

Free, online Danish shallow geological data

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Geological data at the Geological Survey of Denmark and Greenland (GEUS) have been available on the internet for more than 10 years. The first step in making geological data available online was the launch of web access to data from water supply wells (Tulstrup 2004). The database is called Jupiter, and currently data from more than 260 000 shallow wells are available to the public. Figure 1 shows an example of a map from the Jupiter database available in a web-browser.

The first web access was via a text-based search form which supplied data lists and graphical well reports. In recent years, the interface has been extended with more data, map interfaces and extra functionality. This paper describes this development and illustrates the increasing value of the digital data at GEUS.

In its current form, the Jupiter webpage offers: (1) data on wells, geology, water level and groundwater chemistry, (2)

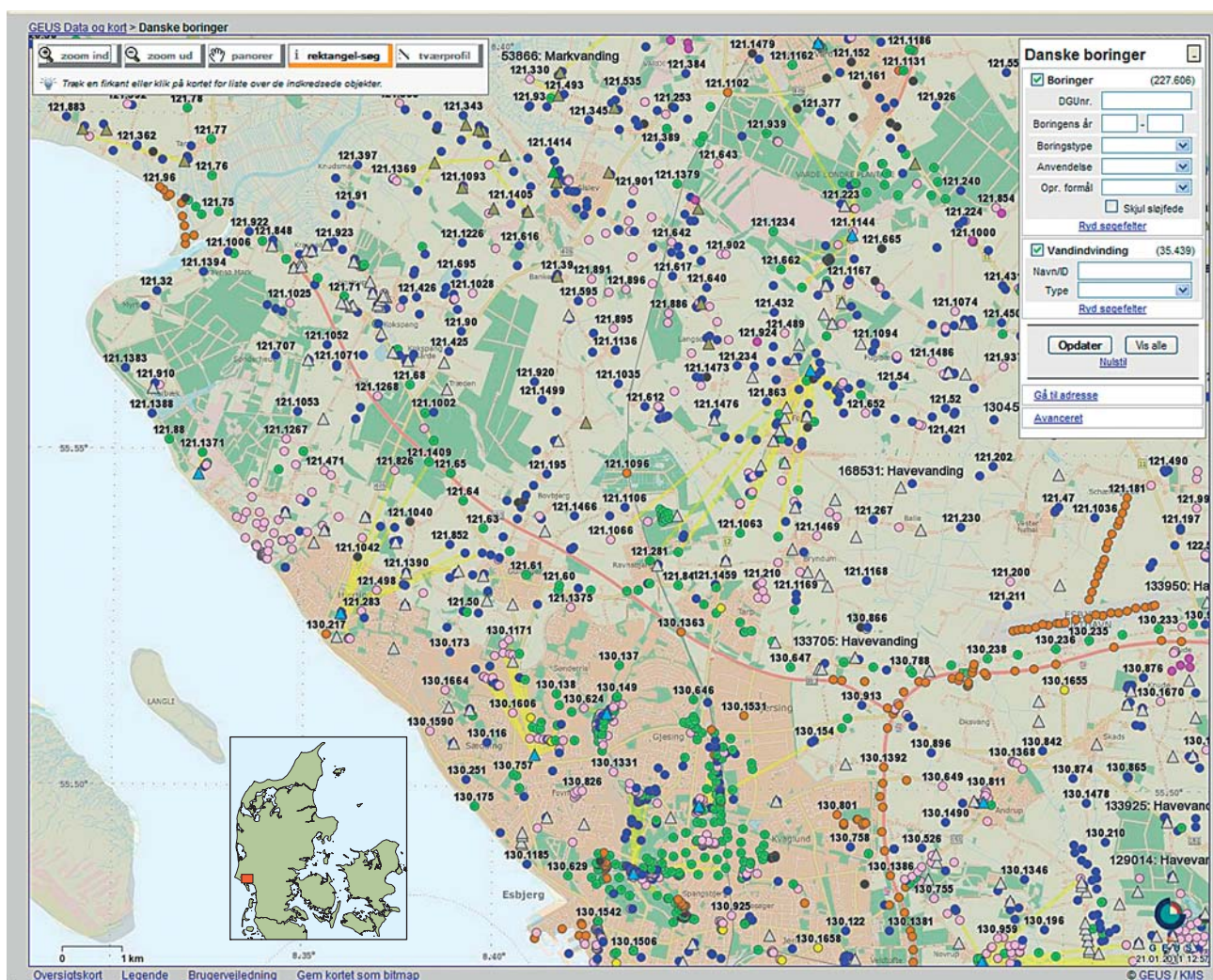


Fig. 1. Map interface showing boreholes (dots) and water extraction plants (triangles). The inset map shows the location in south-western Denmark.

data about water supply, water abstraction licences, yearly abstraction, exchange of drinking water between waterworks installations as well as drinking-water chemistry and (3) the possibility to download complete data sets in various database formats.

