Danish Groundwater Bodies and their chemical status

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LEGISLATION AND DEFINITIONS

- The Water Framework Directive[1] and the Groundwater Directive[2]
- *A groundwater body (GWB)* is an administrative compliance unit
- The chemical status of the GWB'ies is reported every 6th year in the river basin management plans
- Guidance document[3] on assessment of state and background values (BGV)

METHOLOGY[4]

- The geological layers and aquifers in the National Groundwater Model[5] (DK-Model) are the basic units for delineation (Figure 1)
- Links between GWB'ies, borehole screens and aquifers were established through algorithms
- Modeled aquifers were grouped into GWB'ies through automatic algorithms, updating is easy and transparent
- The model provides an overview of groundwater - surface water contact
- Improved coherence between groundwater mapping, monitoring and water plans

DATA ON GROUNDWATER QUALITY

- Data from all water work wells, monitoring wells, investigation wells etc. are public available in the national database JUPITER
- The chemical water analysis in JUPITER were linked to GWB through links to the DK-model[5]
- Data from 2000-2013 were used to assess the chemical status of the groundwater bodies
- 2.379.426 analysis of individual parameters processed to asses groundwater status and trend
- The parameter "pesticides" was calculated as the highest concentration of a detected pesticide or relevant metabolite in a groundwater sample

CHEMICAL STATUS OF GROUND WATER BODIES[3,6]

- Distribution of parameters shows all relevant information (figure 2)
- Ion exchange used to discriminate between natural salt and salt intrusion
- Good chemical status: Compliance with the quality standards and threshold values for >80 % of monitoring points
- Poor chemical status: Non-compliance with the quality standards and threshold values
- Unknown status, no data (pesticides and nitrate have to be analysed)
- EU Groundwater quality standards for nitrate and pesticides
- Drinking water quality standards used for all other parameters

BACKGROUND VALUES (FIGURE 3)

- Background values (BGV) were calculated in river basins grouped with similar hydrogeology
- Only nickel, arsenic, aluminium and NVOC cause the need for background values due to natural concentrations above the quality standard
- BGV = 90 % quantile of the concentrations in unpolluted monitoring points
- BGV discriminated by the redox state of groundwater if > 20 monitoring points

CONCLUSION

- All expert judgments were transformed to systematic algorithms
- Calculations based on the DK- model guaranties a transparent decision making tool.
- Nitrate and pesticides were the most common reason for groundwater bodies to fail having good status
- Background values of specific elements such as arsenic and nickel were found
- Due to water abstraction or acidification elevated nickel concentrations were found

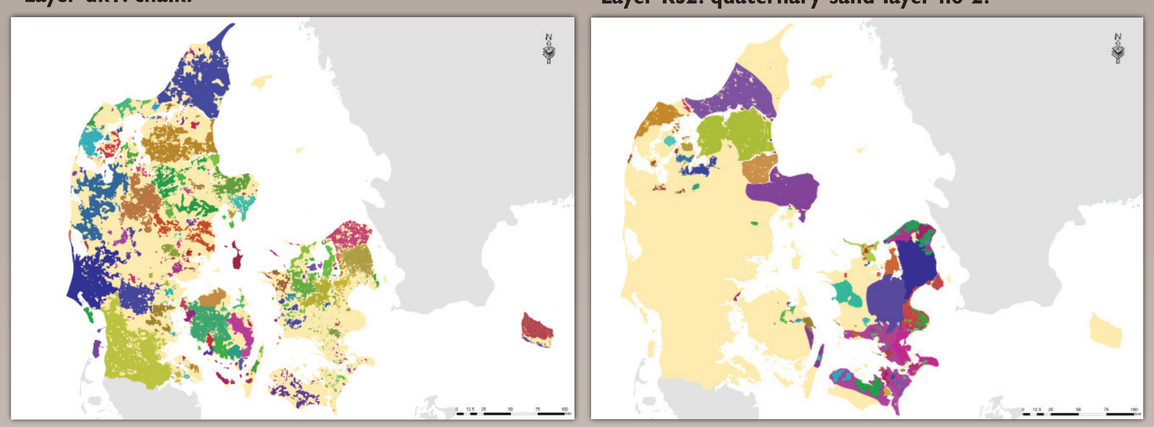

Figure 1
Examples of delineation of GWB in two different geological layers in the groundwater model.

