-biogeochemical and economic models operational.

Overall scientific achievements:

RECOCA has finished a very successful second year. We created a data base relating major anthropogenic and economic drivers to diffusive and point sources for the entire Baltic Sea catchment; the spatial resolution of this data base holding all major drivers causing Baltic Sea eutrophication is 10 $km^2$. We also created a NANI toolbox allowing users to calculate nutrient budgets, estimates of nutrient leakage and retention and creating maps of nutrient sensitive watersheds of for all major 117 watersheds in the Baltic Sea. This is is to our knowledge the most comprehensive data base of his kind and unprecedented before (WP2). These detailed data allowed us to expand the work on the model estimates of diffusive nitrogen leaching (DAISY; WP3) as well on the regional model that runs the cost minimization on a 10 $km^2$ grid cell resolution for the entire Baltic Sea catchment (WP7). Due to this much extended work we down prioritized the SWAT work on the 8 type watershed slightly. However, the SWAT models (WP4) are on track and we anticipate having them operational at the end of the project. The CSIM model (WP5) has been re-coded in a modular set up, i.e., additional optional drivers of diffusive and point sources can now be easily added, watersheds can be aggregated into various spatial resolutions (from single watershed to EU water districts) and most importantly, the model can be easily calibrated by forcing data from the other more detailed models NANI, DAISY and SWAT as well as from climate models. The DAISY model runs will deliver root zone leakage of N (WP3), whereas the applied MESAW model in WP6 deliver the nutrient retention in surface water and lakes; estimates on groundwater retention will be estimated by difference, i.e., root zone leaching plus point sources minus surface water retention will give us the groundwater retention. Both kind of nutrient retention (WP6) will also be used by the regional and large-scale economic models, since retention is of outmost importance for the cost estimates.

We have set out to construct a far more ambitious regionalized cost-efficiency model than the one described in the proposal. In essence, our model will be a bottom-up approach that utilizes data on effectiveness, potential and costs of measures in each region and combines it with retention coefficients of this region to come up with an optimal solution for the entire Baltic Sea region. Thus, we combined the efforts of WP7 and WP8, as our new model will be able to perform all tasks that were expected from the cost minimization model. The new approach incorporates the data on measures (i) effectiveness, (ii) potential, and (iii) costs in each region and combines it with (iv) region-specific retention coefficients to provide the cost-efficient solution. It may then be possible to calculate what measures should be applied, where, and to what extent in order to reach any nutrient reduction target set for the Baltic Sea basins cost-efficiently. At the same time the new model utilizes region-specific data and allows for co-dependencies of the measures – something existing models were not capable of and thus overestimate costs of reaching specified targets. Even if approximate data is used, the development of the model provides a great advancement in the COST component of the NEST model.

<u>Socio-economic relevance and policy implications</u>: The socio-economic and policy implications of RECOCA are under progress. During the RECOCA starting phase in 2009 we were consulted by D.G. Enterprise, European Commission, and the Department of Environment, Spanish National Institute for Agriculture and Food Research and Technology (INIA) for an assessment of the eutrophication risk of phosphates in detergents in the Baltic Sea. This was sponsored by CEEP (a CEFIC Sector Group). Later on in 2009 and 2010 we were also consulted by the European Task Force Group on the EU Marine Strategy Directive for the Quality Descriptor (QD) 5 (Eutrophication). RECOCA data and tools have been applied for both tasks.

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.

