

Integrated Groundwater Management: which data is needed for better management?

BJØRN KAARE JENSEN

GEOLOGICAL SURVEY OF DENMARK AND GREENLAND (GEUS), LOT 2 PROJECT MANAGER

CEWP WEBINAR SERIES

EVENT ON IMPROVING WATER QUALITY MANAGEMENT VIA BETTER DATA

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Integrated groundwater management – multiple purposes

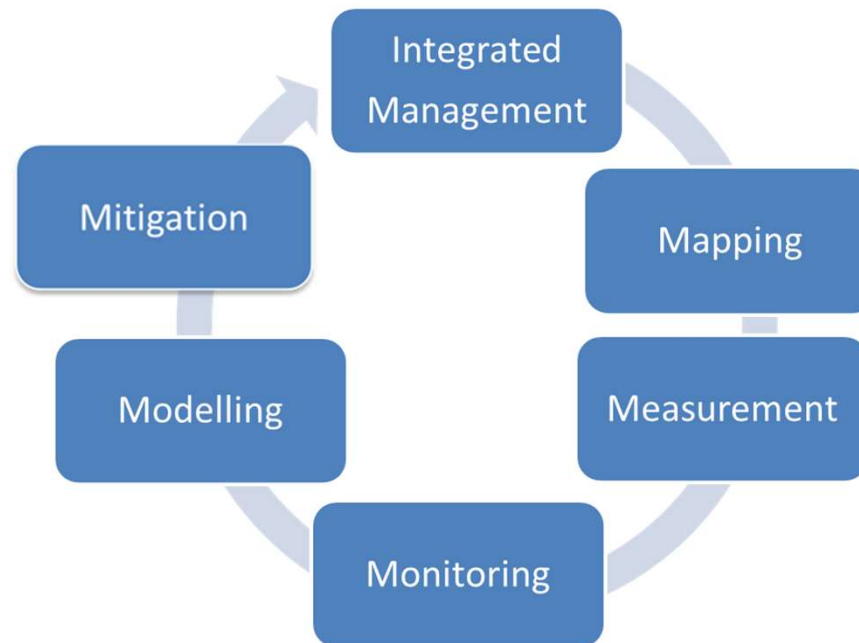
- Ensure supply of safe and enough drinking water for various users (household, agriculture, industry, recreational, etc.
- Protect against contamination from point and diffuse sources
- Ensure compliance with WFD in terms of maintenance and/or restoring environmental acceptable standard of water bodies
- Water cycle management in relation to climate change issues



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Integrated groundwater management in DK the 5 Ms



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Elements of integrated groundwater management

- **Identification and Mapping of groundwater aquifers** to be included in management schemes
- **Mapping of contaminant sources** within the groundwater zones of interest
- **Identification of other pressures** (climate change etc.) within the groundwater zones of interest
- **Groundwater risk assessment** and risk based **groundwater monitoring**
- **Groundwater modelling** for prediction of anthropogenic and geogenic impacts on groundwater resources and defining action plans
- Action plans for **groundwater restoration and protection**
 - Groundwater restoration/remediation
 - Water saving and reuse
 - Regulatory protective measures, including abstraction permits
 - Incentives (financial and compensation mechanisms)

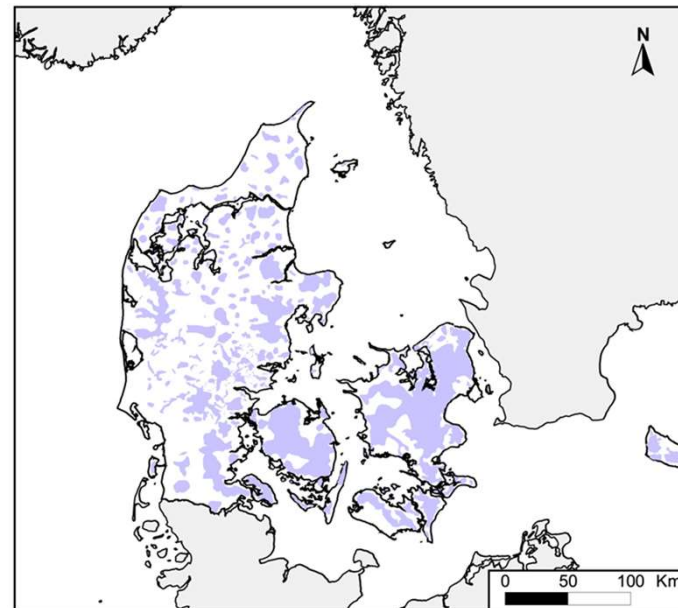


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The Groundwater mapping programme in Denmark

- The national groundwater mapping program 1999 --> 2015 financed by water consumers paying extra 9 EUR cents per m³ of water
- Total cost 360 million EUR
- Particularly valuable water abstraction areas (shown in purple) are mapped
- They cover about 40% (~17.400 km²) of the land area of Denmark



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Mapping of groundwater contaminant sources

Point sources

Industrial sites, landfills, storage facilities, etc.



