Expanded use of superficial deposit information in local government with geographical information systems

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Introduction

NGU has recently put a great deal of effort into customising basic geological data for target groups such as local planners and politicians, aware that such information is vital for high-quality decision-making within local government. Although many public policy decisions and commercial enterprises require earth science information, experience shows that geological maps and data are not used to their potential due to poor presentation using scientific terms which are hard to understand for non-geologists.

This article describes working strategies and some results from a two-year pilot project within the Nord-Trøndelag og Fosen geological programme. The focus of the project has been to transform data from NGU's geological map series and databases into digital geological information (Ryghaug 1992). The objective has been to supply Nord-Trøndelag county in Central Norway and its municipalities with both regional and more detailed digital geological and environmental information for use in local government resource and areal planning (Fig. 1). The article gives some examples as to how thematic information in connection with superficial deposits can increase the quality of decision-making within local government by using a geographical information system (GIS). The aim of this article is not to give a full understanding of the technical concepts relating to GIS. For this it is necessary to study the abundance of literature on this subject (Bernhardsen 1992 and many others).

Data capture and data quality

Geological maps and database information vary widely in detail and age. To be able to produce a complete superficial deposit map covering whole municipalities, it was necessary to use an assembly of map sheets with different origins, scales and quality (Fig.2). Boundaries from the national series of colour Quaternary maps were scanned using an Intergraph system, and preliminary maps and script maps were digitised with FYSAK (software from the Norwegian Mapping Authority). Digital Ordnance Survey base maps (coastline, water systems, administrative boundaries, roads, etc.) were based on the topographic map series from the Norwegian Mapping Authority, and all coordinates were captured in the same coordinate system (UTM zone 32 and datum ED50). Together with additional point source attribute tables (groundwater wells and deposits of sand and gravel aggregates) primarily stored in databases, all data were transferred to the ARC/INFO geographical information system.

Bringing together datasets from different sources and with potentially different levels of data quality (varying scale-related data collection, maps with different status and age), calls for stringent data quality description and metadata (data about data). It is important to include such descriptions in direct connection with the spatial coverage features themselves in order to satisfy most queries about the reliability and suitability of the information for a particular purpose. Looking at the arcs showing the superficial deposit boundaries for one of the municipalities (Fig. 2), it is possible to make drawings based on the different origin of map scale in the dataset. The right sub-window shows the possibilities of controlling/handling the updating of the information. Updated boundaries not equal to the joined source maps are drawn in black, and the date of the updating is also stored. In the same way, a variety of data quality information can be investigated. The map data file will increase by approximately 25-30% in this quality control, but it enables a higher standard of GIS analysis, and decisions based on the combination of information will be more reliable.

Geological information

Due to different grades of data generalisation, it is important to create data with different map scale origins (Fig. 1). Whilst the regional view of the superficial deposits of the Nord-Trøndelag area is based on data created from the Quaternary map of Norway at a scale of 1:1 million.(Thoresen 1991), the municipality map is derived from maps at a larger scale (1:50,000 or 1:20,000). From these Quaternary maps, derivations were made of; (1) the effluent (sewage) infiltration capacity of the deposits; (2) the possibility of finding groundwater resources and; (3) sand and gravel resources.

