INTEGRATED GEOSPATIAL SOFTWARE PLATFORM FOR URBAN GROUNDWATER

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INTRODUCTION

Urban population growth (for 2050 is foreseen that the urban population will be around 68.7% of total population - UN,DESA, 2011) implies a grater consumption of resources (natural or processed) like: electricity, gas and oil products, food and water. As consequence, the urban water management become an important aspect of urban sustainable development planning (Sanchez-Villa, 2002). A large number of urban areas are located in the flood plains of the rivers therefore the geological structure is porous - permeable (sedimentary). Sedimentary media are normally significant aquifers due to their high permeability, storage capacity, interaction with surface water, etc. (Gogu et al, 2011).

Due to the large amount of civil work projects and investigation studies, large quantities of geo-data are produced for the urban areas. These data are usually redundant and spread between different institutions or private companies. Time consuming operations like data processing and information harmonisation represents the main reason to systematically avoid the re-use of data. The urban groundwater data shows the same complex situation due to the fact that the urban elements like underground structures (subway lines, deep foundations, underground parkings, and others), urban infrastructure networks (sewer systems, water supply networks, heating conduits, etc), drainage systems, surface water works and others shows a continuous modification. Due to the rapid evolution of technology in the past few years, transferring large amounts of information through internet has now become a feasible solution for sharing geoscience data. Furthermore, standard data transfer instruments have been developed. They allow easily updating and sharing through internet large geospatial databases between different institutions that do not necessarily use the same database structure. For Bucharest City (Romania) an integrated platform for groundwater geospatial data management is developed under the framework of a national research project.

PLATFORM ARCHITECTURE

The software platform architecture is based on three components (*Figure 1*).

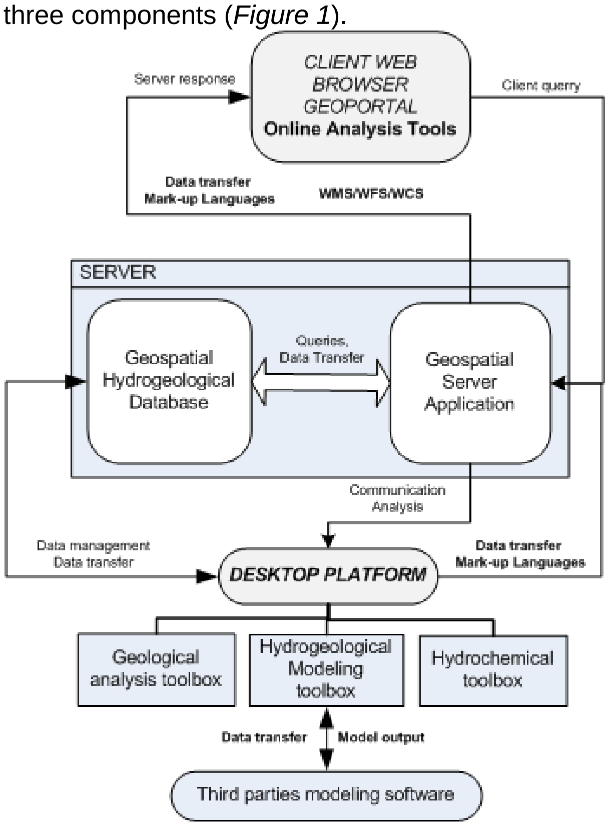

Figure 1 – Software platform architecture

The first component and the core of the platform is the hydrogeological geospatial database and the geospatial server application. The design of the database follows an object-orientated paradigm and is easily extensible. A large spectrum of data is stored in the database (geology, hydrogeology, topography, urban infrastructure, etc). The geospatial database is connected to the desktop platform application and to the geospatial server, so data management and data publishing it is easily made. The geospatial server application allows the communication between the client side application (geoportal), the geospatial database and the desktop platform component. Communication is standardized through a series of services (WMS-Web Map Service, WFS-Web Feature Service, WCS-Web Coverage Service) and mark-up languages (*GML*-Geographic Mark-Up Language, *GWML*-GroundWater ML, *GeoSciML*-GeoScience ML, CityML-City ML).

data: hydrochemical parameter statistics (univariable, bivariable,analysis), geostatistics (using GSLib library), general chemical diagrams, charts and maps (Stiff Map, Wilcox diagram, Ionic Balance, Piper Diagram) and a series of parameter orientated maps.

