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Government of the People's Republic of Bangladesh

Final Report
ON
Development of Deep Aquifer Database and
Preliminary Deep Aquifer Map
(First Phase)

Department of Public Health Engineering
With Support From
Arsenic Policy Support Unit, DFID Bangladesh
JICA Bangladesh

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EXECUTIVE SUMMARY

This consultancy for support to DPHE in preparing a deep aquifer database and a preliminary deep aquifer map was undertaken with support from DFID and JICA. The final report presents the details of activities carried out in the project during the period July 2005 to March 2006.

The project started with the evaluation of borelogs stored at the Research and Development Division (R&D) of Department of Public Health Engineering (DPHE). International Expert for the project along with a DPHE Hydrogeologist visited various field offices of DPHE to collect more borelogs. All together more than 2500 borelogs were collected from various DPHE sources. In addition to DPHE, contacts were also made with BWDB, GSB and BADC for deep borelogs. Only BWDB provided more than 100 deep borelogs for the study, no logs were made available from BADC and GSB. Therefore, this database of 2500 borelogs is composed mainly of DPHE borelogs along with water quality (Arsenic, Iron, Chloride, and Manganese) analyses results from about 1000 deep tubewells. A second database of water quality (As, Fe, Cl), consisting of analytical results of about 6000 deep tube wells, were also collected from the DPHE Zonal laboratories.

Strict data checking procedure was adopted to filter out the poor quality data. This was done firstly by the data entry geologists and secondly, when needed, by the consultant. The field description of each borelog was first entered into excel spread sheet, keeping the all smaller lithological units. This was subsequently converted to hydrostratigraphic sequences by grouping sandy and clayey sequences into aquifers and aquitard, for making hydrostratigraphic cross sections and maps.

The project started with a huge pile of paper records without proper geo-reference for the individual borelogs. Such geo-reference is vital for any kind of mapping. For mapping a unique ID was assigned to each borelog based on the BBS Mouza geocode. Afterwards geo-references in terms of latitude and longitude were extracted from Mouza GIS layers using BTM Projection.

The term deep aquifer is used in a number of different ways in Bangladesh which makes it difficult to define it properly. To overcome such difficulties, deep aquifer is defined in this study as deeper Holocene/Late Pleistocene/Holocene aquifer separated by one or more sufficiently thick (~10m) clay/silty clay aquitard or Pleistocene Dupi Tila aquifer overlain by Pleistocene Clay or separated by Holocene clay from the alluvial aquifer. In the coastal region the Pliocene Tipam formation may also serve as the deep aquifer. It is also conceived in this study that there should not be a fixed depth attached to the definition of deep aquifer. However, it is possible to assign depths on local scales, such as village/union/upazila level, based on the local subsurface geological conditions.
Although a chronostratigraphic approach is better way of making aquifer maps, due to lack to good quality borelogs with correct stratigraphic information it was not possible to produce any such map under this study. However, based on the experience of JICA study in Jessore region, attempts have been made to prepare a number of chronostratigraphic sections in NS orientations for the Jessore-Khulna region in south west Bangladesh. Though various different classifications schemes are there for the aquifers of the country, there is a need to revisit the classifications and adopt a chronostarigraphy based aquifer classification for the country.

RockWorks 2004 software, specialized in visualization of subsurface data, has been used for aquifer mapping in this project. This has been integrated with GIS to produce sections, fence diagrams, 3D aquifer models etc. Most probably, this is first time 3D geological modeling is used for aquifer mapping in Bangladesh. The borehole data manager is used for storing well data. Print and export tools are used to take the RockWorks images into reports and presentations.

