TARGETED REGULATION OF NITROGEN LOADS TO COASTAL AREAS –

A SPATIAL MODELLING CASE STUDY OF A DANISH CATCHMENT (WATERSHED)

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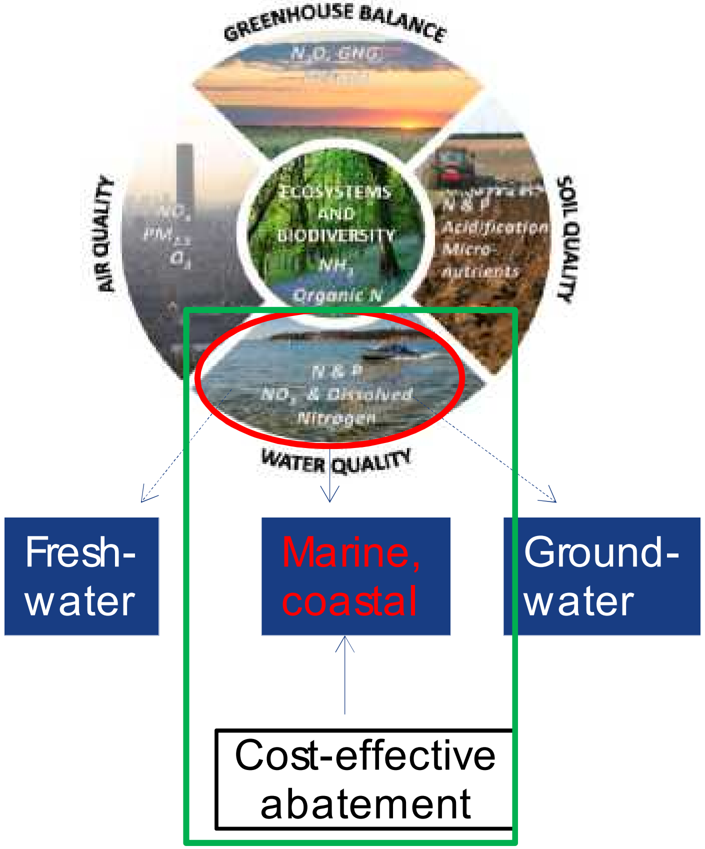
CONTENT

- Introduction and motivation
  - Targeting nitrogen management with a focus on abatement at parts of the landscape with highest potential to reduce nitrogen loads at least cost.
- Method and data: Integrated modelling, economic analysis, social planner approach
- Results
- Conclusions and further analyses

