Basin Scale WQ model

'Integrated Model for Nitrate Transport and Basin Scale Water Management'

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Diffuse inputs into the groundwater:
Monitoring - Modelling - Management
Graz 2007

Basin Scale WQ model

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The WFD perspective

Screening level and basic assessments

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Water management objectives

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Detailed water action plans

Integrated, multi-objective basin water management requires integrated management tools capable of addressing inter-related water resources and water quality issues.

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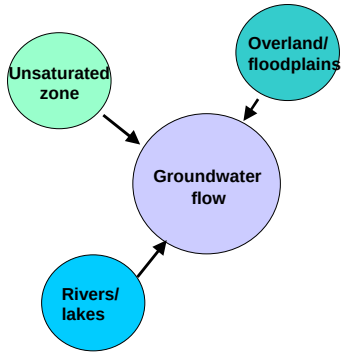
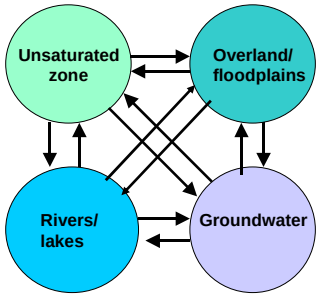
Approach to modelling (and management...)

Traditional groundwater model



Integrated models



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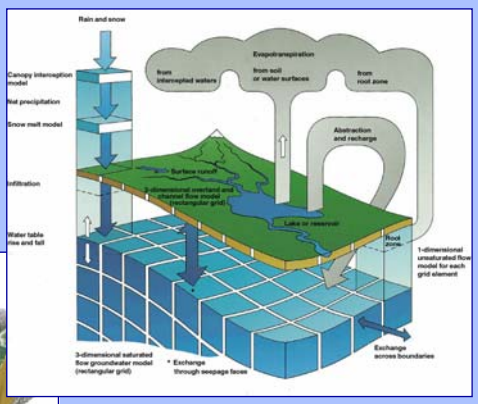
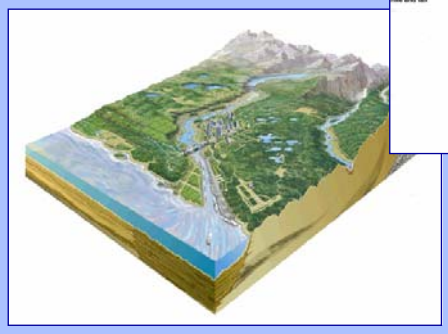
Basin water management

Ground water and surface water
- one hydrological system
- one water resource
- water quality status a function of both ground water and surface water





Requires integrated management tools and models

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DHI Software:

MIKE SHE

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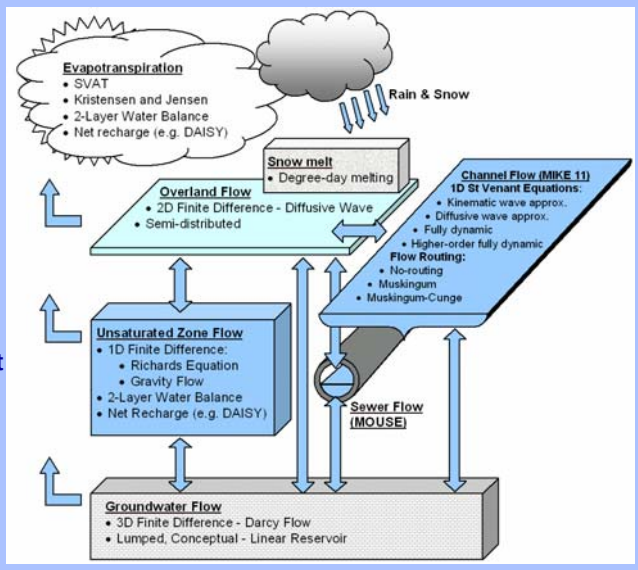
Process have different
• Spatial scales
• Time scales
Processes mixed as required
Time scales independent and automatically controlled
Simpler processes are faster and require less data