Diffuse sources

Agriculture, saltwater intrusion, storm water,

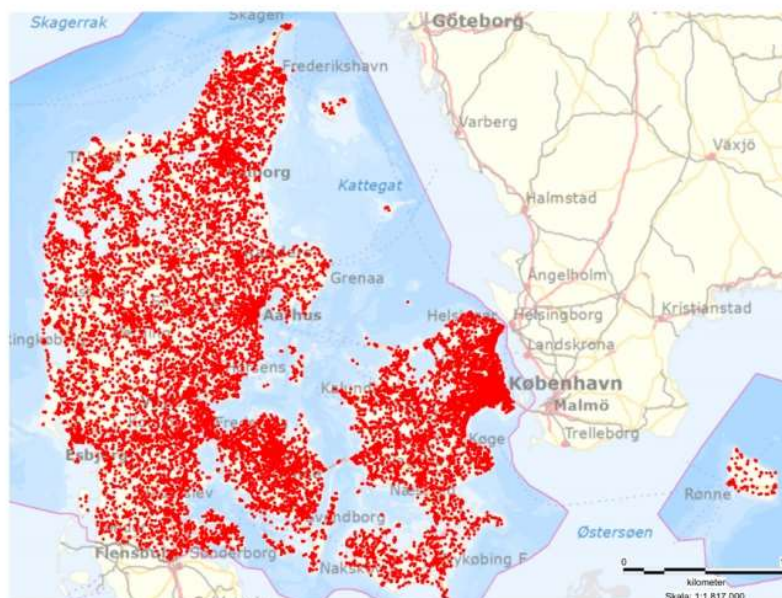


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Registered contaminated sites in Denmark

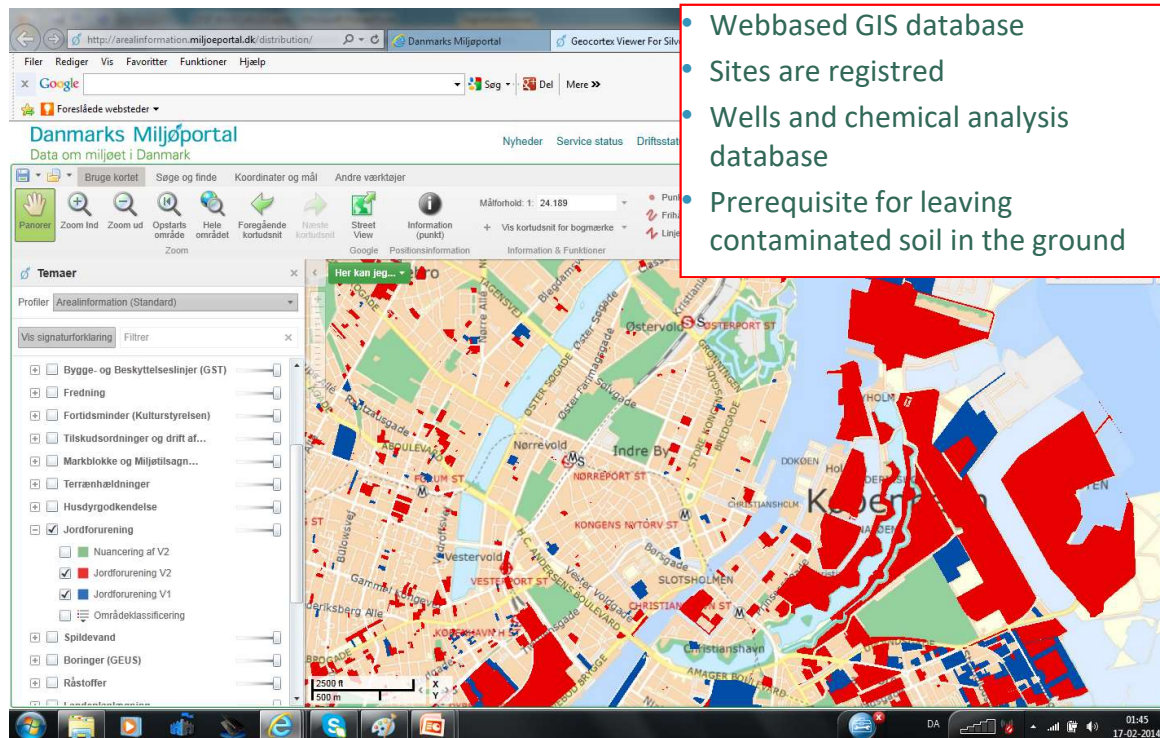
40.000 sites mapped as contaminated or potentially contaminated

