

NATIONAL GROUNDWATER MONITORING AND MODELLING

Integrating groundwater quality monitoring and water resources modelling

Groundwater is the Danish drinking water resource

99 percent of the Danish water supply is based on groundwater extracted from 3100 waterworks and 115.000 single supply wells. The total consumption is about 900 million m³ per year.

Groundwater quality monitoring

Since 1989 groundwater quality monitoring has been conducted in 67 monitoring areas with 1165 monitoring wells. Groundwater is sampled several times a year and more than 80 different components, natural as well as anthropogenic, are analysed.

A classification system of the major groundwater types in Denmark is based on a combination of statistical methods (cluster and discriminant analyses) and existing geological knowledge. Carbon dioxide, sulphate, chloride, bicarbonate, calcium and magnesium have been chosen as classification parameters. Six major groundwater types have been defined, mainly reflecting carbonate conditions and ion exchange but also indirectly aquifer vulnerability and groundwater age.

Modelling groundwater quantity and quality

The National Water Resources Model is based on the extensive amount of geological and hydrogeological information stored in the databases at the Geological Survey of Denmark and Greenland. The data are processed using geostatistical tools.

The National Model is based on the hydrological code MIKE SHE, which is a fully 3-dimensional groundwater model with linkage to spatially distributed precipitation/evapotranspiration and surface runoff. The model will be calibrated on the basis of groundwater level and base flow data, as well as groundwater age dating (CFC gas analyses).

The National Model will make it possible to quantify changes and regional distribution of the Danish water resources in terms of quantity. Integration of groundwater quality monitoring and operation of the National Model will improve our ability to evaluate the available ground water resources with respect to quality and natural protection. The National Water Resources Model will be used for evaluating the impacts of pollution sources, precipitation, climate and land use on the available water resources.

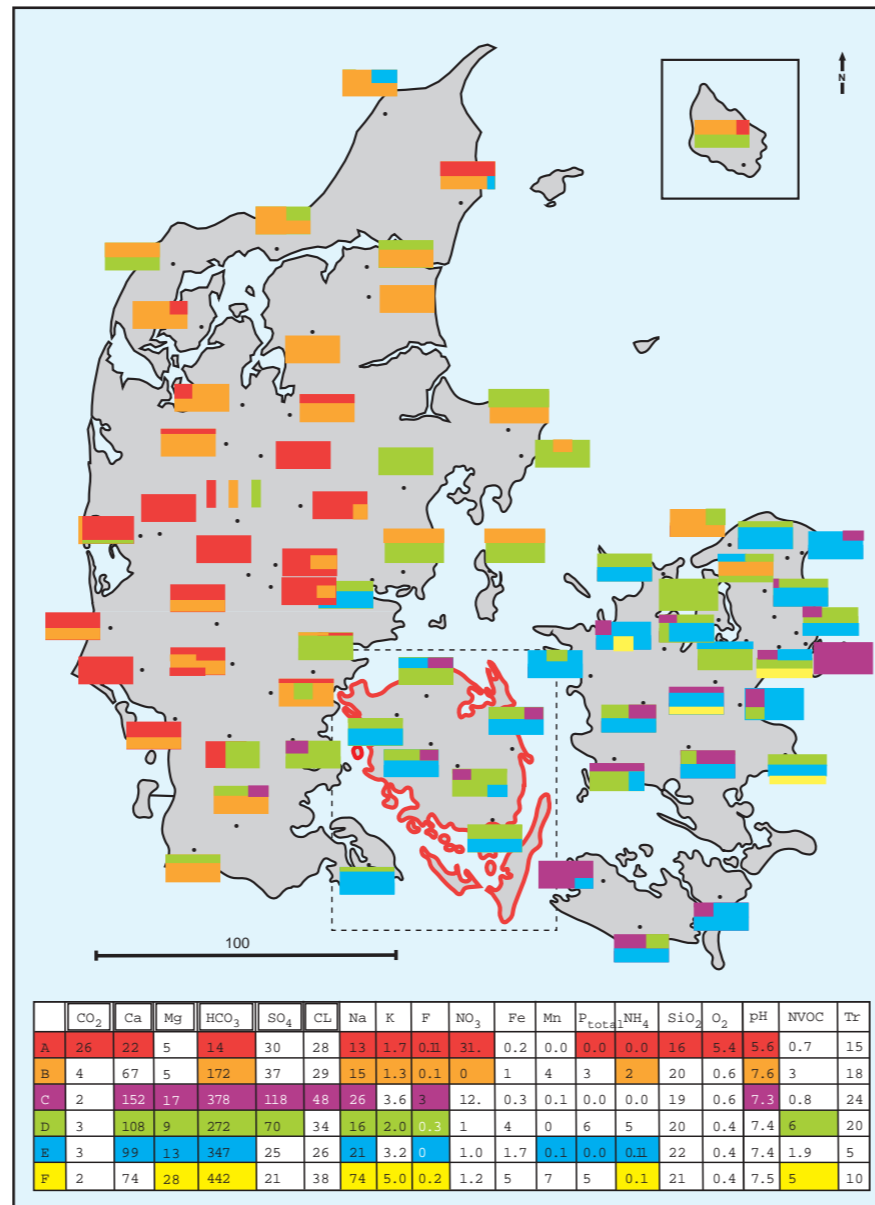


Fig. 1: Distribution (as geochemical cross sections) of the six major groundwater quality classes in Denmark based on cluster and discriminant analysis of data from 67 groundwater monitoring areas and more than 1000 wells. Table shows median concentration for different components (mg/l except pH and Tritium (TU)). Significant concentrations are shown in colour.