As a first highlight of the project, the data base and hydrological-biogeochemical models (WP2-5) have been presented for the HELCOM TARGREV project in June 2010 that will update the environmental targets within the next phase of the BSAP. Our model tools and data will be the basis for the “country allocation scheme”, i.e. the distribution of nutrient reductions needed per country based on the new targets. In total, RECOCA scientists have participated in ten HELCOM meetings of various characters, i.e. HELCOM Load Expert Group, HELCOM Targrev group and acted as observers and advisers in HELCOM MONAS group. Moreover, the RCOCA tools will be used to modify relevant policy documents (Baltic Sea Action Plan, BSAP), i.e., to i) estimate the effect of the compliance of HELCOM contracting parties to the Waste Water Treatment Directive on river nutrient loads, ii) to estimate the effect of the compliance to the Nitrogen Ceiling Directive for atmospheric deposition over the Baltic Sea area and iii) to calculate “country allocation scheme” based on river and atmospheric loads within the updated BSAP. HELCOM acknowledged these tools as appropriate for the BSAP revision to be ready in 2013. HELCOM acknowledged these tools as appropriate for the further BSAP revision and by this the RECOCA suggestions (i, ii, iii see above) for designing, implementing and evaluating the efficacy of pertinent public policies and governance will be implemented. A second highlight was a presentation of the RECOCA data base and hydrological-biogeochemical models during a plenary talk of the Chesapeake Bay Modelling Conference in May 2010 in Washington DC. A third highlight was the presentation of the RECOCA results at the N2010 conference in New Delhi, December 2010.

Within the RECOCA framework we organized two major courses, one on the hydrological-biogeochemical tools and one on economic tools developed. The first workshop was held in Copenhagen, (15-17. February) on COST Minimization models and the second in Warsaw (9-10 September; RECOCA River Basin Models). At both workshops senior scientists, Postdocs and PhD students from RECOCA but also from other related projects participated.

The Swedish Ministry of the Environment of Sweden arranged a seminar “Building marine policy on best available knowledge”, on 25 August 2010 with participation of high level delegates including several ministers of environment (Finland, Sweden, Latvia, Poland, Estonia). The seminar contained three sessions including a high level ministerial segment addressing the latest assessment of the state of the environment in the Baltic Sea, scientific challenges, important policy processes, and new tools and measures. Christoph Humborg and Fred Wulff were invited and Wulff gave a plenary presentation ‘ *Accounting and modeling: the BSAP nutrient reduction scheme (NEST)*

The leaching of nutrient from intensive livestock farms to the Baltic Sea, has been identified e.g. by the Helsinki Commission as a major point source for eutrophication of the Baltic Sea. Fred Wulff is member of the steering committee of the private fund Baltic Sea 2020 (http://www.balticsea2020.org ) A high priority project of the Fund is to reduce the leaching, through technical development and spreading information on “Best Available Technologies” for cost efficient manure treatment. Focus is on pig manure at large industrial farms (>2000 slaughter pigs/750 sows). RECOCA has provided estimates on the importance of manure leaching for nutrient loads to the Baltic. Baltic Sea 2020 will promote the recommended technologies within the Baltic Sea catchment area, for example in the review process of the IPPC Directive and its reference documents, in agricultural advisory services, within the Baltic Sea Strategy and within the multiple ongoing projects aiming to develop intensive animal production within the Baltic Sea region in an environmentally sustainable way.

The RECOCA web page (http://www.balticnest.se/) is frequently updated with all major events and is used by all RECOCA partners frequently. Unfortunately we did not record any statistics on web traffic, but will do so for the third year of RECOCA.

Conclusions: RECOCA had a very successful second 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. Some adaptation on the research plan and schedule of deliverables were necessary, which mainly results from the down prioritizing of WP4 (SWAT models) at the expanse of WP3 (DAISY modelling), the reversing structure of WP 7 and the late start of partner 6 due to the delay in contract preparation with the Norwegian (non-EU) partner.  Deliverables 4.3 and 4.4. are only slightly delayed until month 29; Deliverable 6. 3 will be delivered when all 4 hydrological-biogeochemical model tools are ready and will be compared (month 30). Deliverables 7.1 (draft version available) and 7.3 will come in month 33.