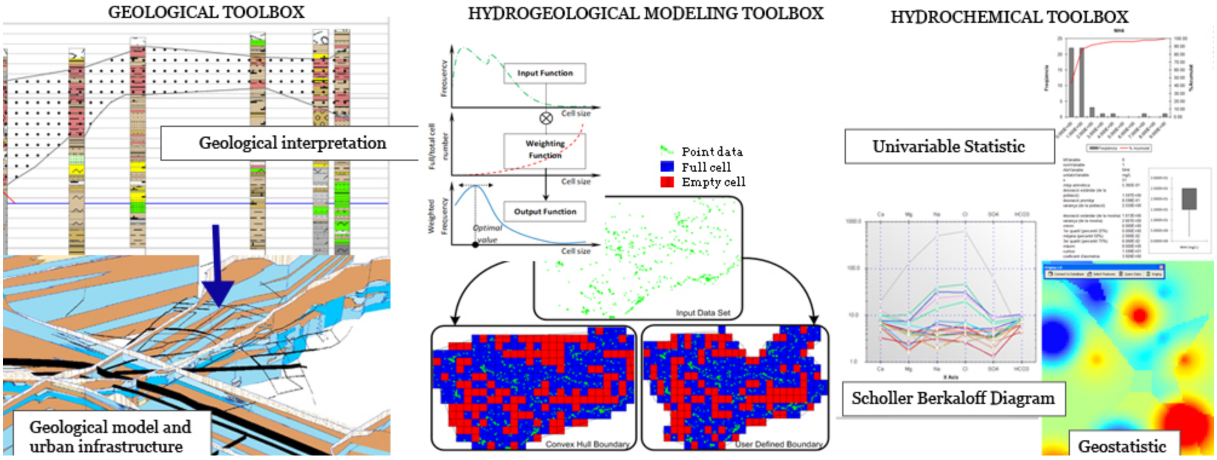

Figure 2 – Software platform toolboxes

The second component is the client side, a geoportal application capable to publish hydrogeological data and to make preliminary analysis (statistic, buffer, intersections) and geospatial queries. The geoportal service offers the possibility of querying a dataset from the spatial database. The query is coded in a standard mark-up language and send to the server to be processed by the local application. After the validation of the query the results are send back to the user to be displayed by the geoportal.

The last and the most developed component is the desktop platform. The desktop platform is designed to be used by specialists and researchers. The platform is developed under a GIS framework (ArcGIS). The main tasks are: (1) geospatial data management and (2) modelling and analysis of different urban groundwater scenarios. Therefore under the ArcGIS framework a series of toolboxes are developed (geological analysis, hydrogeological modelling toolbox, hydrochemical toolbox). Because of the plug-in GIS framework new toolboxes can be added, depending on specific needs.

The geological toolbox allows the specialist to manage litology, geophysical, and petrological data. Analysis such as: borehole diagram, geological cross-sections, defining hydrogeological units, can be easily made and exported in 2D and in 3D environment (geological fence diagram). The toolbox also allows the user to have a preliminary interpretation of the hydraulic conductivity based on geological settings (lithology, sorting, grain size, matrix).

The hydrochemical toolbox performs a series of hydrochemical analysis for groundwater quality

The third toolbox is an interface between the platform and other third parties software (such as GMS - Groundwater Modelling System). Data from the geospatial database are exported to the modelling software and the outputs of model can be imported back to the platform. Beside the communication capabilities, the toolbox can generate an optimal cell-size modelling grid on the basis of the hydrogeological data spatial distribution. Starting from the discontinued point data (distributed randomly, uniformly, or clustery over a spatial domain), the algorithm is developed to find the optimal cell size by increasing the number of cells containing at least one data point.

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REFERENCES

GOGU R., VELASCO V., VASQUEZ E., GAITANARU D., CHITU Z., BICA I. (2011) - *Sedimentary media analysis platform for groundwater modeling in urban areas*, Advances in the Research of Aquatic Environment, Vol 2, Springer Verlang, ISBN -978-3-642-24076-8, Berlin,2011

SANCHEZ-VILA, X. (2002). *Urban hydrogeology-Enciclopedya of Life Support Systems - Groundwater*.

UN, DESA. (2011). United Nations, Department of Economic and Social Affairs, Population Division, Population Estimates and Projection Section: http://esa.un.org/unpd/wup/index.htm