An *infiltration map* is suitable as an aid in fin-

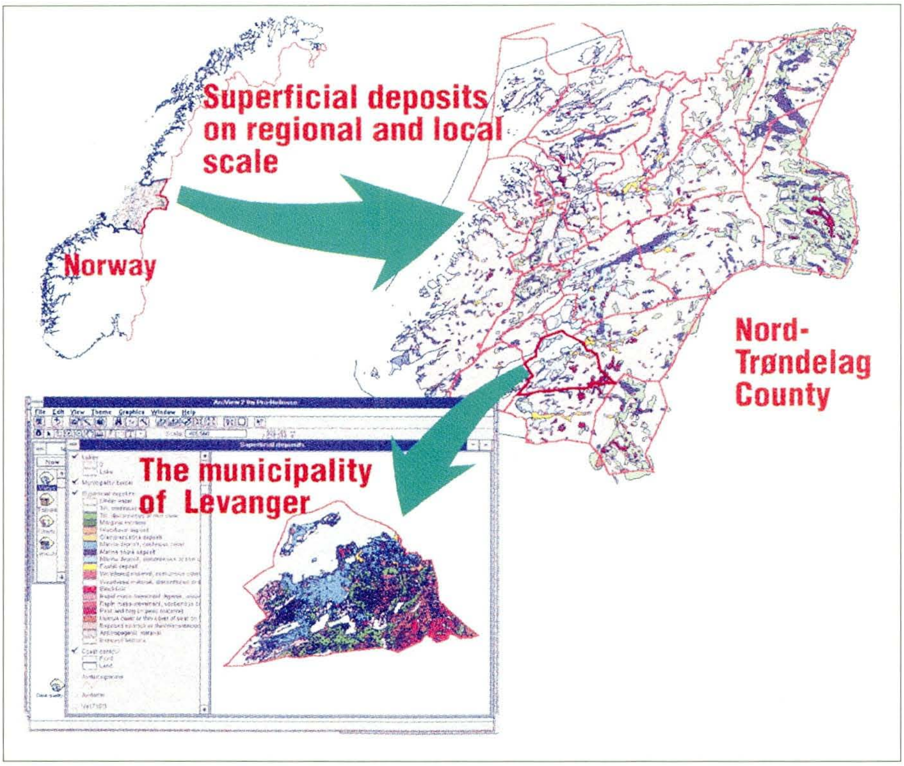

Fig. 1. Digital information on superficial deposits in Nord-Trøndelag County has a regional scale based on the 1:1 million Quaternary map of Norway. For each municipality the information is based on larger scale Quaternary maps (scales 1:20,000 and 1:50,000).

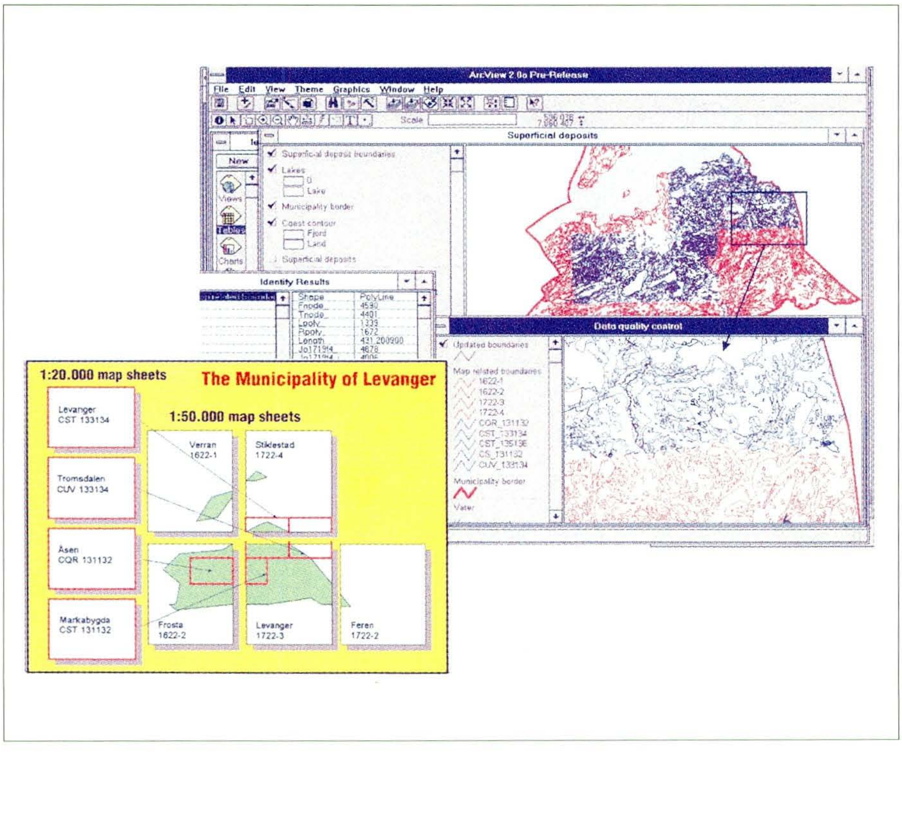

Fig. 2. The digital version of a municipality map, showing the distribution of superficial deposits, contains an assembly of map sheets with different scales and age. Quality control is built in and describes the origin of each line (boundary) and can be investigated in ArcView display windows (red lines from 1:50,000 scale maps, blue from 1:20,000 scale maps, and black show which line has been updated in relation to the original map).