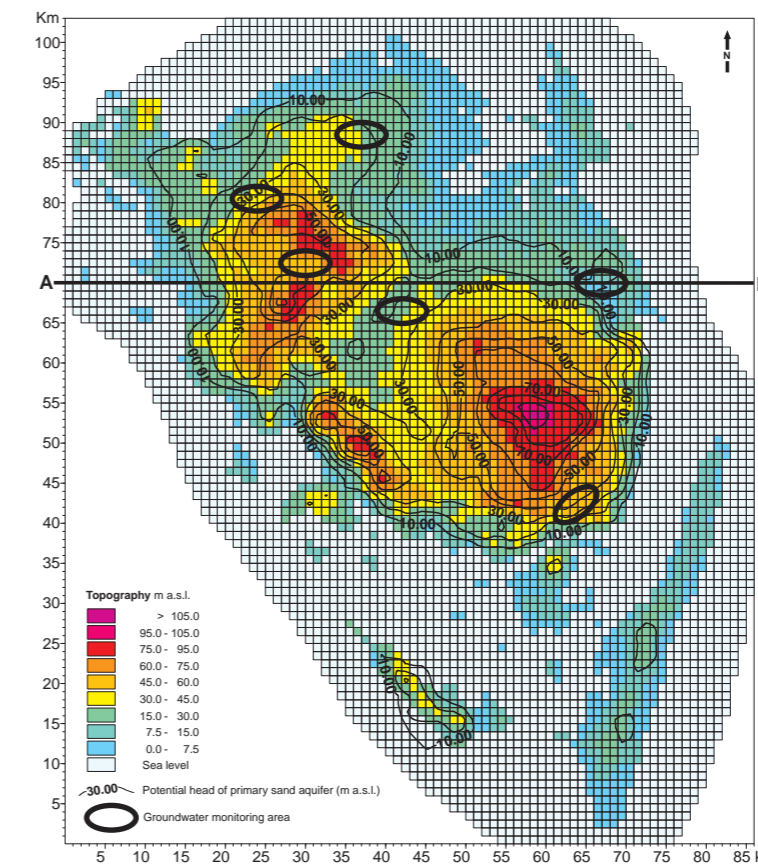
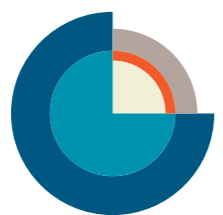


Fig. 2: Model area, potential head and topography for one regional sub-model of the National Water Resources Model. The model grid is 1 km x 1 km. The modelling tool is the hydrological code MIKE SHE model.



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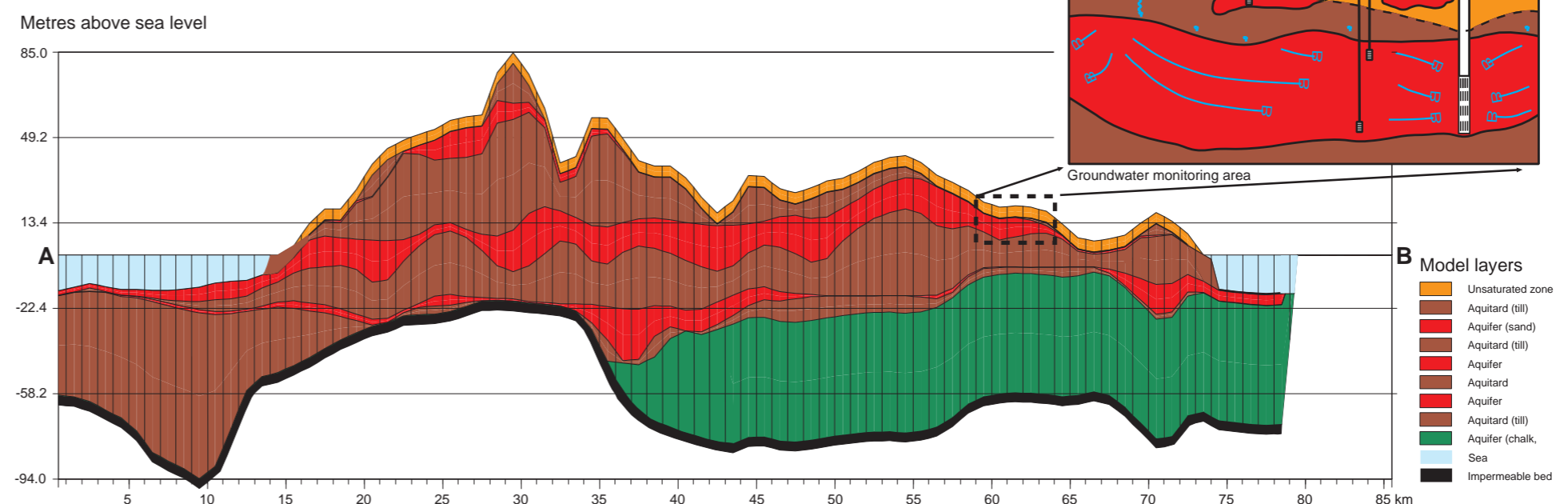


Fig. 3: Cross section showing the 9 layers of the model (red: melt water sand, brown: till, green: chalk/limestone). Insert showing the groundwater monitoring concept of point monitoring wells (left), line monitoring wells (middle) and volume monitoring wells (right). Each monitoring area contains about 16 to 18 wells.