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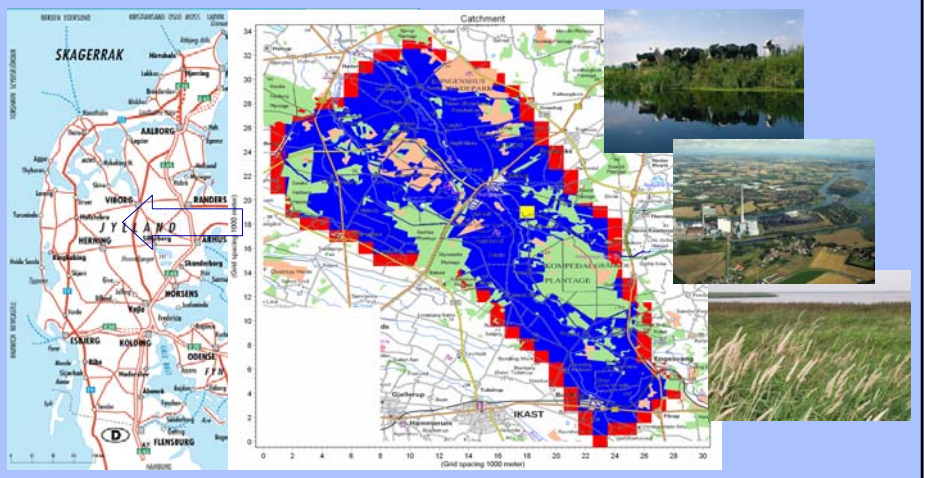
Nutrient Load in an Agricultural Area: Karup Catchment



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Project objectives

Development of distributed hydrology-, load- and transport/decay models for the Karup Catchment:

1) Simulate current nitrate loads to groundwater

2) Identify areas which contribute the most to pollution and develop management strategy

3) Model effects of management scenarios in the basin (land use, wetlands, fertiliser)

- targeted 35 % and 50 % reduction in total N loads

(The model supports multi-objective strategy : distributed groundwater and surface water flow/WQ)

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Data

Topography	(Kort og Matrikelstyrelsen)
Precipitation	(DMI & Foulum, 9 stationer)
Potential evaporation	(calculated based on sunshine duration (4 stations) and temperature)
Temperature	(Station Karup)
Discharge	(Hedeselskabet)
Groundwater – level	(Data from 40 drillings)

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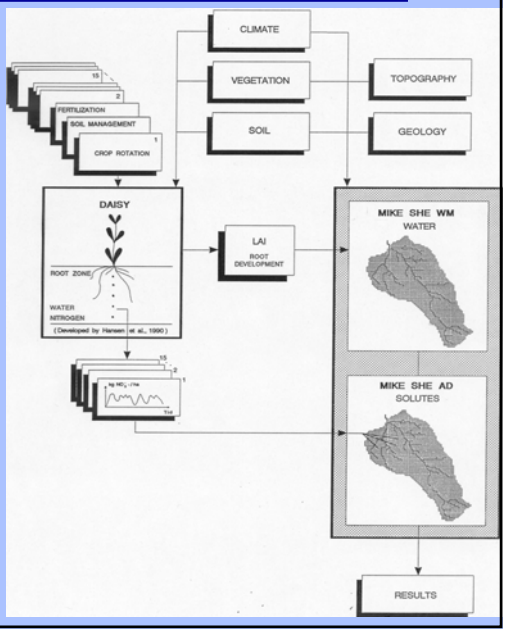
Management Model concept integrated load, transport and degradation



