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Groundwater quality mapping in the Belgian and Dutch provinces of Limburg and Liège : availability of data and methodology

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Abstract

In the scope of an INTERREG project supported by the 'Stichting EUREGIO Maas-Rijn' in Maastricht, transboundary groundwater quality maps in the province of Liège, Dutch Limburg and Belgian Limburg have to be completed. It will be the end-product of investigations and work of three teams : LGIH University of Liège, LISEC Genk supported by the Ministry of the Flemish Region (AMINAL) and NITG-TNO Delft. The project was started in June 1997 and by now, first results in terms of availability of data and about the developed methodology can be described.

The four-step methodology comprises: (a) hydrogeological schematisation, (b) collecting existing groundwater quality data, (c) data quality control, and (d) additional sampling and analysis. Data are stored in databases and maps will be created using GIS.

Introduction

Large parts of the provinces Belgian Limburg, Netherlands Limburg and Liège (fig. 1) are located insite the hydrological basin of the River Meuse (Maas) so that large amounts of water from rainfall are channeled by the surface-water network or groundwater systems to the Meuse. There are no important natural boundaries between the three concerned provinces. The regional hydrological system - including surface water as well as groundwater - shows important transboundary aspects and groundwater quality in the main aquifers is undoubtedly one of them.

Data collection is intended to lead to the creation or improvement of databases to be used for groundwater quality maps. It is the intention to show general waterquality aspects of the main aquifers but also the possible anomalies in order to better understand the consequences of possible contaminations. The hydrochemical maps will be useful for decision makers as well as for public institutions and scientists.

Hydrogeological schematization

First of all, hydrogeological schematization and dressing of cross-sections (fig. 2) were constructed in the entire area to understand the continuity between the different geological layers and to correlate the different formation names.

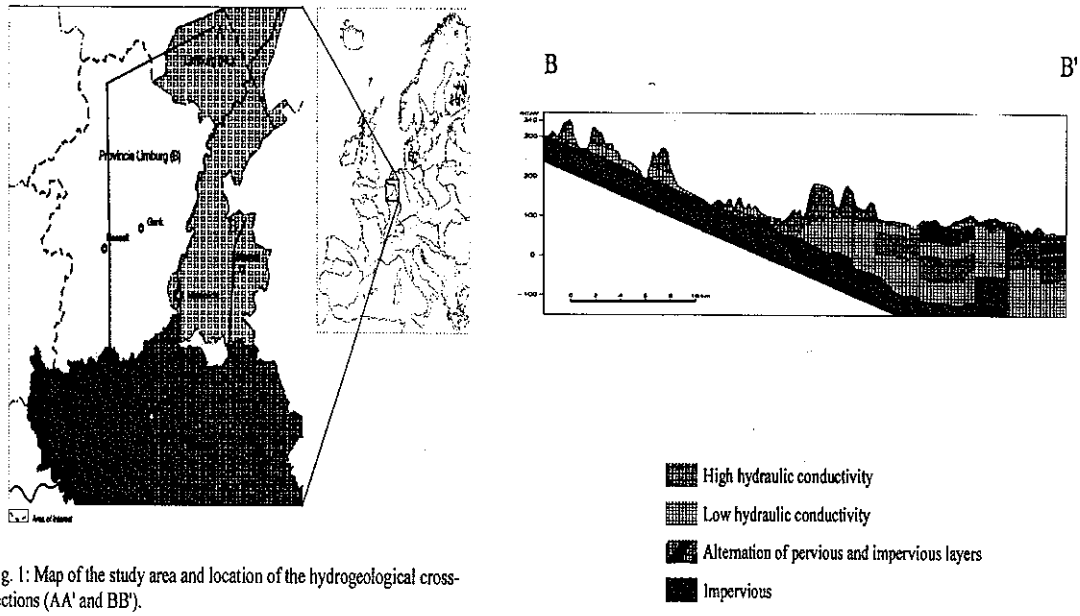

Fig. 1: Map of the study area and location of the hydrogeological cross-sections (AA' and BB').

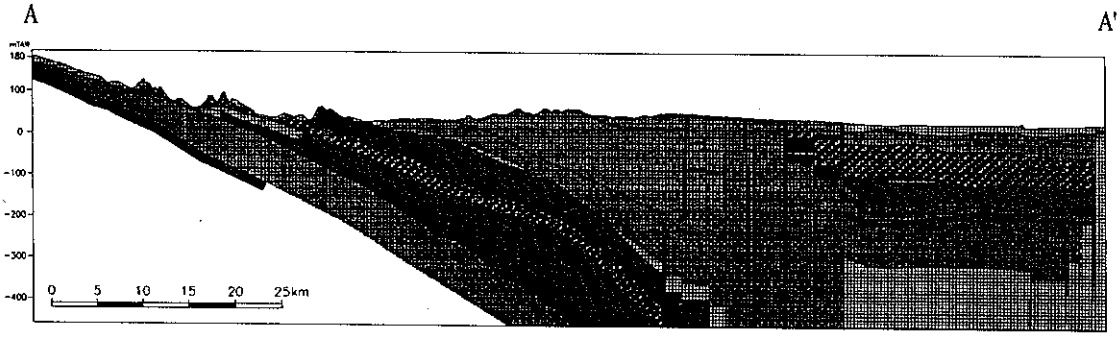

Fig. 2: Hydrogeological cross-sections AA' and BB' showing the main aquifers for which groundwater chemical data are collected.