The simple text-based search form has been extended with new functions and supplied with different types of map interfaces. Data can now be accessed via web map services, web feature services and in Google Earth format. In 2007, after implementation of a local government reform in Denmark, Jupiter became the national database for shallow geology, groundwater and drinking water. A data model based on the Jupiter database was established and all the data were made available to the public. A set of simple object access protocol web services was launched giving full read-only access to all

data in the public domain data model. Editing was allowed for the part of the data model that is maintained outside the Survey.

After the reform of the local government system, tasks involving shallow geology and hydrogeology were divided between (1) the state, which is responsible for hydrogeological mapping and groundwater monitoring, (2) the regions for dealing with soil pollution and remediation and (3) the municipalities (kommuner) for issuing groundwater abstraction licences and checking drinking-water quality.

With the demand for geological data at three administrative levels the ability to share knowledge is important. In addition to geological and hydrogeological information from the Jupiter database, shallow geophysical data from the Survey's GEophysical Relational DAtabase (GERDA) can now

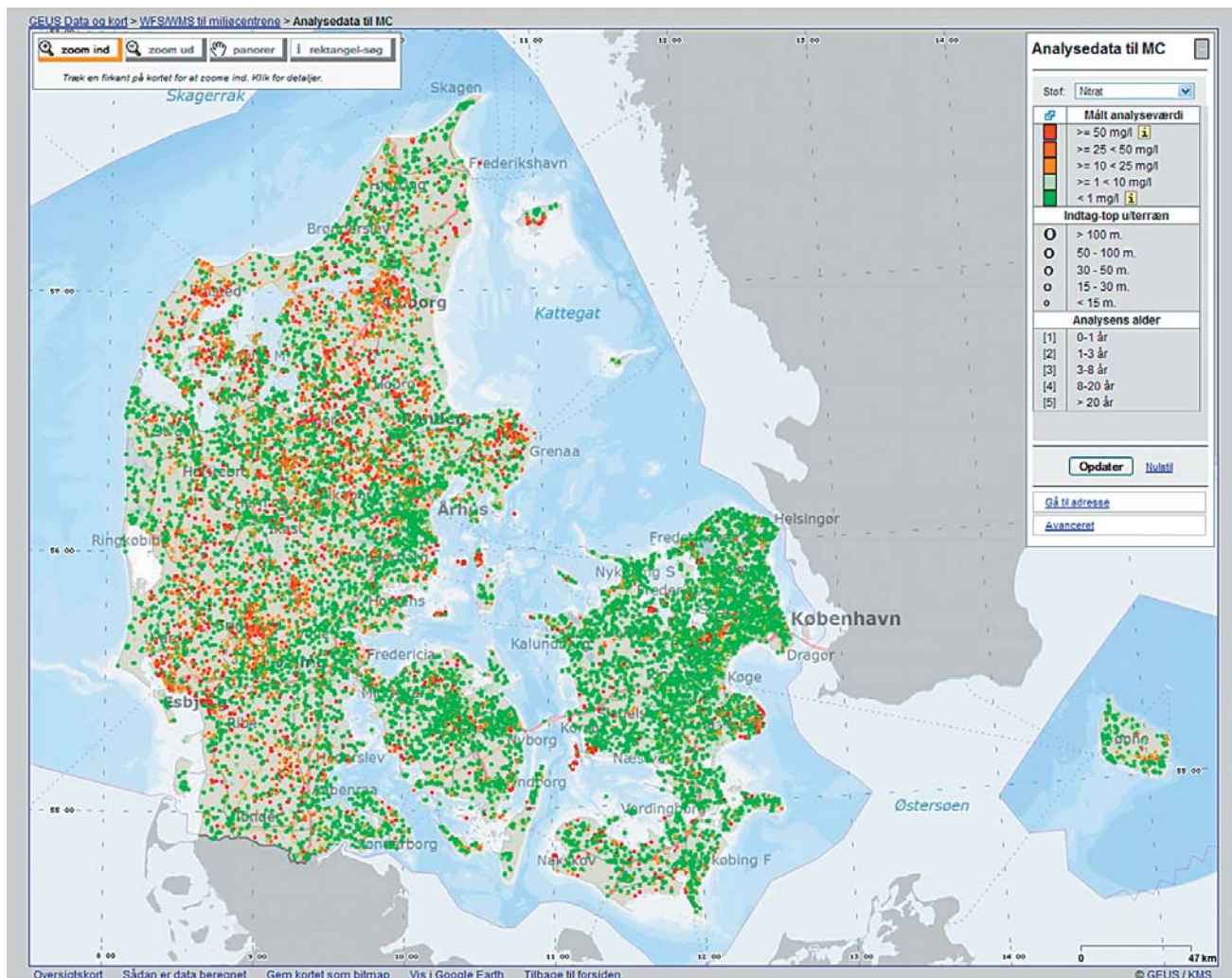


Fig. 2. Map of Denmark showing nitrate analyses from groundwater samples. These data are made available through web map services, web feature services and a simple map interface. Thirty-five other types of analyses are available in the same form.

Table 1. The databases can be accessed via different interfaces

Data set	Website	Map interface	Download	Google Earth format	WMS/WFS [§]	SOAP [#] web services
Jupiter	Yes	Yes	Yes	Yes	Yes	Yes
GERDA	Yes	Yes	Yes	No	Yes	No
Report database	Yes	Yes	Yes	No	Yes	No
Database for geological models	Yes	Yes	Yes	No	No	No
Groundwater chemistry for 36 selected parameters	Yes*	Yes	Yes*	Yes	Yes	No

[§]web map services/ web feature services, *part of Jupiter, [#]Simple object access protocol.

be used free of charge (Møller *et al.* 2009). Databases with hydrological reports and geological models were also established. The reports and models are also available at no cost.

At the same time, more than 750 000 documents from the Surveys' old Well Data Archive, and files from well archives

held by the former Danish counties (amter) were added to the website, all linked to the wells they describe.

The data in the Jupiter database are in accordance with Danish legislation updated by GEUS and by local authorities. As an example, laboratories must deliver analyses of