Sutton, M.A., et al. (2013). Our Nutrient World. http://www.gpa.unep.org/

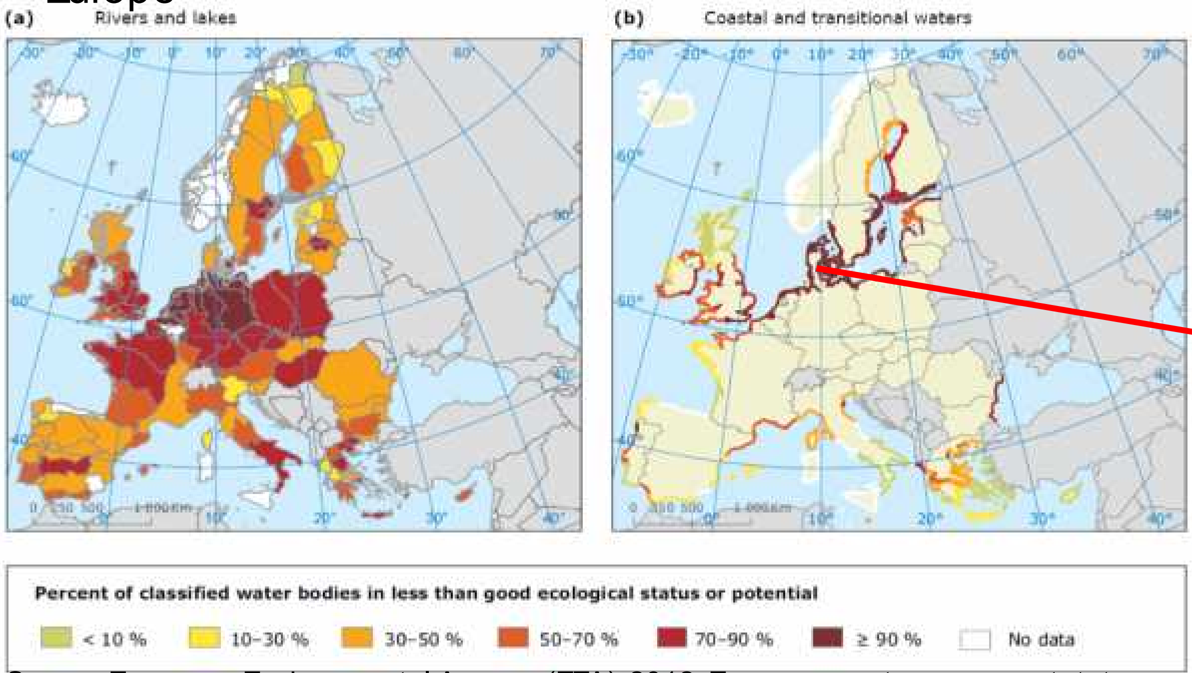


BACKGROUND

- ✓ The Water Framework directive (WFD) and the implementation of nitrogen load reduction to marine waters is important to obtain good ecological status
- ✓ WFD targets are ambitious, and implementation costly for farmers
- ✓ Potential cost-savings by targeting the measures spatially compared to uniform regulation
- ✓ Non-point nitrogen emissions are difficult to trace back to polluter – modelling can therefore be a helpful tool to guide management.

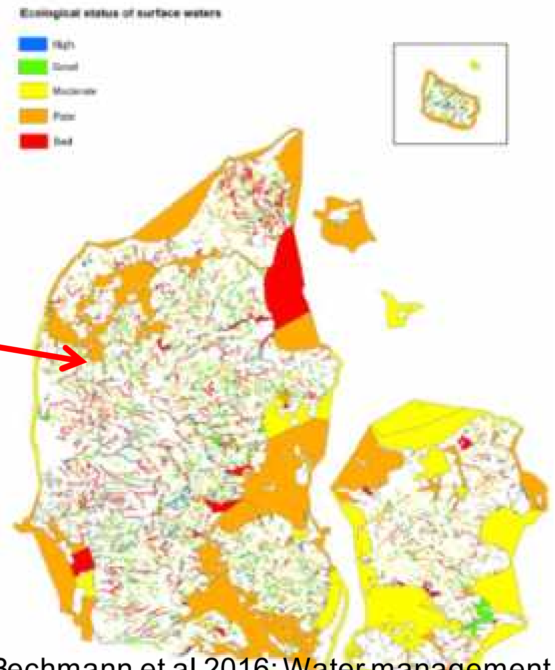
WATER BODIES IN LESS THAN GOOD STATUS

Europe



Source: European Environmental Agency (EEA), 2012. European waters — current status and future challenges.