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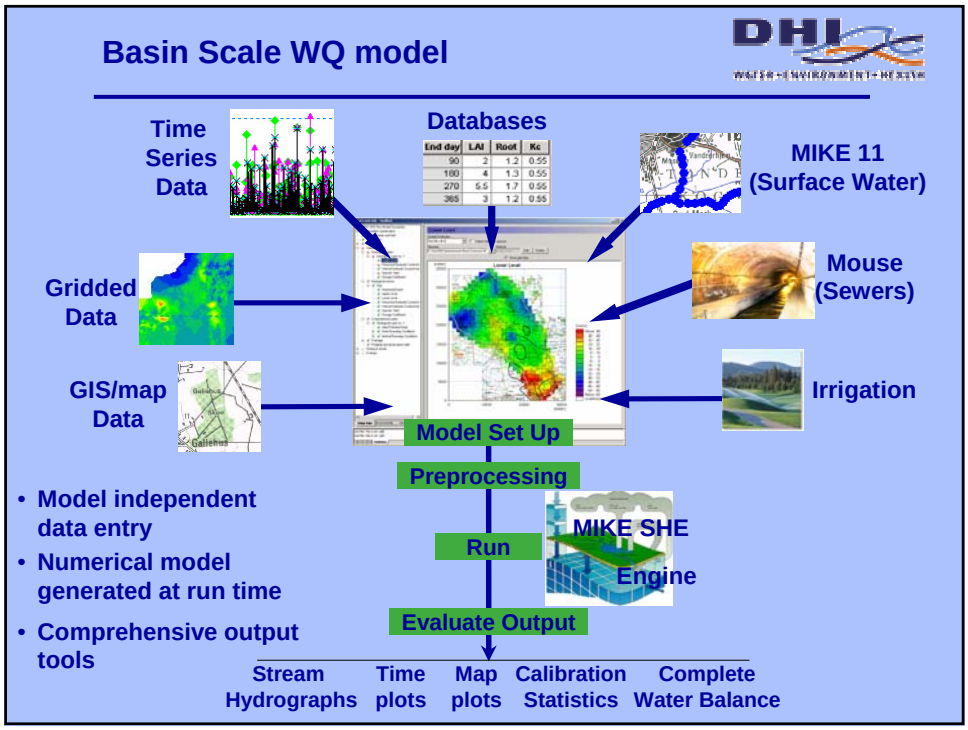

- Model independent data entry
- Numerical model generated at run time
- Comprehensive output tools

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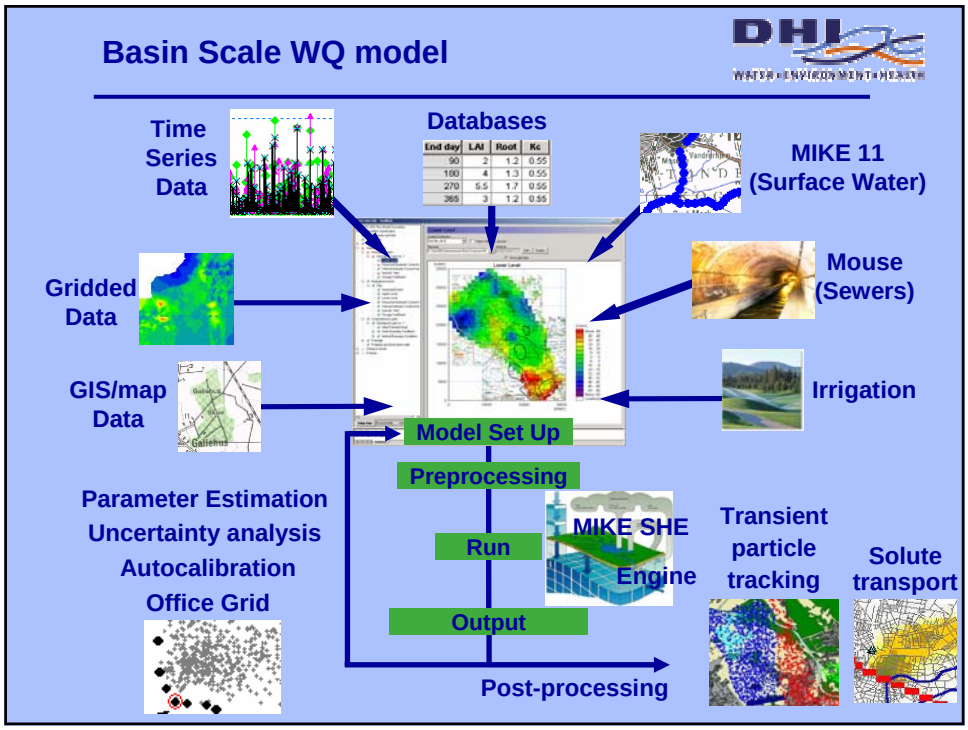