# 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, the establishment of a Project Advisory Board and Regional Liaison Groups and disseminations via NEST.*

### 2.1.2 Methodology and scientific achievements

*Task 1.1 Review project implementation and set annual work plans*

The project implementation and the follow up of the annual work plans have been presented and discussed during the second annual meeting in January 2010 (Warsaw). Moreover, numerous meetings of the natural scientific (Warsaw, Stockholm, Roskilde and Silkeborg) and the economic subgroups (Copenhagen, Roskilde, Stockholm) have set up more specific working plans of the individual disciplines.

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

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 models and related models (DAISY, SWAT) are given throughout the BSAP implementation process, because the BSAP follow up will be built on the extended data base on diffusive and point sources that RECOCA has established (WP2) with CSIM results. Moreover, RECOCA receives advice for economical analyses from the Baltic Stern Secretariat at the Stockholm Resilience Centre. This secretariat has the aim to coordinate the economic analyses on measures 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 is coordinating within RECOCA the development of the NEST COST model and is affiliated to the Stern secretariat. Advice for the development of COST is given both by the Stern staff and by the economic scientists in the other northern countries. Thus, the BSAP implementation group and the Baltic Stern secretariat have proven to be valuable Liaison groups for the overall advice on the implementation of RECOCA overall aims.

The RECOCA web page (http://www.balticnest.se/) has been further developed and we are continuing to update and improve the project website (deliverable 1.1).

*1.3 Designing new NEST modules showing effects and costs of measures*
We have started to discuss the implementation of major RECOCA deliverables in the Nest decision support system. The extensive data base will be presented, and online access of the second and updated versions of the CSIM and COST models is in preparation.

## 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 Bongghi Hong (Cornell University, US) and from Erik Smedberg (SU)

### 2.2.1 Objective

Forming a common database 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 levels of economic activities have been further compiled during the second year of RECOCA using GIS technique and are stored in the major RECOCA database. We further analysed the data from the EU Joint Research Centre (fertilizer use, crop types), EUROSTAT (livestock data), HYDE data base (population), CORINE (land cover) and SMHI (hydrological and climate forcing). 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 2.3) is available to all other partners within RECOCA. The data have been organized now following the NANI calculations that are also retrievable for the other hydrological-biogeochemical (DAISY, SWAT) as well as economic models (COST, regional economic model). These data are organized into fertilizer data, atmospheric deposition data, biological N-fixation data, crop data, animal data, population data and resulting food and feed budgets for all watershed types addressed in RECOCA. Moreover we created for this deliverable a detailed list of point source data, i.e. statistics on MWWTP including estimates on people connected and unconnected to sewage systems.

*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*

We have finalized the Net Anthropogenic N and P inputs to all 82 main watersheds using the updated data (D. 2.3). Moreover, we created a map of nutrient sensitive watersheds, i.e., those that export large amounts of nutrient to the Baltic Sea in relation to the net inputs.

## 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 3.3 Model calibration and validation in data-rich mini catchments nested in or adjacent to meso-scale type river basins* is ongoing and will be finalized during February. We have expanded this task to also include experimental data from national agricultural research institutions on yield responses to varying inputs of fertilizers in order to validate model responses also in the extremes. This is important since agriculture is very heterogeneous, ranging from highly intensive to subsistence farming in the Baltic Sea drainage basins.

*Task 3.4 Quantifying the effect of eco-engineering approaches such as wetland formation based on existing experimental data* is ongoing and will be finalized at the end of January. In solving the task we have consulted national experts on the effects of wetlands on water quality. Further, we are differentiating between restored and constructed wetlands since in Sweden the latter is an important measure.

*Task 3.5 Simulating type concentrations for surface and ground waters as a function of agricultural measures used in CSIM* is ongoing and will be finalized during February. However, the task is partly delivered in month 24 (deliverable 3.3) as a 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 combination of climate zone and country we have defined three different agricultural management strategies. Prior to running the root zone N leaching model DAISY the management strategies have been parameterized using various data sources: national statistics, the data compiled in task 3.1 at a 10 $km^2$ grid level for the entire Baltic Sea drainage basin, and data compiled for type watersheds (achieved in WP4). The work on farm scale modeling using DAISY has been strongly prioritized and expanded during the project since the results are of paramount importance for the economic model.