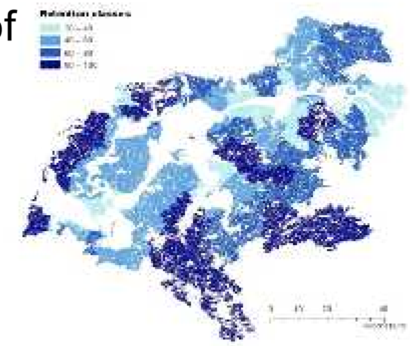
Denmark

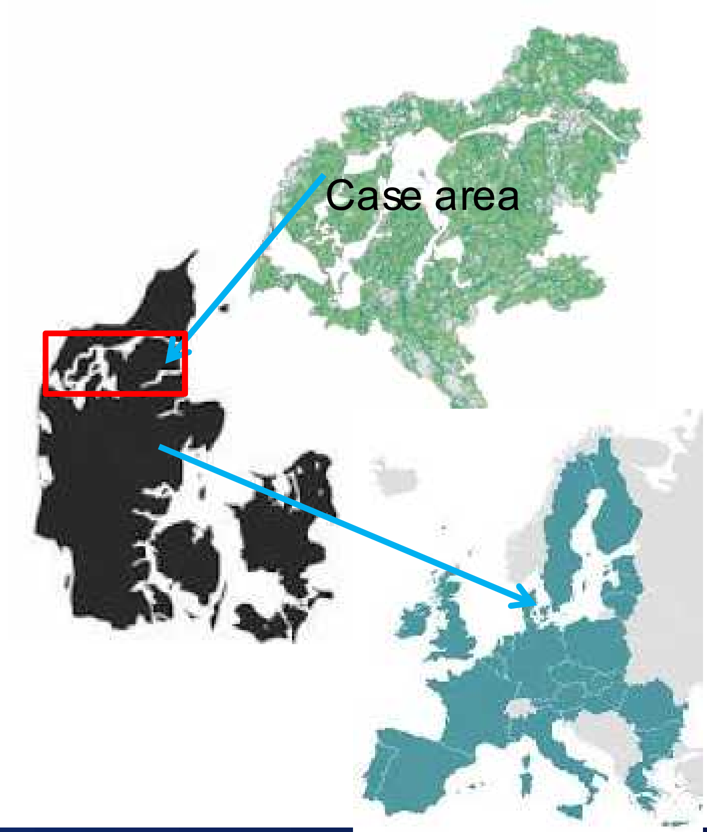


Bechmann et al 2016: Water management for agriculture in the Nordic countries. Nibio report.

THE QUESTIONS WE HAVE STUDIED:

- What are the costs of an uniform regulation of all farms, compared to a differentiated, targeted regulation?
- And the focus of this presentation:
  How important are the uncertainty of e.g. hydrological and biochemical assumptions in the modelling of the cost-effective solution?
- Especially the assumptions of the retention of N in the catchment:





RETENTION

The retention takes place in the aquifers, groundwater, rivers and water courses, wetlands and lakes.

The retention ratio is the share of the nitrogen that is naturally removed as it travels from the rootzone (field level) to the coast and marine waters.

If the retention at Field A at Farm A is **30%**, 70% of the nitrogen lost at this farm will reach the coast.

If the retention at Field B at Farm B is **60%,** 40% of the N will reach the coast.

Abatement measures at **Farm A therefore reduce more to the coast, all else equal.**

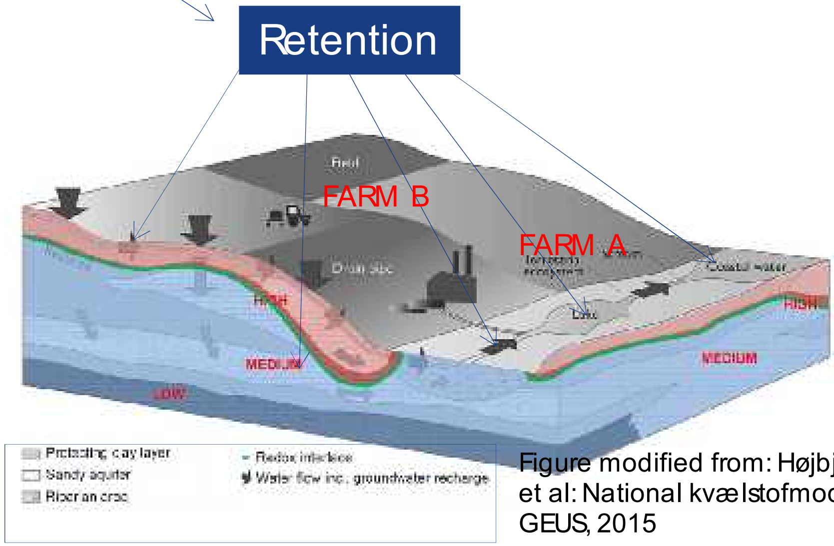
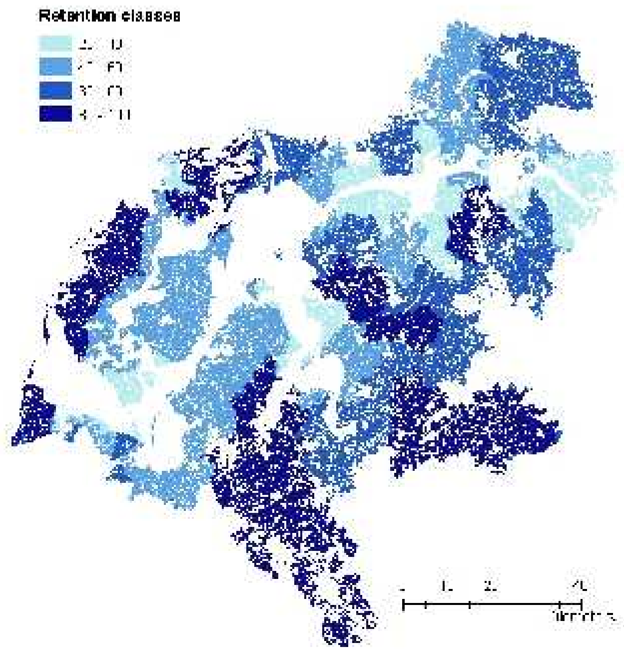