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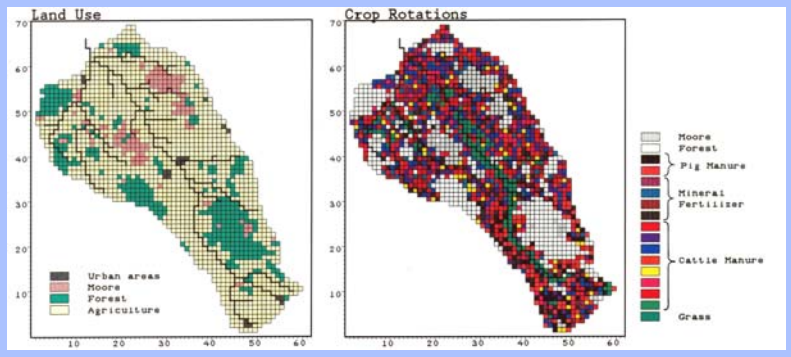
Karup – Land use



15 crop rotations was defined for the Karup catchment

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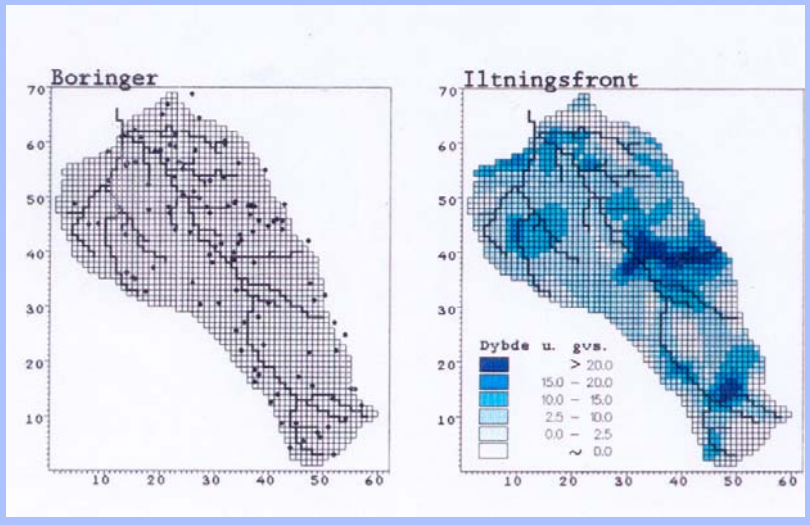
Redox cline – estimated based on a well data



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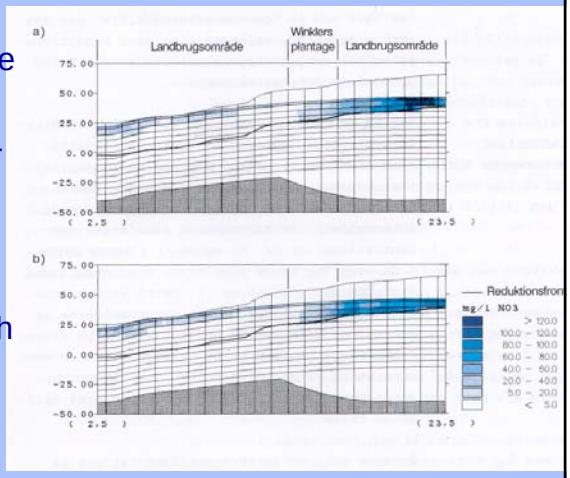
Present nitrate concentrations in at Rabis bæk

- Nitrate concentrations particularly high just above redox cline
- Low concentrations under natural vegetation (wetlands, heath and forest)
- Dilution of grundwater with “reduced” water
- a) Crop rotations
- b) Average



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Results

Grundwater main recipient

Large variation within the catchment

Response to nitrate

What happens with the nitrate?