## 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, Csilla Farkas

LLU: Viesturs Janssons, Kaspars Abramenko, Ainis Lagzdins

SGGW: Jaroslaw Chormanski, Adam Was

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 4.3 Sensitivity analyses to assess the influence of uncertain input parameters and input data on important output data.* The more extended work on DAISY as described above (task 3.5) has been done partly on the expense of the work on the river basin model SWAT. Therefore the work on task 4.3 is delayed and expected to be finalized during May at which time also deliverable 4.3. will be uploaded.

*Task 4.4 Simulating type concentrations for surface and ground waters as a function of measures on point and diffuse sources used in CSIM.* As for above task the work on task 4.4 is delayed and expected to be finalized during May at which time also deliverable 4.4. will be uploaded. Currently, the SWAT models for the type river basins are being calibrated using monitoring data. The modeling work is performed by four model groups (from AU, Bioforsk, LLU and SGGW). So far three workshops have been held between the modelers in order to harmonize the work and to educate young scientists. A fourth workshop is scheduled in March.

### 2.5 Work Package 5 – Baltic Catchment Model

Lead Partner: Carl-Magnus Mörth, 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 Bongghi 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 An updated CSIM model where measures on point and diffusive sources can be demonstrated*

Added to the CSIM model are now also output data on the contribution from WWTP. In the CSIM model calculations are made to estimate load of N and P from WWTPs according to official EUROSTAT data. These data are now added to the output and compared with the total load (after subtracting river retention), giving a percentage of the load from WWTPs. This mode will later be added to the NEST system. A report was written in 2010 to demonstrate this feature (see, ftp://RecDel:Bonus10@bnisrc.dyndns.org/RECOCA_users/Deliverables/WP_5_deliverables/del1/).

*Task 5.2 New CSIM spatial integration modes: 1) individual river basin mode, 2) Baltic Sea sub-basins catchment mode 3) EU Water District mode*

The aggregation of data from the watershed model runs has already been available for individual basins and for the Baltic Sea sub basins. Now we have also added the possibility to aggregate data according to the EU water districts. A report will be uploaded shortly showing maps of the aggregation modes (deliverable 5.2).

*Task 5.3 Model calibration and validation for 117 river basins*

The new CSIM model (now version 3) is now up and running and works very well for hydrology. The model is now built around a MySQL database server. This will make the implementation in NEST much easier. The model calibration will start as soon as data is available from DAISY model runs and NANI calculations.

*Task 5.4 Linking Daisy, SWAT and CSIM models*

Running the CSIM model and all varieties of the GWLF model requires knowledge about the type concentrations. This is the concentration of for example nitrate in different compartments (land class/use or groundwater) that is used to describe the watershed, i.e. a fixed concentration is given to the groundwater and all land classes/uses defined which then is 'mixed' in different proportions according to the soil water flow paths to give the runoff signal. In the RECOCA project type concentrations were suggested to be created in DAISY (for N) and SWAT (N and P). DAISY model runs are soon ready. Since SWAT is only to be run on a small amount of watersheds and that NANI calculations were so successful in describing N and P loads vs. total emissions (calculated from what you actually do with the land) we will also use NANI data for generating type N, P concentrations. This work is on-going and will be ready during the spring 2011.

## 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, Erik Smedberg and Hanna Eriksson Hägg, Stockholm University, Sweden

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

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

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

### 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)*

Results, obtained from Task 6.1 in the first year of the Project (retention calculates for four type catchments) and those, achieved from Task 6.2 during the second year of the Project (see below) were used to evaluate the applicability of the NutRet Euroharp tool for calculating nutrient loads in the Baltic sea. When applying NutRet on the 117 Baltic Sea river basins, it was found that the NutRet software strongly overestimates the surface water retention of N and P in many cases, most probably because this software was developed for smaller river systems, differing from those used in the RECOCA project. Therefore, the so-called MESAW model (Grimvall & Stålnacke, 1996) was tested and further developed for RECOCA retention calculations. This model-approach uses nonlinear regression for simultaneous estimation of source strength (export coefficients to surface waters) for the different specified land-use or soil categories and retention coefficients for pollutants in a drainage basin.