Figure modified from: Højbjerg et al: National kvælstofmodel, GEUS, 2015

N- RETENTION AND LEAKAGE

- Fresh- and groundwater retentions are calculated from monitoring data and empirical models (Windolf and Tornbjerg 2009). New retention data are now available.

- Leakage effects of measures are estimated by the NLES4-model and field data (Børgesen & Greve, 2009)



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NITROGEN ABATEMENT MEASURES

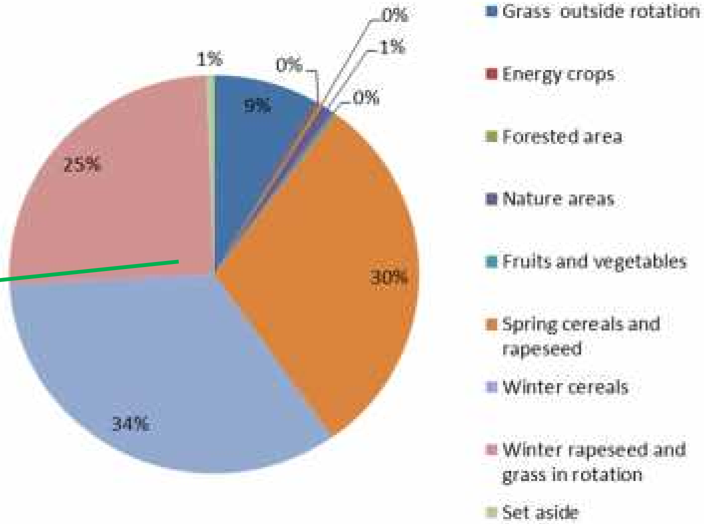
- Set aside
- Forestation
- Buffer zones
- Wetlands restoration
- Wetland construction
- Energy crops
- N norm reduction (10 + 10%)
- Increased utilisation of animal manure and manure handling technologies
- Catch crops / cover crops

All measures modelled with costs dependent on the crops grown within field block (lost profits)

Leakage effects vary between sand and clay soils,

SPATIAL REFERENCED DATA FOR MAIN CROPS AND INPUTS

Register data from agricultural registers, CAP pillar 1



SCENARIO ANALYSES , SENSITIVITY

Retention:

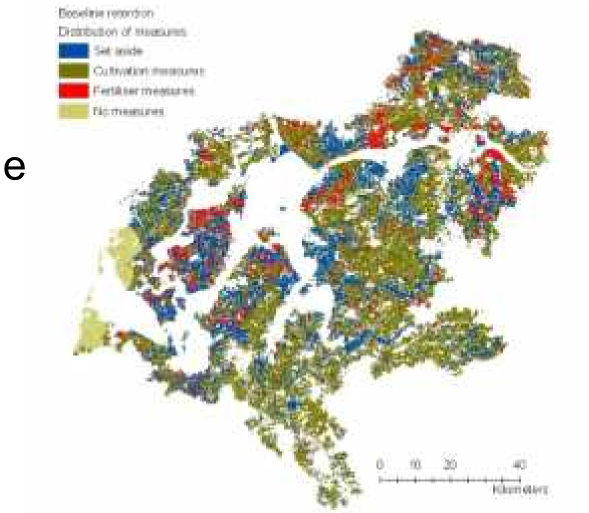
Baseline: the retention shown at the map:

Sensitivity Scenarios:

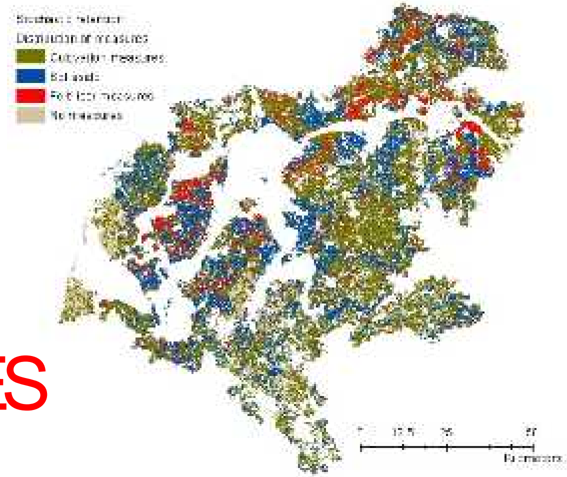
- Retention reduced and increased by 10 and 20%
- Stochastic distribution of 10% decrease (i.e. 40% zone is decreased to 30%)
- Average retention, entire catchment: all fields 71%.

MEASURES

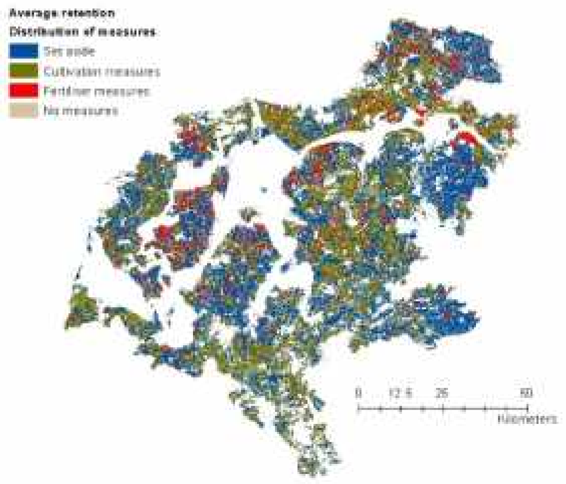
Baseline



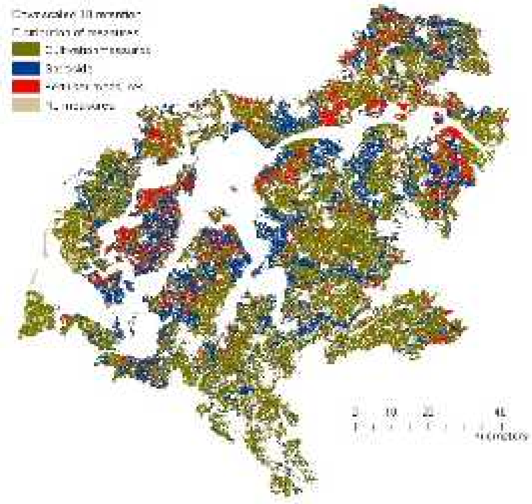
Stochastic



Average



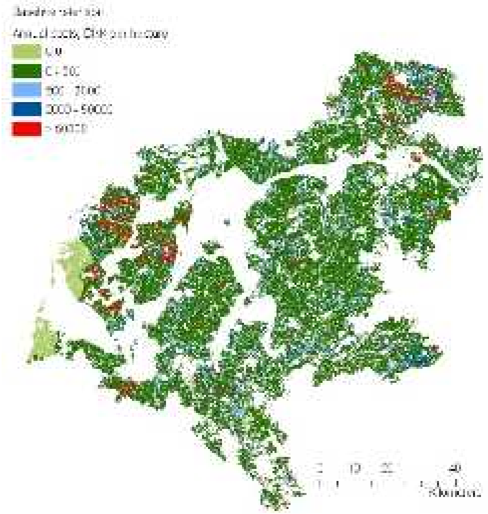
Reduced 10%



COSTS

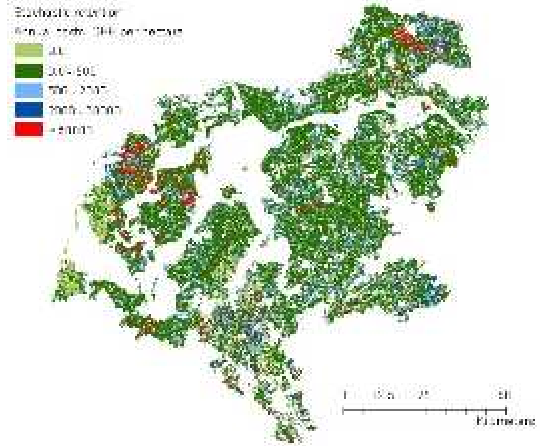
Baseline

218 Mill. DKK



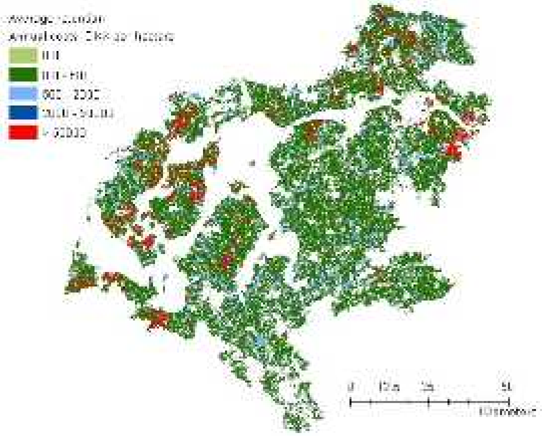
Stochastic

214 Mill. DKK



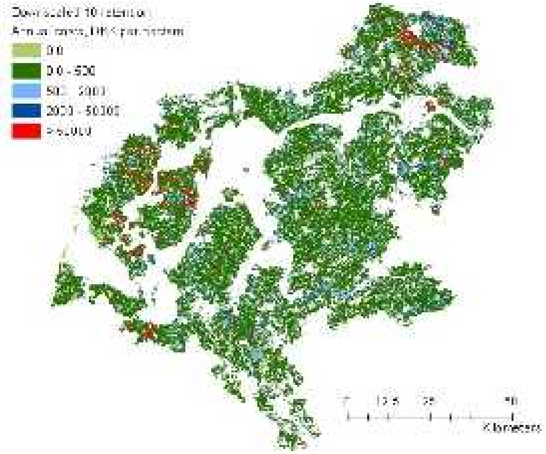
Average

273 Mill. DKK