How are the results used?

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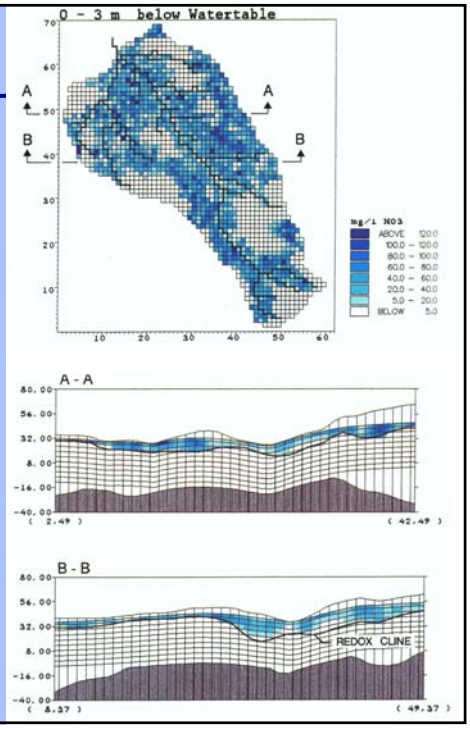
Exampel:

Model results of Nitrate concentrations in groundwater

Distribution of Nitrate in the Catchment:

0 to 3 meter below groundwater table and two cross sections



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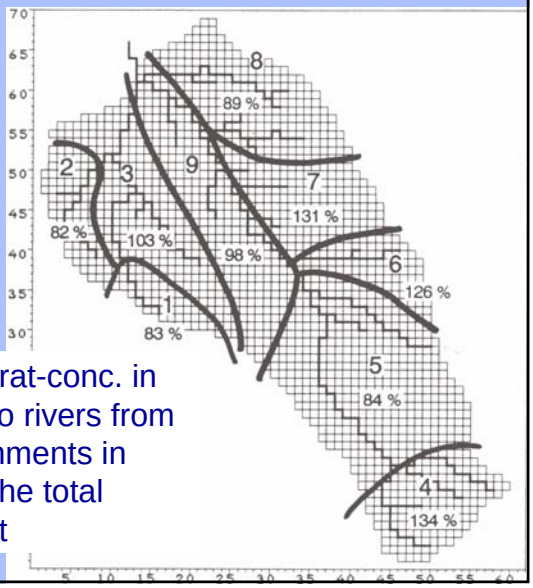
Local variation in contribution to the rivers in various sub-catchments

Nitrate in rivers depend on:

- Land-use
- Density of animals
- Reducing capability of aquifer



Relative nitrat-conc. in discharge to rivers from 9 sub-catchments in relation to the total nitrate input

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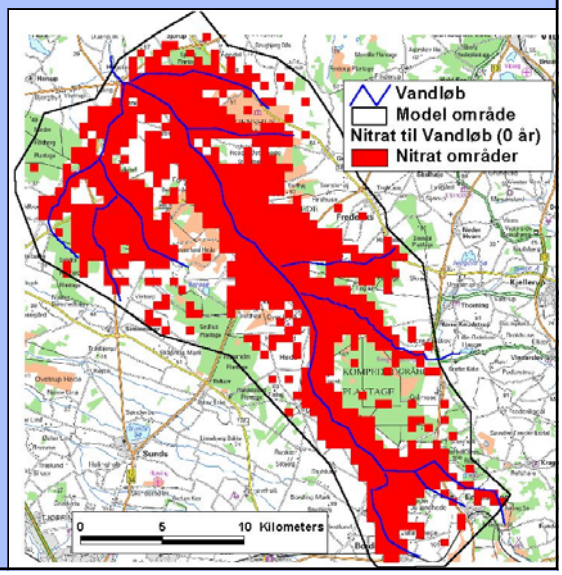
Local differences - effect of redoxcline