Initially it was planned to generate national scale deep aquifer maps. The absence of adequate number of bore logs over most of the northern parts of the country does not allow such mapping. Instead of national scale mapping, regional scale mappings have been performed for the southwest Bangladesh where maximum numbers of deep borelogs are available. Four separate clusters consisting of Khulna-Jessore, Barisal-Patuakhali, Comilla-Noakhali and Greater Faridpur areas were selected to prepare preliminary deep aquifer maps. The models constructed for the four regions show the presence of deep aquifer separated by thick aquitard at varying depths. There are considerable local variations in the depth and thickness of the deep aquifer within each region. A higher data density with uniform distribution is needed to address such variability. Apart from regional scale mapping district scale mapping have been performed for Jessore, Satkhira, Khulna and Comilla districts. The constructed models show wide variations in the occurrence and distribution of the deep aquifer. In number of cases the lack of borelogs after certain depths constrained the deep aquifer mapping. Upazila scale mapping has been conducted only for Hajiganj of Noakhali district where the model shows the presence of deep aquifer all over the upazila separated by a thick aquitard. Such 3D aquifer models on district and Upazila scale can be found useful for planning purpose. If enough data is available this can be taken down to union scale.

It is very important to assess the quality of the deep aquifer groundwater before going for large scale installation of deep wells. There exist considerable amounts of water quality information on the deep aquifer. The bulk of the data, with some reservations about the accuracy, show deep aquifer water quality is good for drinking purposes in terms of Arsenic (80 and 90% within WHO provisional limit; 98 and 100% within Bangladesh limit as per two data sets consisting of 820 and 6055 deep tube well respectively), Chloride and Iron. However, a large number of wells (10 to 20%) included in the present database have been reported to contain arsenic above the WHO provisional guide line value. Previous investigation, such as the BGS & DPHE (2001) reported arsenic concentrations in most deep wells below the WHO provisional limit. As there are uncertainties about the quality of analysis collected from the DPHE Zonal Laboratories, 100 deep tube well water samples were collected under this project for cross checking. The samples were analyzed at the Environmental Engineering Laboratory of BUET. The analytical results show that As concentrations in 85% of the samples are below WHO provisional guide line value and only 5% exceeded the Bangladesh standard. These results are consistent with previous investigations such as the BGS & DPHE (2001). Also the larger number of samples reported by the DPHE Zonal Laboratories to have arsenic concentrations above the WHO limit from the Comilla-Noakhali region found to be inconsistent. However, there is a need for regional deep groundwater quality investigations covering a large number of samples and quality parameters. While
collecting samples for such investigations the depth of the well should be checked as well to avoid incorrect information about the deep aquifer water quality.

It is evident that DPHE is the largest storehouse of borelog data on the deep aquifer in the country. However, inaccurate recording makes use of the data difficult for mapping purposes. To overcome the issue, a standard log format with all relevant information including sediment color should be used from now on. Also though there are thousands of deep tube wells in the country, in most cases the borelogs are not available. DPHE should collect and preserve geological borelog for all deep wells. DPHE field level personnel need training in these aspects.

There are information gaps regarding the various aspects the deep aquifer including geology, water quality, and hydraulic properties. It is not possible to make any recommendation regarding the use of the deep aquifer without all these information. A systematic deep aquifer investigation project should be undertaken to overcome this difficulty. Until such a study is conducted the deep aquifer groundwater should be used cautiously.

It is possible to install some monitoring network using DPHE growth centre investigating test wells. As all existing monitoring of groundwater is based on shallow aquifers, it is urgent to develop a monitoring network for water level and quality of the deep aquifers. Proper understanding of the deep aquifer flow system is not possible without such a monitoring network. In certain instances the deep groundwater can be of trans-boundary nature.

It is possible to generate various different types of maps and sections using the software. Time was limited for this project to try all these. DPHE R&D Division can take this further by continuing these activities. Also they can update the database continuously by adding borelogs from various different sources along with their own data. Necessary manpower with hydrogeological background should be engaged for this purpose.

A national archive of deep geological logs needs to be set up. Logs from all concerned agencies like DPHE, BWDB, BADC, GSB, WASA, and private drillers should be preserved at this archive. Some kind of legal provisions can be made to make it mandatory for anyone drilling a deep well to record the geological borelog and deposit it to the national archive with proper location information.
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