In the area concerned, the main aquifers where continuous transboundary hydrochemical trends are expected are : (a) the chalky aquifers of the Cretaceous, (b) the sandy-silty formations of the Paleogene (Paleocene, Eocene and Oligocene) and Neogene (Miocene and Pliocene), (c) the Meuse alluvial sediments including all terraces of the Quaternary.

Collection of existing data

A second step is collecting existing groundwater quality data from different sources. Groundwater quality data are until now scattered between Ministries, public and research institutions, public and private water companies. In Belgium, the water policy is now under the mandate of the Regions (Flemish and Walloon Regions).

For the Province of Belgian Limburg, the main providers of data are AMINAL (Flemish administration for environment, nature and land-infrastructure), the VMW (Flemish company for drinking water supply) and the BGD (Belgian Geological Survey).

For the Province of Liège, the main providers of groundwater quality data are the two public water companies, the SWDE and the CILE. Data are also available at the Ministry of the Walloon Region. On the other hand, the LGIH possess some specific data in the Meuse alluvial sediments (chemical analysis carried out during pumping tests). Other data are also collected from private companies.

For the Province of Netherlands Limburg data are mainly provided by the RIVM (National Institute of Public Health and Environment), the Province of Netherlands Limburg, N.V. Waterleiding Maatschappij Limburg (Water Supply Company Limburg), N.V. Nutsbedrijven Maastricht (Water and energy supply of the city of Maastricht) and N.V. Waterleidingmaatschappij Oostelijk Brabant (Water Supply Company of east Brabant). Furthermore miscellaneous data are obtained from industries and various geohydrological studies, partly carried out by NITG-TNO. The list of considered chemical parameters will allow to obtain an idea about (Broers 1996): (a) the groundwater general characteristics (Cl^-, HCO_3^-, Na^+, Ca^{2+}, Mg^{2+}), (b) acidification (pH, Al^{3+}), (c) overfertilisation (K, PO_4, NO_3 and redox parameters Fe^{2+}, SO_4^{2-}, NO_3^-, O_2) and (d) other contaminations (Zn^{2+}, Cd^{2+}, AsO_n, ...).
Even if it is not the priority of the project, time variation in all these elements/parameters will be taken into account for helping to possible eventual trends in time, in relation with the groundwater flow pattern and anomalies.
For a reliable interpretation, additional data may be collected concerning local land use, soil type, surface water locations and characteristics, exact depth of the screens within the aquifer, etc.

Quality control of groundwater chemical data

A third step is data quality control. A data quality index is calculated, based on four controls that are currently being used in the groundwater database of NITG-TNO (Meer *et al.*, 1998):

(a) the cation/anion balance : a positive number means that either there are excess cations or insufficient anions in the analysis, whereas a negative balance indicates the opposite. A reasonable balance for routine analysis is generally considered to be less than 5%. So when the balance exceeds 10%, particular attention will be given to the reliability of the analysis. As mentioned by Deutsch (1997), several possible reasons, alone or combined, can cause an electrical imbalance in the reported data : (1) the design of the sampling program neglected a major dissolved species, (2) laboratory errors, (3) using unfiltered water samples that contain particles that that dissolve in the sample when acid is added for preservation purposes, (4) the precipitation of a mineral in the sample container, and (5) the dissolved species of the element or compound may not correspond to the typical species used in making the ion balance calculation.

(b) the comparison between calculated and measured electrical conductivity. When a difference higher than 20% is found, additionalchecks are needed.

(c) test on extreme values. If a measured concentration is far higher (i.e. three times higher) than the expected maximum for this species, additional checks are required.

(d) test on unrealistic combinations of elements. The unrealistic arrangement of elements are found out as for example : (1) unrealistic combinations of pH and CO_3/HCO_3 ratio ; (2) unrealistic combinations of pH and Mg + Ca ; (3) unrealistic combinations of pH and Al ; etc.

The data quality index is a four digit number giving respective information for each of the four above mentioned tests. This index is stored as a separate number and is used to select unreliable analysis data to exclude them from further evaluation.
Hydrochemical data taken from 'too old' wells or wells where different aquifer beds are not screened separately will be excluded as well.

Additional data

After collecting all available data, additional sampling and analysis will be performed during the years 1998-1999 in areas where the density of reliable data is unsatisfactory. A complete chemical analysis will be performed for each additional sampling point.
Collected data are stored in a database; the design of the databases used by each team should facilitate exchange of data. Maps of the data will be created using an Arc/Info GIS.

Expected results

The result of this INTERREG project will consist in the publication of an interpretative report together with 1/100000 thematic integrated maps of the groundwater quality in the different aquifers of these three provinces. The maps and reports will be available in July 2000 and will be 'public domain'

documents. However, the access to the databases for consultation will be in reserved in principle to the providers/owners of the data. Other accesses will probably be strictly réglemented.

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