



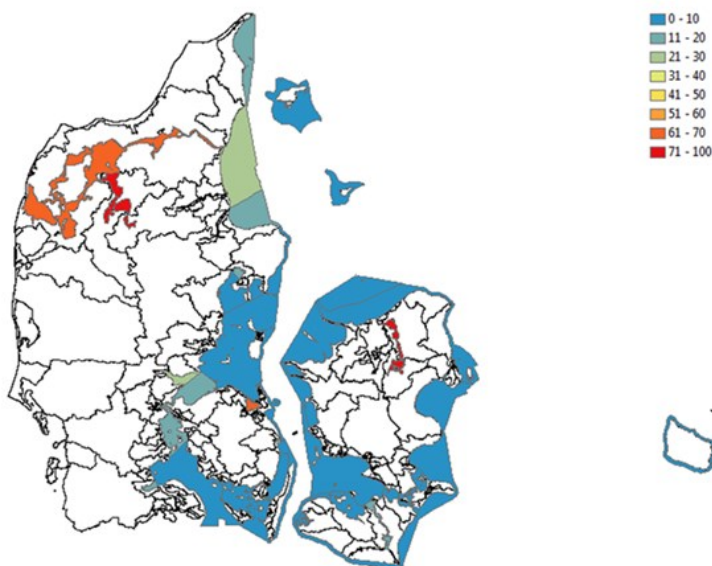
SUPPORTING DANISH RIVER BASIN MANAGEMENT PLANS

Ensuring good ecological status in estuarine and coastal areas through mechanistic modelling

In 2000, the European Union (EU) adopted the Water Framework Directive (WFD) which sets the basis for managing and protecting the ecological values of European water bodies. The directive initiates a new approach based on natural geographical and hydrological formations – river basins – instead of national boundaries. It applies to all waters, including rivers, lakes, canals as well as coastal and transitional waters. In general, the WFD mandates that all EU Member States meet this common goal: To get all European waters into good ecological status no later than 2027. DHI was commissioned by the Danish Ministry of Environment's Nature Agency to assist in developing tools for setting nutrient load targets to ensure 'good environmental status' in Danish marine waters, hence allowing the authorities to develop specific river basin management plans (RBMPs).

DEVELOPMENT OF THE SECOND GENERATION RIVER BASIN MANAGEMENT PLANS

In Denmark, the Danish Ministry of Environment's Nature Agency is responsible for implementing the WFD and preparing plans for management and protection of Danish water bodies.



Percentage of summer chlorophyll-a concentrations explained by Danish nitrogen loading. © DHI

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Danish Ministry of Environment, Nature Agency

CHALLENGE

- Setting environmental targets defining good ecological status
- Setting load targets for marine waters and accounting for nutrient inputs from neighbouring countries
- Balancing European legislation and national economic interests
- Applying consolidated and stakeholder accepted tools

SOLUTION

- Developing mechanistic models describing the most important physical and biological parameters and processes
- Identifying specific correlations between Danish nutrient loading and ecological status for each Danish marine water body
- Developing an approach combining monitoring data and model results
- Providing future proofed tools for assessing natural and anthropogenic pressures

VALUE

- Specific and differentiated load targets to obtain good ecological status defined for each water body
- Broad acceptance of the developed tools from universities, NGOs and the agricultural associations
- Providing a strong mandate during consultations with ministries such as the Ministry of Business Affairs and Ministry of Finance