Sites mapped as potentially contaminated in Denmark



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Public internet based inventory of contaminated sites



- Webbased GIS database
- Sites are registered
- Wells and chemical analysis database
- Prerequisite for leaving contaminated soil in the ground

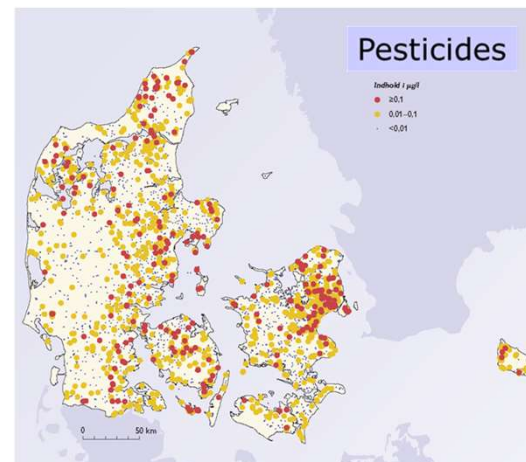
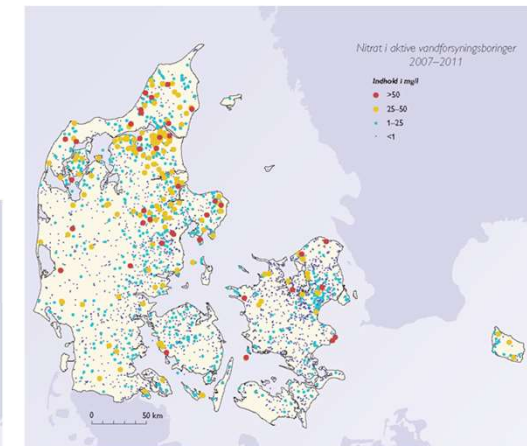


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Groundwater quality assessment - groundwater monitoring in DK

- Revised every 6th year – substances in and out – shifting focus – last time in 2011
- Initial focus of nutrients, then pesticides, now also on quantity – integrating surface and groundwater
- Annual national reporting

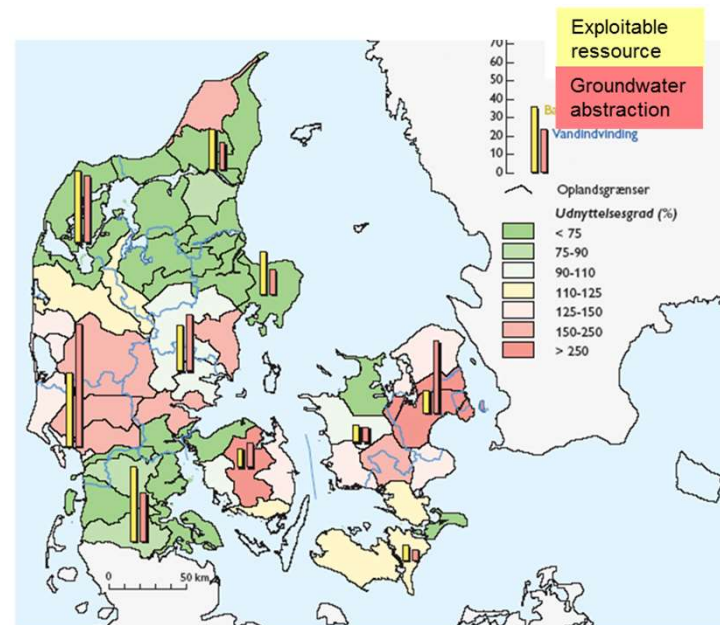
Nitrate



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Groundwater quantity assessment - estimation of sustainable groundwater abstraction

Sustainable groundwater abstraction has been assessed based on a national water resource model (DK model) and selected indicators