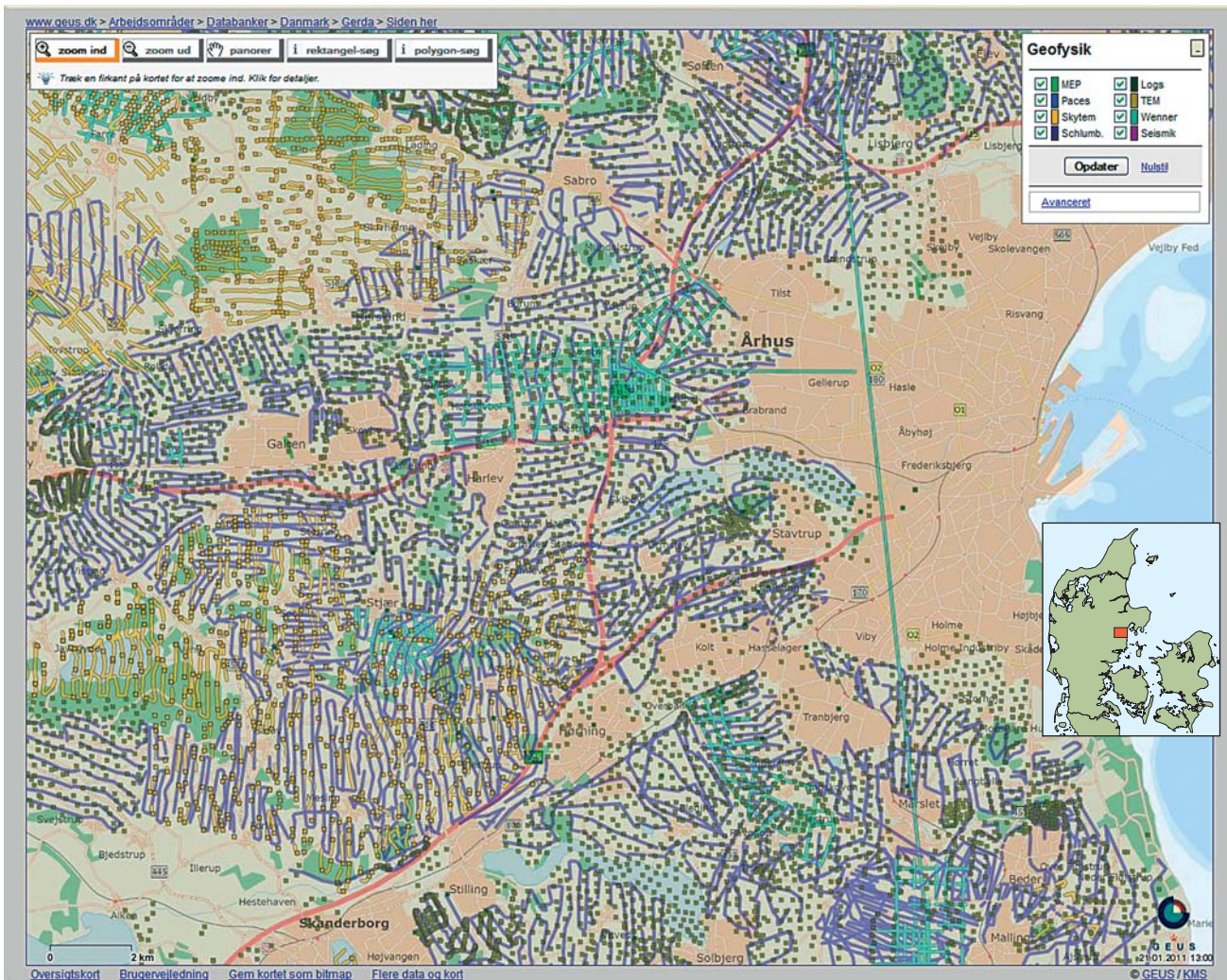


Fig. 3. A close-up of the area west of Aarhus showing GERDA data coverage of different geophysical data types. The inset map shows the location in central Denmark.

drinking and groundwater conducted for waterworks directly to the database. When data are entered into the Jupiter database, users responsible for drinking-water quality receive notification by e-mail, and after quality control the data are immediately available online.

Users of the data

The Jupiter data are used by a wide range of people. By storing data in a central database, the data of one municipality are available not only to the neighbouring municipalities but also to users of drinking water, to the educational system as well as to advisors working for the environmental centres in Denmark.

Different users with different needs and skills call for different user-interface types. At present, data can be accessed through a variety of interfaces. Maps and Google Earth can be used by the public, whereas web map services and web feature services are mainly for professional users (Fig. 2). The web services give full reading access through specially designed software and allow editing possibilities for public employees with the appropriate privileges. It is also possible to download complete databases that can be used for complex analyses and to develop geological and hydrogeological models.

Online shallow geophysical data

The geophysical relational database (GERDA) contains geophysical data acquired during hydrogeological mapping in Denmark over the past decade. The GERDA data became available to the public on 1 January 2007. GERDA comprises a wide range of geophysical data, geoelectric and geoelectromagnetic data, both raw and processed, reflection seismic data and borehole logging data (Fig. 3). Inverted 1D and 2D models are included with the geoelectric and electromagnetic data, and the processed sections are available with the seismic data. All information on data acquisition, data processing and inversion procedures can be stored, thus facilitating full reprocessing and inversion of data when required, which makes the inversion and interpretation of data transparent.

Hydrological reports and geological models

