SESSION 3:
MODEL DISSEMINATION AND DATA MANAGEMENT

As Geological Surveys and private contractors keep modelling, geological models become larger and more detailed with more features and attributes. How is the resulting knowledge managed? Do you follow any specific standard, for example the FAIR principles to make geological models Findable, Accessible, Interoperable, and Reusable? Here, we invite presentations focusing on use cases and working solutions where geological models contribute to a sustainable future for society.

3D MODELS AS A BRIDGE BETWEEN SCIENCE AND POLICY

Abigail K. Burt and Riley P.M. Mulligan

Recently, the Ontario Geological Survey (OGS) formed part of a multi-disciplinary team tasked with creating a defensible boundary around an 80 km long section of a complex glacial moraine system being considered for environmental protection. This task provided the OGS with the opportunity to become our own clients and use our products to answer land use planning questions.

Publicly accessible (and free!) data from the OGS included seamless maps of surficial geology and sediment thickness, bedrock topography and geology, and areas of karst. Published groundwater resources studies comprising a 3D model and derivative products cover the northern and southern, but not the central, portions of the moraine. GIS and Google EarthTM versions of structural and isopach maps for each model layer, a subsurface database, interpreted logs, photos and analytical data for all cored boreholes, high-resolution plates of prepared cross-sections and a detailed report are found within each study. Cross-section viewers designed to display and save user-defined vertical slices through the 3D models no longer function, but we were confident our products would still satisfy the request.

It quickly became apparent that team members lacked the geological expertise needed to use the information we provided. Our maps and 3D models convey a wealth of information to other geoscientists but were either incomprehensible to the team or did not easily integrate with other ministries' data. When we outlined proposed planning boundaries, it was difficult communicating the reasoning behind those boundaries. Many basic (to us) geological concepts required leaps of imagination for our collaborators: the moraine is composed of many component landforms, displays rapid changes in sediment texture, thickness and architecture, and is variably connected to multiple regional groundwater flow systems.

Our products were not suitable for communicating these concepts to non-subject matter experts – but this was a tremendous learning opportunity. We are learning to communicate core knowledge first and then slowly build on this foundation. We are working on a new 3D model cross-section viewer, new derivative maps, and finally, we have seen the power of getting non-experts out of the office and into field.

GEUS 3D DATABASE
PRESENT STAGE AND WHAT DID WE LEARN

Marianne B. Wiese, Christian Brogaard Pedersen

We would like to present GEUS 3D database, where geological 3D models produced in different modelling tools of all scales and geometries can be archived. So, 3D models are archived in a common format, that may be read also in the future, when original model-files may have become outdated.

The development of GEUS 3D database has been coordinated with the development of the 3D database for the European Geological Data Infrastructure. The EGDI 3D database is a common facility for the european geological surveys to make their 3D models available for the public and the two databases share their data model and routines.

Along with the 3D database itself, an application has been developed to show whatever is stored in the database. Besides giving other geologists and consultants the opportunity to find and acquire existing geological models for re-use, this viewer application gives a broader audience an accessible version of current geological knowledge.

GEUS 3D database archives local models and as of now 2 national models. One of the national models is of the deep underground and the geological units important for the utilization of geothermal energy. The second national model is of shallow hydrogeological layers and is used, among other purposes in the management of groundwater in Denmark.

3D VISUALISATION OF GROUNDWATER QUALITY AND GROUNDWATER QUANTITY CONTRIBUTES TO SUSTAINABLE PLANNING AND PROTECTION OF GROUNDWATER

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A good understanding of groundwater systems is essential for weighing different interests relating to human uses that depend on the water resources. The Roer Valley Graben (RVG), a Dutch, Flemish and German transboundary area, contains an important aquifer system that is crucial for many uses, including drinking and industrial water supply and heat storage, as well as playing a role in the conservation of terrestrial and aquatic ecosystems. In H3O-PLUS, which is part of the Horizon2020 funded GeoERA RESOURCE-project, 3D visualisation of transboundary patterns of measured groundwater quality and groundwater heads has been realised, contributing to improved sustainable planning and protection of groundwater.

Two groundwater viewers were developed, one for groundwater quality and one for groundwater heads, bringing cross-border groundwater data together. In these viewers, the cross-border (hydro)geological 3D models were merged and subsequently used for interpretation purposes, relating groundwater properties to the subsurface hydrogeological structure. For example, water quality problems in eastern North Brabant, the Netherlands, can be visualised by showing the concentrations of various hydrochemical parameters (e.g. nitrate, sulphate, oxidation capacity) relative to the shallow Beegden and Sterksel Formations and the deeper Peize/Waalre and Kieseloolite Formations. The concentration differences between the formations can be analysed on maps, in cross sections and in different types of graphs.

Due to deterioration of water quality over the depth range of the formations mentioned, abstractions for drinking water supply were shut down or moved towards deeper aquifers in the Peize/Waalre and Kieseloolite Formation in the RVG. The increase in abstractions in these aquifers contributed to the decrease of groundwater heads, which is now visualized visible using the groundwater quantity viewer. This tool enables the easy identification of temporal trends in groundwater heads for individual observation wells. Moreover, the tool allows for aggregation of trends over larger areas, depth ranges and/or geological Formation are and visualizing them maps and cross-sectional views.