Last nationwide assessment (Henriksen et al., 2003):
Exploitable groundwater ressource
1 billion m³/year

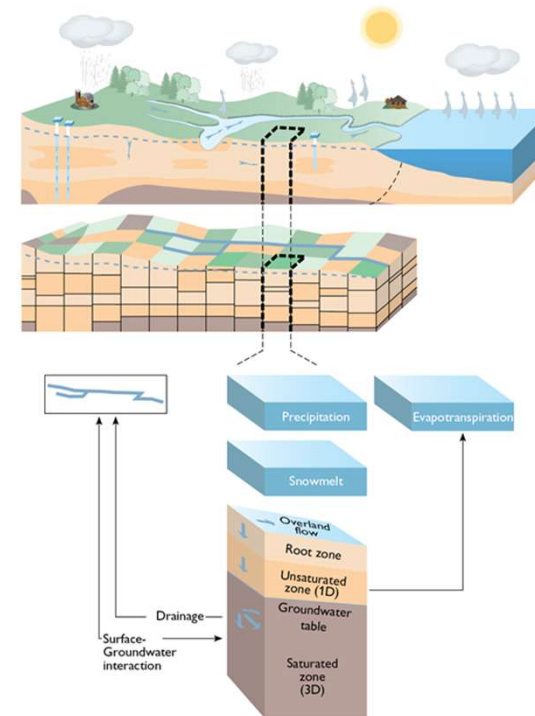


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National Water Resource Model – DK-model

Objectives:

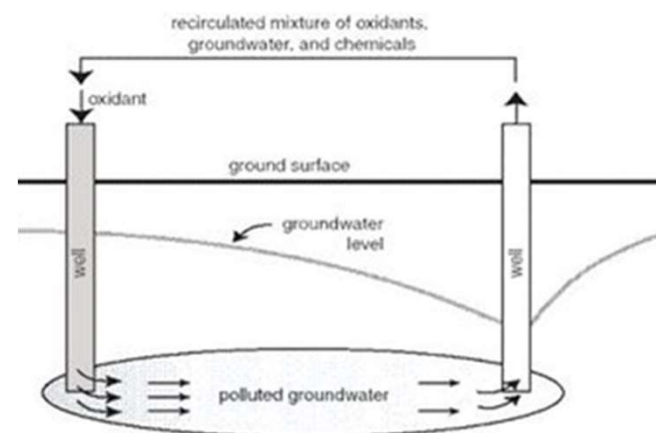
- To assess groundwater recharge at large scale /at groundwater body level
- To assess the size of the ground-water resource and the rate of exploitation taking into account land-use, climate change effects and abstraction strategy
- Assess the size of the exploitable groundwater resource
- Platform for more detailed models



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Groundwater restoration measures

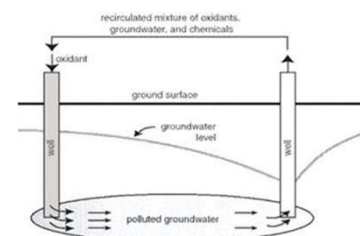
- Groundwater remediation
 - Contaminant point source removal, containment or stabilization
 - In situ treatment
 - On site treatment
 - MAR
- Regulatory measures
 - Land use restrictions
 - Forestation
 - Abstraction permits
 - Pesticide bans
 - Crop changes
- Financial and other incentives
 - Pricing schemes
 - Land compensation



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Data needed for IWM

Management component	Input data	Output data	Technologies
Groundwater mapping	Geophysical data, well data	Aquifer delineation	SkyTEM, tTEM, well data
Contaminant source mapping	Archives, maps	Geographical location, contaminant plumes	Databases, GeoEnviron (IT based reporting tool), historical archives
Groundwater quantity monitoring	Groundwater table levels, abstraction data	Groundwater long term availability	TEM, Soundings technologies, pumping tests, numerical models
Groundwater quality monitoring	Chemical and microbiological parameters well data,	contaminant time series, trends	Analytical techniques, smart sampling, on line sensors, data bases
Risk assessment	Contaminant monitoring data in abstraction wells, fate and transport contaminant characteristics, geological models	Contaminant exposure	Numerical models
Groundwater restoration	Soil contamination data, plume quality monitoring data,	Performance, treatment efficiency, treatment time	In situ and on site remediation techniques, MAR
Groundwater saving sustainability	Consumption data	Water saving	Smart meters, smart irrigation schemes, water saving household machines, etc.



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Thank you for your attention !

感谢您的参与和关注！

谢谢！



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