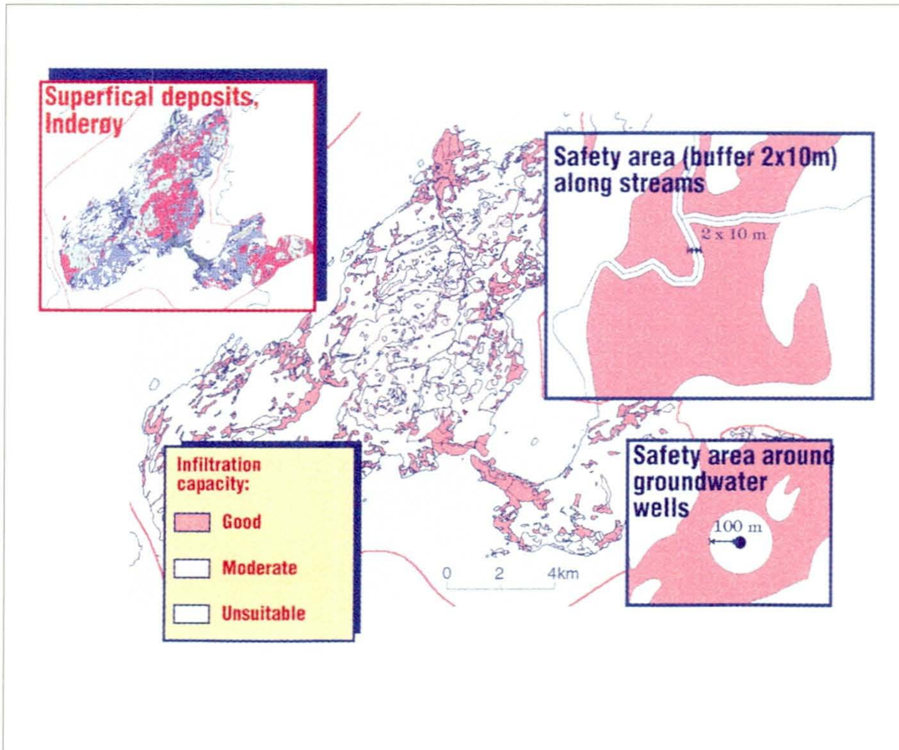

Fig. 3. Built-in derivation functionality in the dataset transforms the superficial deposit map into an infiltration capacity map. Such information aids the derivation of more cost-effective solutions concerning the clean up of effluent in sparsely polluted areas. Buffer zones are included around streams and groundwater wells for safety reasons.