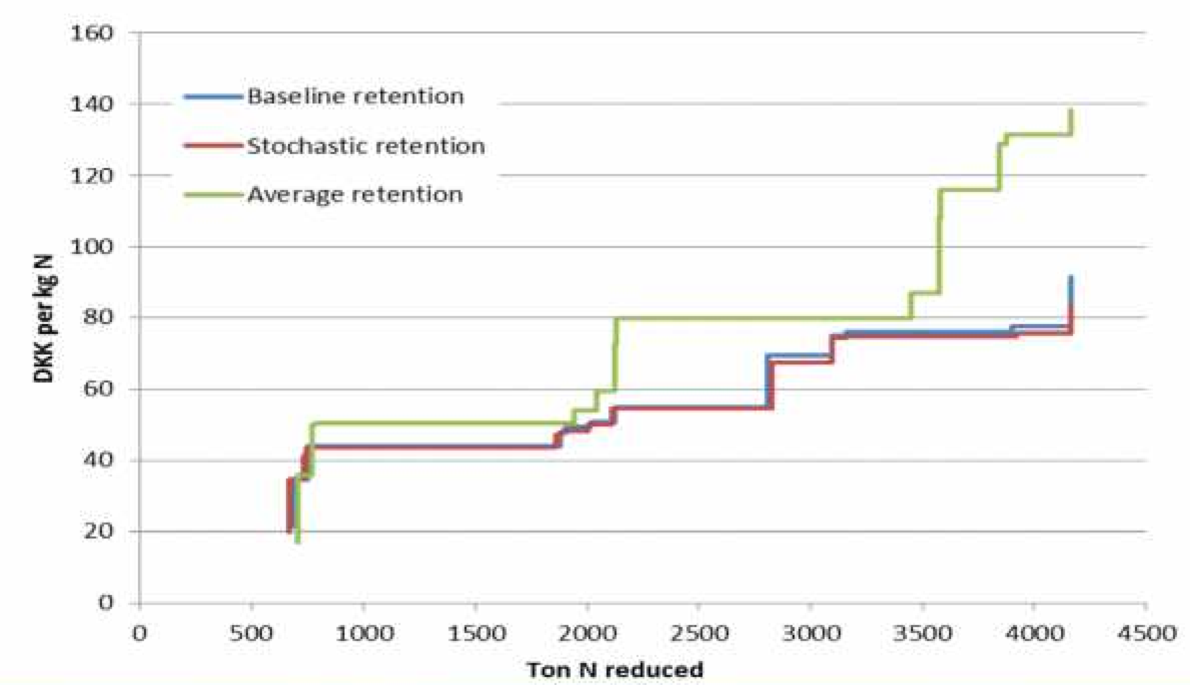


Down 10%

206 Mill. DKK



MARGINAL ABATEMENT COSTS - COMPARING RETENTION



CONCLUSIONS

- The catchment models are suitable for identification of cost-effective reduction scenarios for specified load reduction targets

- Comparison of uniform and targeted regulation

- Assessments of the sensitivity of the assumptions on e.g. retention, heterogeneity of costs, where uncertainty has implication for the distribution of costs

- Uncertainties on the retention dont seem to affect the solutions much, but not taking retention into account increases the total costs of abatement.