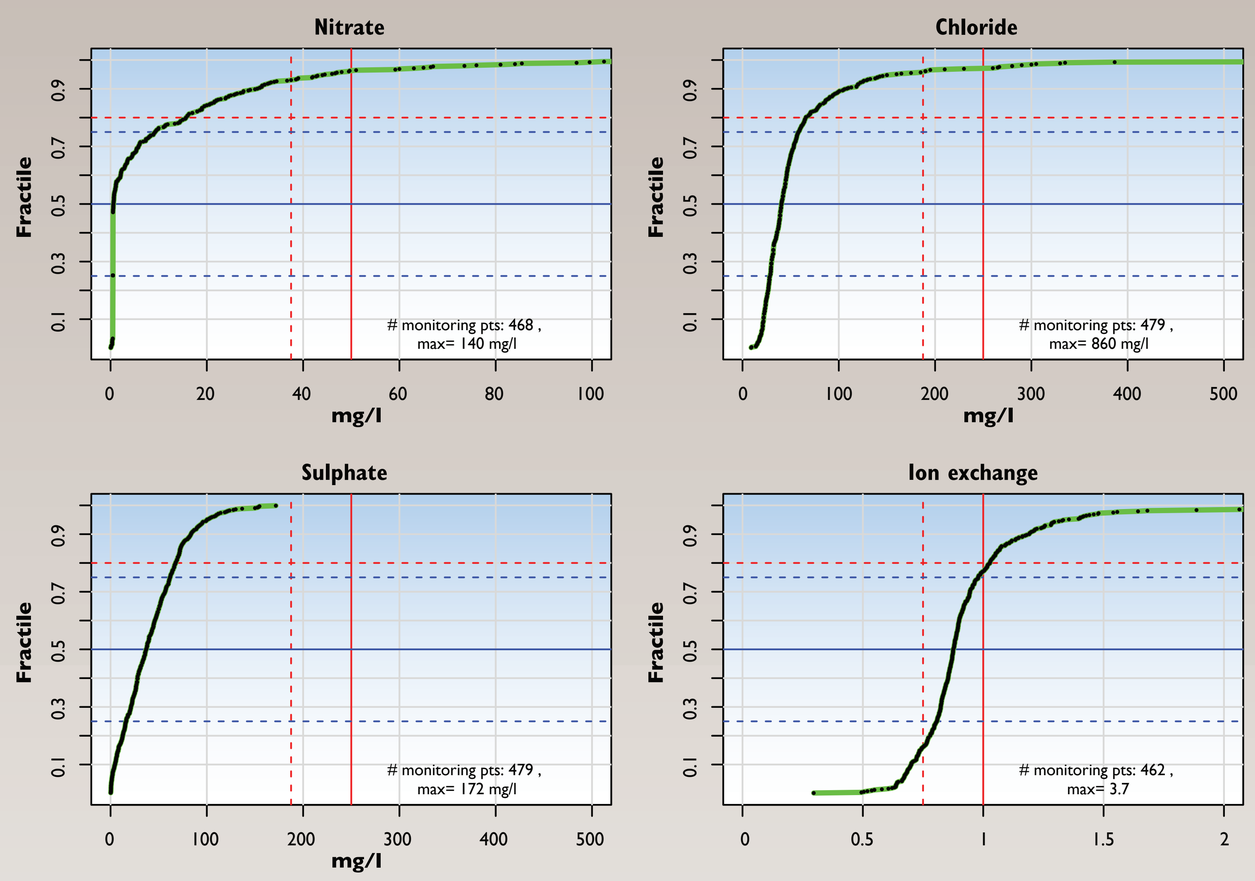

Figure 2
Data from a groundwater body at indiviual monitoring points[6]. The quality standard (red) and 75 % of quality standard (red dashed) are higlighted in the vertical grid. Median, 25 %, and 75 % fraktiles in blue and 80 % fraktile in red dashed are highlighted in the horisontal grid. A groundwater body fails the test for good state on a specific subtance if less than 80 % of the monitoring points are below the quality standard.

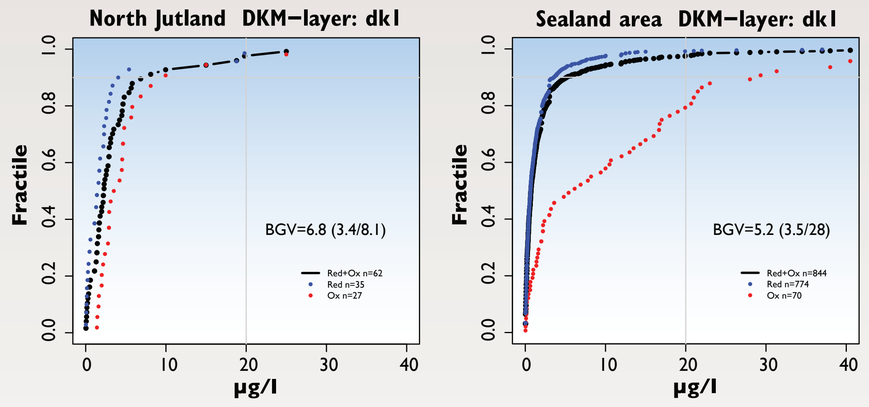

Figure 3
Natural background values for nickel in eastern Jutland and at Sealand where water abstractions causes nickel in elevated concentrations due to pyrtite oxidation. Red: reducedgroundwater, Ox, oxidised groundwater. Background values (BGV) are automatical calculated for the layer in the relevant area. The anthropogenic impact at sealand hinders establishment of a BGV there.

REFERENCES

/1/ *European Commission, 2000: Water Framework Directive (2000/60/EC)*
/2/ *European Commission, 2006: Water Framework Directive (2006/118/EC)*
/3/ *European Commission, 2009: Guidance on Groundwater Status and Trend Assessment, Guidance Document no. 18.*
/4/ *Troldborg L., Sørensen B. L., Kristensen, M. og Mielby S.: Afgrænsning af grundvandsforekomster. Tredje revision af grundvandsforekomster i Danmark. GEUS rapport 2014/58.*
/5/ *The National Groundwater Model, DK-model http://www.vandmodel.dk*
/6/ *Thorling, L. & Sørensen, B.L., 2014: Grundvandets kemiske tilstandsvurdering Vandområdeplan 2015-2021, data og metodevalg. GEUS rapport 2014/78. http://www.geus.dk/DK/water-soil/water-management/Sider/grundvand_kemiske_tilstand.aspx*