Application of the SPICOSA Systems Approach Framework on HIMMERFJÄRDEN, Sweden:

focus on nitrogen management

Starting the SAF process

1. Recruiting the stakeholder group

At a meeting co-organised with the regional Water Authority, a stakeholder group of environmental managers, company and farmer representatives and one NGO was recruited.

2. Identifying the policy issue

The stakeholders' main concern was eutrophication (nitrogen management to reduce algal blooms) and how to meet the related targets of the WFD.

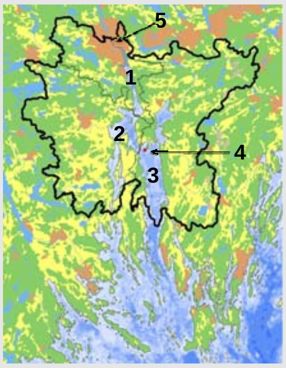
3. Constructing Conceptual models

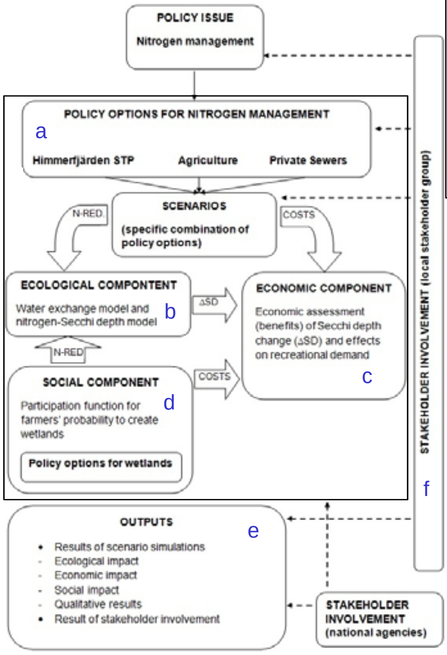
Conceptual models were gradually refined and simplified. They helped in defining objectives and visualising important relationships. As illustrated in the overall model the focus was finally on:

a) different policy options for nitrogen reduction
b) the effects of reductions on phytoplankton biomass and water transparency
c) the economic costs and benefits of policy options. Increased demand for recreation due to water quality improvements.
d) The social component is a participation function explaining willingness of farmers to construct wetlands.
e) Outputs of scenario simulations
f) Stakeholder involvement (annual meetings)

Himmerfjärden study site area (SSA no. 4)

Himmerfjärden is a brackish estuary, receiving fresh water and nutrients from Lake Mälaren (at 5 in figure), several local brooks draining forest and farmlands, and a sewage treatment plant (STP, at 4 in figure) serving 300 000 persons in southern Stockholm. Its ecology has been well-studied in a long-term monitoring programme established in 1976. The area modelled consists of three sub-basins: 1. Hallsfjärden (HA), 2. Näslandsfjärden (NA), and 3. Himmerfjärden (HI), see figure.





4. Defining scenarios

The policy options identified are shown in the table below. Combinations of these were used in scenario model simulations. The options in blue circles are included in the main scenario (wetlands in basin NA only), the pipeline scenario is consistent with the main scenario plus the red circled policy option (referred to in model result section).

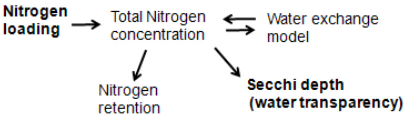
Human activities		
Policy options for HSTP as effluent nitrogen concentration, and other measures	Policy options for agriculture: wetland creation or catch crop creation (no valid reference scenario)	Policy options for private sewers: share connected to larger or local STP (no valid reference scenario)
4 mg/l	Wetlands	25 % connected to STP
10 mg/l (reference scenario)	Catch crops – large area sown	50 % connected to STP
4 mg/l + move outfall vertically	Catch crops – small area sown	100 % connected to STP
10 mg/l + move outfall vertically	No measure	No measure
Move outfall to the open Baltic Sea by long pipeline		

Constructing and testing simulation models

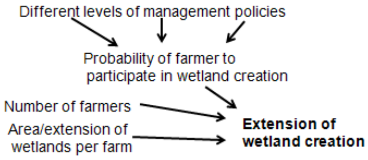
1. The ecological sub-model

is based on a estuarine water exchange model with three depth layers. Salinity data and daily freshwater inputs were used to calculate water exchange between basins and the open Baltic Sea. Inputs of total and dissolved nitrogen were distributed by water exhange and reduced by nitrogen retention, estimated as a fraction of the dissolved inorganic nitrogen uptake in the surface layer. An empirical relationship was used to estimate Secchi depth from modeled total nitrogen concentration.

The conceptual ecological model

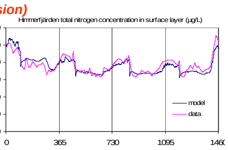


The conceptual social component model: participation function of farmers in wetland creation .



Ecological model hindcast (Nov. 09 version)

Variations in boundary conditions, nitrogen input and water exchange explain most of the variations in total nitrogen concentration. The biology added is primarily seen as loss of nitrogen during the annual spring bloom of phytoplankton.



2. The socioeconomic sub-model

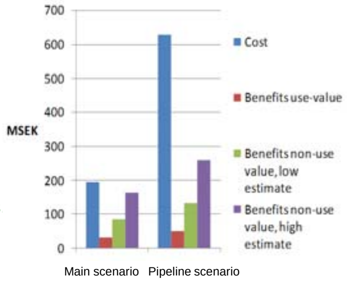
A crucial link between the ecological component and the economic component is the change in Secchi depth caused by the nitrogen reduction of the chosen scenario. The Secchi depth is a measure of water transparency and an important indicator of water quality that affects people's well-being and demand for coastal recreation. The economic value of a one-metre Secchi depth improvement in the case study area was estimated by using data from a travel cost study for the Stockholm archipelago. The economic component includes a cost-benefit analysis comparing the benefits of an increased Secchi depth to the costs of the chosen scenario. The social component (see figure to the left) consists of a participation function, simulating the willingness of farmers to participate in wetland creation, given different levels of management policies, e.g. the degree of economic compensation.

Model results and stakeholder involvement

1. Selected model results for main and pipeline scenarios. Both scenarios indicate a clear ecological effect of the STP load reductions.

Nitrogen loading →	Total Nitrogen concentration →	Secchi depth (water transparency)
from STP reduced from 10 to 4 mg/l. Minor reduction in nitrogen land runoff. A pipeline for STP outfall in open Baltic Sea could eliminate local STP load completely.	decreased from 390 to 350 µg/l in Himmerfjärden basin for main scenario and to 320 for the pipeline scenario.	increased from 3.1 to 3.7 m in main scenario and to 4.1 m in the pipeline scenario.

The diagram to the right shows a rough overview of costs and benefits of the main and pipeline scenarios



2. Stakeholder involvement - conclusions

-The stakeholders determined the research focus, and proposed policy options for private sewers, agriculture and the STP, e.g. a pipeline option for the STP discharge. The regular meetings with the stakeholders focussed the modelling work on producing a simple, yet useful model.

- The model facilitated evaluation of relevant management scenarios and communication of the likely ecological, economic and social effects of these scenarios to the stakeholders.

- The stakeholders found participation a rewarding and useful experience, with both knowledge and social gains, indicating a successful process of social learning.

- The success of the SAF application in this study was facilitated by a relatively good coherence of knowledge perceptions among the stakeholder group and the research team already from the outset, and on the availability of a large data base.

- The SAF application clearly strengthened the social capital in the area and created a potential for continued collaboration, also after the end of SPICOSA.

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SIXTH FRAMEWORK PROGRAMME