Areas contributing to river nitrate today



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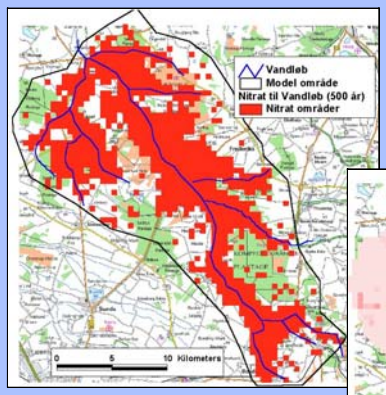
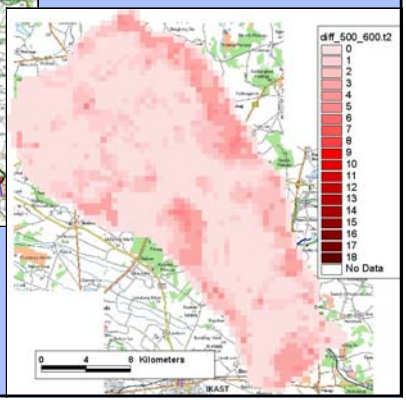
Local differences - effect of redoxcline

Areas contributing to nitrate in surface water after 500 years and prognosis of changes in redoxcline





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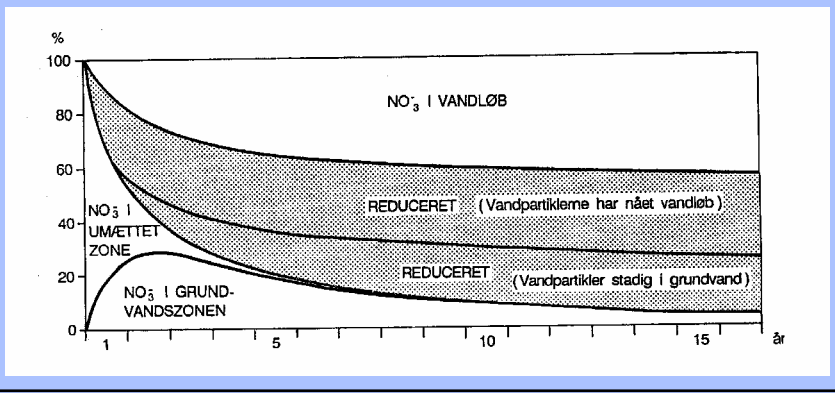
Impulse-Response-function

What happens to nitrate?

Input: = e.g. 1 Kg Nitrate just under root-zone in the total catchment



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Nitrate-concentrationer in river:

Med reduction in aquifer: avg. 24 mg/l

Measured: average 9 mg/l

In the Karup catchment about 2/3 of the nitrate is assimilated or reduced in wetlands

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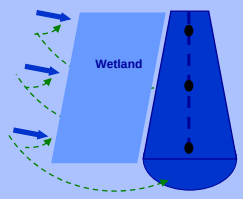
N degradation in wetlands

$$\frac{d\,NO_3}{d\,t} = f_{(NO_3\text{-flux, Area, Temp, Type})}$$



Type I - **Full infiltration**
~constant potential : 2500 kg/ha/year

Type II - **Flooding**
~ mean potential : 600 kg/ha/year

Type III - **Temporary flooding**
~mean potential : 450 kg/ha/year

Type IV - **Shallow lakes with short residence time**
~mean potential : 250 kg/ha/year

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Conclusion

We must focus on areas (flow paths) where denitrification is low. That is where we get most value for the bucks.