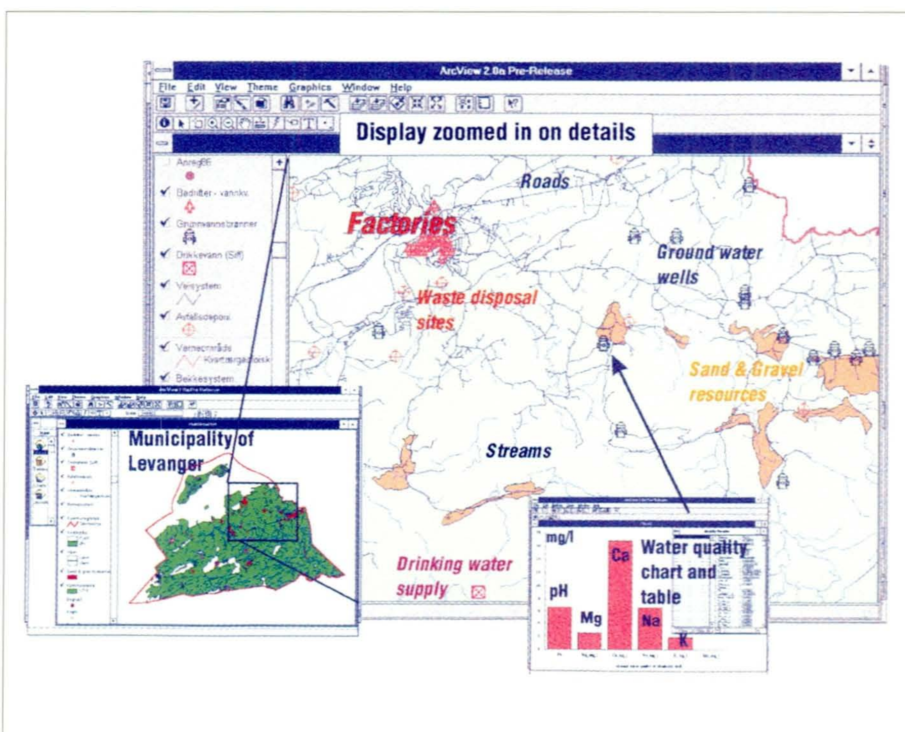

Fig. 4. Views, tables and charts are opened and queried simultaneously. In this decision-making framework, it is possible to assemble all relevant information concerning the demand for better drinking water quality.

ding deposits with a suitably high effluent infiltration capacity. On the infiltration map of Inderøy municipality (Fig. 3), the superficial deposits are divided into four classes of infiltration capacity (very good, good, moderate, unsuitable), mainly based on thickness and permeability of the deposit. However, no deposits classified as very good capacity are shown in this figure. As a large proportion of sewage is still released into the environment in a raw state (even close to deposits suitable for infiltration), the infiltration of effluent into suitable superficial deposits has proved to be a simple and a cost-efficient method instead of the building of expensive cleaning plants. Detailed infiltration capacity mapping on a scale of 1:5,000 within the municipality of Inderøy (Hilmo & Sveian 1993) shows an acceptable accordance with the derived map and test soil-cleaning plants show good results. Extrapolated for the whole municipality, savings of NOK 5-10 million. could be made in this tiny municipality alone.

A register for *sand and gravel aggregates* is now being transformed to an Oracle database (Neeb 1993). During this GIS project, adjustments of the sand and gravel database (including standard coding and qualitative classification) have been made to satisfy the requirements of a GIS product. In Fig. 4, some of the sand and gravel resources in the municipality of Levanger are shown in orange. These deposits commonly represent a groundwater resource as evidenced by the location of several groundwater wells (shown as black hydrants).

In the same way as for the infiltration map, a derivation map has been made illustrating the potential of finding *groundwater resources* within the superficial deposits. The largest abstractions of groundwater are generally assumed to occur in large fluvial, glaciofluvial and shore deposits, whilst more limited abstractions usually occur in smaller/thinner deposits of lower permeability.

Assembling information relevant to a resource planning assessment (such as existing water supply, groundwater wells, streams and sand and gravel resources), the water supply potential of an area can be estimated. In Fig. 4, factories which demand better water quality are also shown. The environmental impact is illustrated by the marking of features such as waste disposal sites, contaminated ground (Misund et al. 1991), traffic routes with hazardous waste and even deposits earmarked for the infiltration of effluent (not shown on this figure), i.e. all features representing a risk to groundwater quality. The water quality of a specific well can then be investigated in sub-windows containing tables or charts (Fig. 4).

The use-friendly interface

While use of the ARC/INFO system demands specialisation, ArcView desktop GIS can be used by almost anyone after a short introduction. ArcView can be run under MS Windows. Themes can be switched on and off by clicking on the left of the theme name. It is easy to zoom in and customise a map display (layout) for final presentation and export it in a wide range of formats. All illustrations (figures) shown in this article are made in ArcView. Selections can be made by geographical search and attribute search. It is possible to display the results in a view, table and chart simultaneously. A dynamic link can be established between the spatial data and other databases such as Microsoft Access or Oracle. One can combine fields from more than one table and make queries with a one-to-many relationship. ArcView contains a geographic Hot Link capability that allows various types of datasets (pictures, videos) or programs to be attached to geographic features and initiated on request. It has essentially become a multimedia approach.

Using a GIS system and a desktop GIS interface on the geological information has undoubtedly made raw scientific data more available to non-specialists in local government. It has strengthened strategic decision-making, preventing resource- and land-use conflicts, and contributing to better resource exploitation.

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