The two viewers enable the interactive viewing of hydrochemical and hydrological information in relation to the hydrogeological structure of the subsurface. By using the cross-border harmonised (hydro)geological models, this is even possible across national borders in the Roer Valley Graben groundwater system. Combining information from both the quality and quantity viewer, the tools enable establishing interdependencies between groundwater quality developments and quantitative water trends, thus supporting integral sustainable management and protection of the resource.

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OBTAINING A SOCIAL LICENSE FOR GROUNDWATER ABSTRACTION AT KURIKKA AQUIFER, FINLAND USING A COMMUNITY ACCESSIBLE HYDROGEOLOGICAL DATA AND SOFTWARE PLATFORM

Niko Putkinen, Ben Wood, Holger Kessler

Groundwater has a strategic importance in Finland, especially in western coastal areas that lack large groundwater bodies. The city of Vaasa is the capital of Ostrobothnia and struggles with sufficient access to clean drinking water, which is largely sourced from surface water. After the discovery in 2010 of a large buried valley aquifer system in the Kurikka region and from 2014 onwards research in the area is conducted in the collaboration the Water Services Public Utilities of Vaasa, (Vaasan Vesi), the Water Services Public Company of Kurikka, (Kurikan Vesihuolto OY) and Centre for Economic Development, Transport and the Environment in South Ostrobothnia (Etelä-Pohjanmaan ELY-keskus) and Geological Survey of Finland (GTK).

Geological surveys in the region have proved hydrogeological units interlink between bedrock faults, fractures and other structures, the topography of the bedrock surface and glacial deposits above. Buried valley aquifers are connected to high standing groundwater recharge areas covered by sands and gravels formed under the shoreline processes. The 50 - 100 m deep bedrock palaeovalleys are filled by multiple thick sand and gravel beds (aquifers) with till (aquitards) between them, and a marine clay/silt deposit forms an impermeable cap for the aquifer system. Due to the hydrogeological setting and the long route from the recharge area to the valley bottom the clean groundwater circulation and storage is big enough for Kurikka and Vaasa cities.

Meanwhile, the region of Kurikka is an important agricultural centre in Finland, due to a presence of clean and sustainable groundwater resource. A wide variety of agricultural products come from here, including organically grown produce. The local community have a strong connection to, and deep pride in their natural environment. Water is important for everybody and geologists need to convince people that extracting groundwater is safe and sustainable. So, the future challenge for the water companies therefore is not water treatment, but to demonstrate to the local communities and landowners that large water use and drawdown of groundwater will not adversely affect the local environment.

To assist with this, the Geological Survey of Finland have developed the concept of an accessible web system which will enable geoscientists and stakeholders to interact with the data and the model. On the backend, this system will store large volumes of time-series downhole water logger data ready for query, and support rapid queries into that data by location and by time via an API. In the user interface, the system will display live and historic groundwater level monitoring data in boreholes, cross-sections and maps, putting the data in context with real world geological features. The system will link to work done in collaboration with the British Geological Survey using the Groundhog software, which contains a useful modelling engine, and is now open source. The system API will be made compatible.

HEADING TOWARDS INTEGRATION OF 3D DATA FOR MUNICIPALITIES – GEOCIM TRIAL FOR LIBEREC CITY

Zita Bukovská, Jan Jelének, Lucie Koucká, Ondřej Švagera

With growing demand for underground use in urban development, the lack of knowledge about an underground arises as a significant problem in some areas – typically cities with long history. The development and usage of a 3D modelling with ongoing cooperation between the City of Liberec and the Czech Geological Survey led to a pioneering project on "geological" near-surface city information model of small testing area within Liberec city centre.

The general idea of the project was to establish urban underground 3D data exchange between geological surveys and cities which will be supported by development of 2D and 3D data visualization and exchange platform. Such model should give full power to the municipalities to display all underground data provided by the geological survey and work with them on daily basis. 3D model of a city should comprise all available archive data, together with new interpretation of such data. It should also feature important engineering networks, such as sewage system, water and gas pipelines or historic underground structures. Revealing the conflicting natural and man-made elements helps to make city management and urban planning safer.

Data available in archive of the Czech Geological Survey (boreholes, geological maps etc.), Museum of Northern Bohemia (underground works etc.) and the City of Liberec (data from urban planning department) were pre-processed and integrated together with modelled geological structure based on geological expertise and modern history findings. The 3D geological model was built in MOVE software with high stress on near-surface in order to show possible spatial interactions of man-made structures with water level, tectonic faults and other potentially problematic objects.

In order to allow the local municipality to use the 3D model a QGIS-based environment was used to prepare a license-free 3D environment with a possibility to obtain subsurface data directly at a specific point. These data are derived from the meshed 3D model into planar point-based grid , which can be easily opened by urban planners in GIS software.

In scope of these topics in cooperation with colleagues from Norwegian geological survey – supported by the Norway Grants – promotional video on this topic was made to raise public awareness and knowledge on underground.