LOCATION / COUNTRY

Denmark

SOFTWARE USED

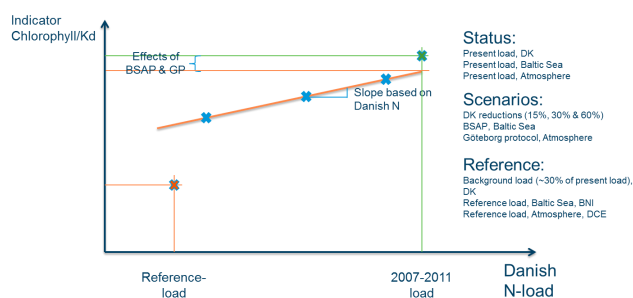
MIKE 3
ECO Lab

Under the WFD, it is compulsory for Member States to draw up RBMPs to safeguard each river district. Denmark's first generation RBMPs were exposed to extensive criticism – particularly because the applied tools were considered unsatisfactory and implied considerable uncertainties in the defined targets on nutrient loading. In preparation of the second generation of RBMPs, improvements of the applied methods were therefore heavily called for. Along with the Danish Centre for Environment and Energy (DCE), we were commissioned to improve the tools for the second generation RBMPs with a focus on nutrient loading to support good ecological status in the marine water bodies.

Defining RBMPs is a difficult task. The directive is clear: Get all European waters into good ecological status. However, overdoing the effort may have considerable negative economic impact for agriculture – and hence Danish export. The development of strong and scientifically consolidated tools to assess and optimise the RBMPs are therefore highly appreciated by the non-governmental organisations (NGOs), agricultural associations and authorities.

NITROGEN REDUCTION BASED ON MECHANISTIC MODELS

The major objectives of the second generation plans are to set differentiated goals for the water bodies and to account for nutrient loading crossing borders between water bodies and between countries. Our solution was to develop marine modelling tools based on mechanistic regional and local models using MIKE Powered by DHI's 3D modelling software MIKE 3 and ECO Lab. These mechanistic models describe the causal link between the physical parameters (for example, wind, currents and mixing), chemical parameters (such as nutrients) and the growth and biomass of the biological elements (such as phytoplankton and benthic flora), which are crucial to the overall health of the ecosystem.



Schematic example of a screening tool based on Danish N-loading developed for the authorities as part of the project. © DHI

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“ It has been a professionally challenging and demanding task that DHI has solved with a high degree of professionalism and flexibility.

Mr Harley Bundgaard Madsen—Head of Section—Danish Ministry of Environment, Nature Agency

Contact: info@dhigroup.com

For more information, visit: www.dhigroup.com

Meteorological data and information on nutrient input from Denmark – as well as from our neighbours around the Baltic Sea – were entered into the mechanistic models. The modelling results were used to develop specific relationships between the nutrient loading from Denmark and the environmental status of each Danish water body. These relations were then applied to identify requirements for nutrient reductions in order to obtain good ecological status. Our solution provided the Danish water authorities with an improved tool for setting differentiated and optimised estimates of Danish nitrogen target loads for each specific water body.

CUSTOMISED ECOLOGICAL MODELLING AND SCREENING TOOL DEVELOPMENT

The WFD requires that Member States consult the public and stakeholders to identify factors to be included in the RBMPs. Prior to the project, Danish stakeholders had developed a set of ecological factors that needed to be included in the models. Hence, we used ECO Lab – our ecological modelling tool – to develop and adjust templates to meet their exact demand.

PRECISE BASIS FOR WATER MANAGEMENT PLANNING

Our solution supported the preparation, completion and submission of Denmark's second generation RBMPs – plans estimated to have a direct cost of 200 million euros when fully implemented. Through the development of tools based on mechanistic models, uncertainties related to the estimated requirements for nutrient load reductions have decreased – providing a more precise basis for management planning.

The Danish water authorities now have a strong mechanistic modelling tool which can help assess impacts on the marine ecological status of a number of natural and anthropogenic pressures, such as climate change, fisheries, raw material extraction and dredging. This tool also helps to support decision making on the most optimal measures to invest in.

With the help of our advanced technologies and dedicated consultancy, our work in this prominent project has established us as an important player in Denmark when it comes to determining environmental status and assessing impacts from pressures such as nutrient loading. Additionally, the developed modelling approach can be exported to support consultancy services on ecological water management worldwide.