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

The MESAW model has been tested and applied for calculating the retention of nutrients (N and P) in surface water bodies in the Baltic Sea river basins. Because of the lack of load data, 81 of the 117 catchments were included in the study. Results showed that MESAW were able to simulate the riverine loads with a very good accuracy. The retention values are also in line with the ones reported in literature. The draft final retention values for nitrogen were provided to other RECOCA consortium members for comments. The phosphorus retention estimates need further refinement. Possibilities of defining the river basins in one or several groups within the MESAW model will also be studied. Inclusion of data from Denmark and refined point source data are in progress.

The method proposed by Behrendt and Opitz (2000) has also been tested which show good agreement with the MESAW results although some deviations are noted.

*Task 6.3 Assessment about uncertainty regarding retention. Qualitative assessment supplemented with CSIM simulations models on coastal loads (input to WP 7 and 8), including estimation of uncertainties regarding these impacts.*

The advantage of the applied MESAW model in comparison with the NutRet tool is that the MESAW model also calculates uncertainty of retention estimates. During the model application, statistically significant N estimates were obtained that showed very good correlations. This will enable us to calculate confidence intervals

*Expected changes in future working plans*: Due to the delay with the contract and since the original working plan on using the NutRet software for providing retention estimates of N and P in surface water failed, a new approach had to be adapted and tested. This has caused a 6-9 months shift in tasks submission. No overall changes in tasks and working plan are foreseen.

Moreover, regarding Task 6.4 (Estimation of impact of measures in regional (river-basin) and Baltic-wide models on coastal loads (input to WP 7 and 8), including estimation of uncertainties regarding these impacts), this will be postponed to when WP2-5 are ready given the slight change in work plan there. The idea is to scale the uncertainties that can be addressed by the various modelling tools i.e. to address the question how impacts of measures can be addressed by the various tools NANI (large scale), DAISY (farm scale), SWAT (sub watershed scale) and CSIM (large scale).

*Expected changes in deliverables*: The expected deliverables will be delivered within the project timing, but with a 6-9 months time lag compared to the original work plan. Deliverable 6.3 Report on impact of different measures on coastal loads and D6.4 Report on uncertainty regarding the impact of different measures on coastal loads will be delivered once WP2-5 are completed.

## 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 Was

### 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 Creating the Baseline Scenario*

This task included specifying current riverine nutrient loadings from each watershed (in cooperation with WP2). This task has been completed.

In addition, we utilize data from WP6 to create a credible baseline scenario. In particular, this involves collecting data on the scale the measures are currently applied in different regions of the Baltic Sea, thus allowing for calculating the extent to which they can be applied further (their potential). This task is a work in progress.

*Task 7.2 Calculation of cost functions*

This task includes collection of region-specific cost data for different measures in the agricultural, energy and transports sectors, for wastewater treatment and for different eco-engineering methods, and including them in the model. For most measures the cost functions are not estimated directly but rather data and functional relationships are included in the optimization model, where cost-effective solutions for all the measures are then determined.

We have collected the data required for estimating costs of most measures. In particular, these are: Standard Gross Margin of crop and livestock production (as a way of including opportunity cost of their reductions) and prices of mineral fertilizer. We have estimated costs of municipal wastewater collection and treatment. In the future we are going to propose ways to make extrapolation of cost estimates more precise, based on labour and capital prices and possibly other region-specific factors. We will also estimate mean costs of connecting new people to sewage collection systems.

