Cost-effective nitrogen load reductions to Danish coastal areas – comparison of three economic models and results

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Abstract

Good ecological status of the coastal marine waters should be achieved no later than 2027 to fulfil the European Water Framework Directive. To advise the Danish Ministry of Environment and Food of the most cost-effective solutions and combinations of measures to achieve this target, economic models have been set up for assessments of cost-effective nitrogen load reductions from 90 subcatchments within the 21 main catchments, to the Danish coastal areas. The results, input data and assumptions in the two model approaches have been compared and a number of sensitivity analyses have been performed, including how the spatial scale of the assumptions applied for the modelling affect the solution. The final results, which are due before August 2020, will provide a span for the cost-effective allocation of measures to reduce the nitrogen loads.

Keywords: Cost-effectiveness, integrated modelling, water quality term, term, term

1. Background

Nitrogen load reductions from agriculture and other sources cause eutrophication of the aquatic environment, and Nitrogen load reductions are necessary to achieve god ecological status of water ecosystems. Good ecological status is required by the European Water Framework Directive, and should be achieved before 2027 at the latest.

2. Data and methods

Two models are used and compared to assess the sensitivity of environmental and economic assumptions for the cost-effective achievement of the water quality targets. The first model, TargetEconN (Konrad et al 2014, Hasler et al 2019) is a cost-minimisation model which minimizes the costs of achieving the targets in the 90 subcatchments, subject to retention of nitrogen in the subcatchments, measure and soil type specific load effects of measures as well as abatement costs. The abatement costs are being specified at a detailed spatial scale (field level). The model identifies optimal spatial allocation of nitrogen abatement measures at different load reduction targets to the fjord. The other model is the SMART model (some model results described in Jacobsen and Lausten, 2016, as well as in Hansen et al), a simulation model applying average costs of implementing measures within a catchment as well as average catchment hydrological conditions.

We use the models to evaluate the range of the cost-effectiveness results from applying both models to achieve the load reductions necessary to obtain good ecological status, and we assess the sensitivity of the results to different forms of assumptions on costs, retention and spatial scale, as well as the assumptions of potentials of each measure included, at subcatchment scale.

3. Results and use of them

For all scenarios the results from the two models are compared with respect to total costs, the marginal costs and the distribution of measures. Maps are used to illustrate the differences.

Former results described in Hasler et al (2019) and Hansen et al (2017) indicate that differences in the assumptions of the potential of how much each measure can be implemented have significant effects for how the differences in retention affects the cost-effective achievement of nutrient load reductions, when the reduction target is increased towards the objective in 2027. The analysis of the effects on the marginal abatement costs of differences in retention assumptions in Hasler et al (2019) indicates, that the effect of taking assumptions on the retention into account increases with expanding load reduction targets, while Hansen et al. (2017) conclude that retention plays a decreasing role with increasing N load reduction targets. The reason for their conclusion is an assumption that there is less room for spatial targeting when more of the potential (capacity constraints) are binding, while Hasler et al (2019) assume that the potentials (capacity levels) are not binding, even though a high reduction target is applied. These assumptions is put to test in the comparison of the models, and the purpose is to develop further the knowledge base related to cost-effective implementation of WFD and the results from comparable assessments.

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