GEUS also hosts a database with hydrogeological reports and a database for geological models. Both databases have been developed in cooperation with the Danish environmental centres. Reports from hydrological surveys are stored in the report database, which was established to allow easy exchange of information between administrators at different levels. Reports can be accessed from a search form or from a map interface, if the report is geocoded.

The database containing geological models was established to store geological and hydrological models in a tool-independent format. The database is closely connected with the borehole, geophysical and report databases to give the users easy access to reports describing the models and to the data on which the models are based. All models developed by or for the environmental centres during the mapping of the Danish groundwater are stored in the model database.

Concluding remarks

Most of the Danish environmental data are available free of charge and most of them can be found through different Danish interfaces (Table 1). Users can access data through websites, where they can search for specific data sets; they can find data through different types of map interfaces, download parts of databases or complete databases. Through web services users can read directly from the database and privileged users can update data belonging to their own administrative unit.

The easy access to data makes it easy to share data between different administrative units, between individuals and between consultant companies. Private companies, often working for the public administration, have benefitted from the central data storage as they can now access most of the relevant data from one website. In addition, the data are updated and always in the same formats.

References

- Møller, I., Søndergaard, V.H. & Jørgensen, F. 2009: Geophysical methods and data administration in Danish groundwater mapping. *Geological Survey of Denmark and Greenland Bulletin* **17**, 41–44.
- Tulstrup, J. 2004: Environmental data and the internet: openness and digital data management. *Geological Survey of Denmark and Greenland Bulletin* **4**, 45–48.

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