*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 is made for both non-random and for random estimates of the impact of measures on coastal load (the latter will be made using stochastic programming methods). In particular, the cost model will incorporate the data on measures (i) effectiveness, (ii) potential, and (iii) costs and combine it with (iv) region-specific retentions to come up with cost-efficient solutions.

*Task 7.4 Analysis of cost-effective nutrient reduction scenarios.*

Cost-effective reduction scenarios will be analyzed for different sets of targets (policy scenarios), such as the Baltic Sea Action Plan. The results from our model will be compared with the more general top-down models developed earlier. This task will be conducted in 2011, once the model is functional.

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

We have decided to develop the regional cost minimization model in such a way that it is fully capable of solving Baltic-wide nutrient reduction allocation schemes. The regional cost-effectiveness model will be constructed in such a way that it will be possible to estimate a cost-efficient mix of measures to reach any set of targets set for the Baltic Sea regions, while utilizing region-specific data. This bottom-up approach is definitely more demanding in terms of computational time and data requirements, however, it gives an opportunity to utilize region-specific data – something existing models were not capable of doing and thus overestimated costs of reaching specified targets.

The general structure and theoretical framework for this model is complete. We have conducted test-runs to see how the model performs in terms of computational requirements. In order to complete the model and make it fully functional additional data inputs are necessary from other WPs.

*Expected changes in future working plans:*

We have set out to construct a far more ambitious regionalized cost-efficiency model than the one described in the proposal. In essence, our model will be a bottom-up approach that utilizes data on effectiveness, potential and costs of measures in each region and combines it with retention coefficients of each region to come up with an optimal solution for the entire Baltic Sea region. This way, we combined the efforts of WP7 and WP8, as our new model will be able to perform all tasks which were expected from the cost minimization model. At the same time, this way we were able to address task 7.5 – fully integrate the regional and Baltic-wide models.

The new approach incorporates the data on measures (i) effectiveness, (ii) potential, and (iii) costs in each region and combines it with (iv) region-specific retention coefficients to provide the cost-efficient solution. This way it is possible to find the solution to the problem of what measures should be applied, where, and to what extent in order to reach any nutrient reduction target set for the Baltic Sea basins cost-efficiently. At the same time the new model utilizes region-specific data and allows for co-dependencies of the measures – something existing models were not capable of doing and thus overestimated costs of reaching specified targets. This will allows us to complete Task 7.4 – analyze cost-effective nutrient reduction scenarios – in a much more thorough way.

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 all the objectives of WP8 at the same time.

The bottom-up approach we took is more demanding in terms of computational time and data requirements. In order to complete the model and make it fully functional additional data inputs are necessary from other WPs (some of it was not originally planned). Therefore, we have not yet completed Task 7.4, 7.3 and 7.2 as they require other WPs to complete and provide additional inputs for the model. This is expected in 2011.

*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 D7.1 – 'Report on costs estimates for different measures, regions and locations'. This requires that all the data from other WPs (especially WP2 and WP6) are available and included in the model. The same holds for deliverable D7.3 – 'Analyses of cost-effective reductions of coastal loads (scenarios), including reductions suggested by HELCOM BSAP, and comparisons between different regions'. These deliverables are expected in month 33. The draft versions of deliverable D7.2 and D7.1 are available. They are, however, subject to change, depending on quality and completeness of data expected from the other WPs.

## 2.8 Work Package 8 – Cost Minimization Model

Lead Partner: BeritHasler, ÅU

Researchers involved in the current work:

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### 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. To distinguish between the former COST mode, and the new model the model has been renamed BALTCOST. 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, and as mentioned as part of the WP7 description a close cooperation has been developed between these two WPs and the aim is to develop a more regionalised model as the putput from both WP's.

*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. The model has been renamed BALTCOST; and a documentation report of these improvements will be published medio 2011.

*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 closely linked to WP7 by data collection delivered by the other WP's dealing with NANI, SWAT, DAISY and CSIM-modelling. The cost functions are 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 abatements 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 final phase of RECOCA.