- **Targetting can reduce costs but implementation should be analysed.**

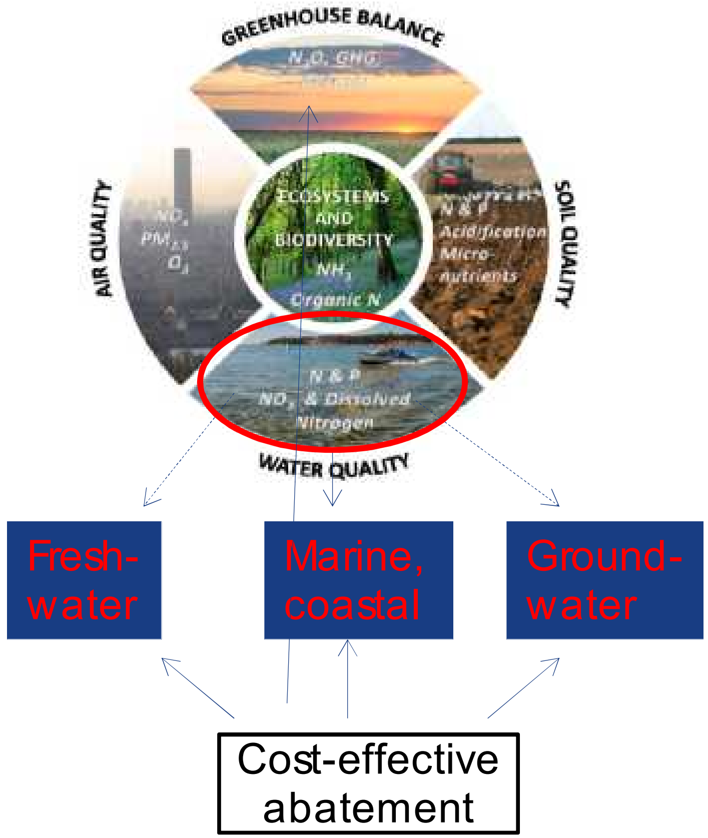
FURTHER RESEARCH

The model results can be used to assist implementation of targeted nitrogen abatement, illustrating how uncertainty on the assumptions affects total costs and the distribution of costs.

Further development and use: optimisation of **multiple targets** for marine and groundwater, freshwater, climate – the spatial distribution of abatement and costs will change compared to the single policy.

Important knowledge for regulation and policy – how implementation of one policy affects other policy areas.

Sutton et al 2013.



Thanks for your attention!