Drainage and wetlands are key areas for nitrate turn-over and areas with huge potential for improvements

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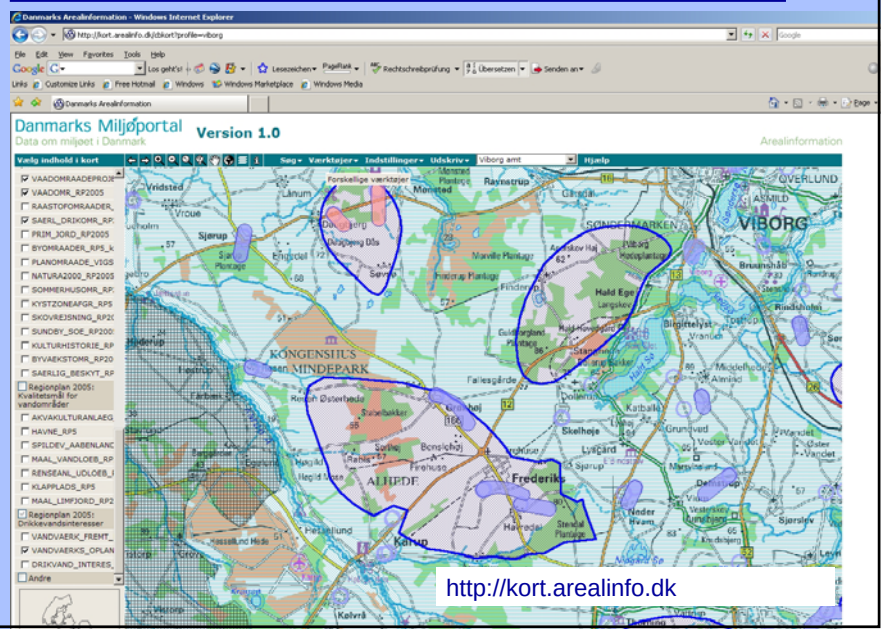

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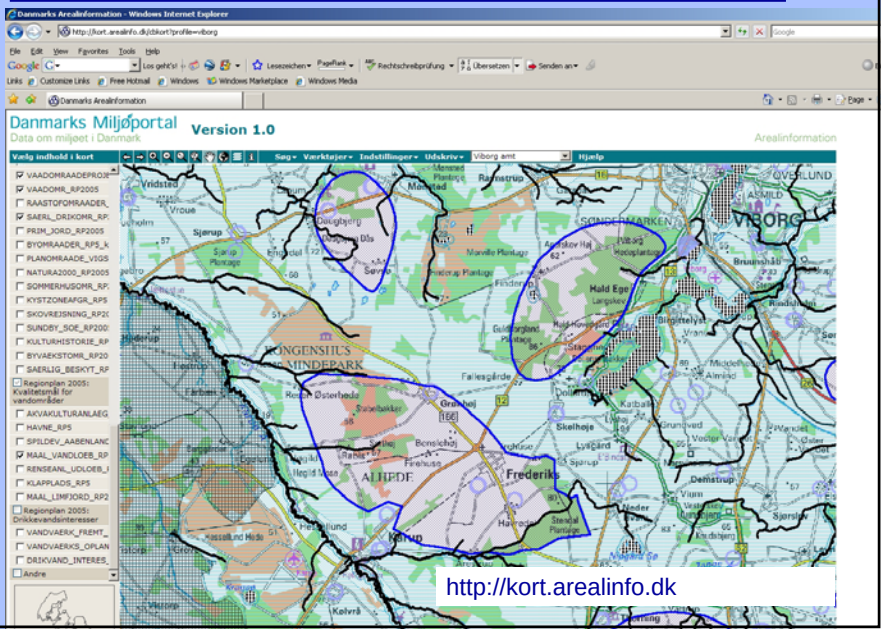

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Thanks for your attention!

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