

GOVERNMENT OF NEPAL
MINISTRY OF IRRIGATION
GROUND WATER RESOURCES DEVELOPMENT BOARD
BABARMAHAL, KATHMANDU, NEPAL

GIS Based Updating of Groundwater Level

Siraha District

Final Report

Submitted to

Ground Water Resource Development Board (GWRDB)

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Submitted by



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EXECUTIVE SUMMARY

Groundwater (GW) is one of the most important sources of water for Nepal. Its extensive use in Terai region and Kathmandu valley has highlighted the importance of its study. GW systems are all the time adjusting with respect to changes in climate, ground-water withdrawal, and land use. The Groundwater Resources Development Board (GWRDB), which is the sole organization responsible for monitoring GW in Nepal, has been collecting GW data since 1996 from the different Terai districts of Nepal. The United Nations Department of Technical Co-operation for Development (UN/DTCD) and GWRDB initiated a project in 1987 to investigate the shallow GW resources of Terai districts. Siraha district was one of these districts. With the limited quantity of pumping test data during the project, the transmissivity of the shallow aquifer in Siraha district was estimated between 36 and 1214 m²/day with an average value of 669.4 m²/day. Hydro-geological assessment has estimated that Siraha district has 274 million cubic meters (MCM) of annual recharge. Water level contour map revealed the general flow of GW from north to south with a gradient of about 5.7 m/km in the north and about 1.43 m/km in the south. According to the GDC report annual groundwater fluctuation of shallow aquifer is in the range of 2 to 12m in this region, the average being 7mbgl. Similarly, average percentage of aquifer 40mbgl is 30 percent.

As substantial analysis of GW condition was missing since a long time, GWRDB intends to develop a GIS database for GW level with respect to the abstraction, change in climatic condition and other natural and anthropogenic causes. Such a database is expected to be an integral component within the GWRDB. The GWRDB intends to carry out the study in Siraha district as a pilot project. Siraha district is one of the richest districts from the groundwater availability and development perspective. With this backdrop, the consulting services for "Updating of groundwater GIS database of Siraha District" was awarded to Water Modeling Solutions Pvt. Ltd. (WMS) by GWRDB. WMS is pleased to submit this Final Report after timely and successful completion of the assigned task.

The main objective of the study is to assess the inventory of the different types of wells (shallow, deep, monitoring, etc.) in the district and to prepare and update a GIS database of the same. In addition, examining the trend of change in historical observed GW level data and updating its status is another objective of this assignment. Similarly, delineation of Bhabar zone in the district based on desk study is another objective of the study. The methodology adopted for this consists of four major steps: 1) literature review and data collection, 2) field verification, 3) water level data analysis and development of GIS database and 4) delineation of Bhabar zone within the Siraha district based on desk study. Geospatial technology has been popularly used in deciphering groundwater potential zone as it produces important information on geology, geomorphology, and lineaments slope in cost-effective way. Integration of such data in a systematic way with the help of hydrogeological investigation can provide a very good delineation of groundwater potential zones. The GIS data was acquired from the Department of Survey (DoS), Government of Nepal (GoN), the climate data from the Department of Hydrology and Meteorology (DHM), GoN and others from relevant sources.

Mainly two types of deposits are found in the Siraha district- Bhabar zone deposits and Terai Plain deposits. Terai plain deposits are thick sequence of clastic sediments deposited by the major rivers. The depositing materials are eroded from the Siwaliks hills and the mountains to the north. These deposits cover about 750 km² in Siraha district with a thickness of more than 2000 m. These deposits are also the major recharge source to the groundwater reserve. These deposits comprise more clay, silt and fine sand than sand and gravel. The aquifer in Siraha is recharged primarily by precipitation percolating directly through the soil and rock materials on the surface to the water table. The Bhabar formation comprising boulders, cobbles and gravels as piedmont deposits occurs all along the southern slope of Siwaliks as a distinct belt, varying in width between 3 and 24 km. The actual dimension of the Bhabar zone is controlled by the flow regime, energy and catchments size of the river entering into it. Since the flow regime is continuously changing in this zone, the width of the Bhabar zone is not continuous throughout the Nepal Terai. Its presence is determined by historic flow of the rivers. A spring line is usually seen to separate the Bhabar from the Terai. The Bhabar zone is particularly receptive to direct percolation to the water table because of the large size of the particles constituting the deposits. However, the Terai plain is also receptive to direct percolation of precipitation to the aquifer.

A total of 44 shallow tubewells (including monitoring wells) have been installed in Siraha district at different times. Some were installed by the UN/DTCDD project, some by the GWRDB and some by the water users' groups. Not all the wells are in working condition and the geographical coordinates of their location has not been recorded for all the stations. Data for these wells was available from 2006 to 2015 at monthly timesteps. It was noted that all the wells did not have complete sets of data and taking this reference period of 2006-2015, the total availability of the data was checked. It can be seen that five stations have no data recorded at all (100% missing), 16 wells have more than 70% data missing, 24 wells have more than 20% data missing and all stations have more than 5% data missing.

Trend analysis of the groundwater levels for all the wells in the study district was carried out at the annual and seasonal levels between 2006 and 2015. All the wells show continuous decline in the water level at both the seasonal and annual scales. Thus, it can be inferred that except for some very limited places, the groundwater levels are declining with differing rates for each location. Similarly spatial analysis shows that except in a very small part in the north-west, the groundwater level has significantly declined over the entire district, the decrease ranging from 0.4 to 3.2 m for the 10 year analysis period. The reason for maximum decline in the groundwater level in the central part of Siraha could be excessive abstraction for domestic and irrigation purposes and/or reduction in recharge due to climate and other anthropogenic causes.

Delineation of the Bhabar zone within the Siraha district was done mainly using GIS/RS techniques. The estimated width of the Bhabar zone in Siraha is about 2.5 km in the east and west and about 1 to 2 km in the central part whereas the length is approximately equal to the width of the district (41 km). The shape of this polygon is roughly parallel to the East-West highway. Although field verification of the delineated Bhabar zone was not possible during

this assignment, an attempt was made to verify the extents of the delineated polygon by overlaying it on Google Earth.

In line with the scope of work, a GIS based groundwater database of the Siraha district was developed. Necessary corrections have been done and all the files have been projected to the WGS 1984 UTM Zone 45 N system so that it is compatible with other GIS data complying with the standard of the DoS/GoN. The developed system is conveniently and readily expandable as per need when additional data are available in the future. This system has been handed over to GWRDB Office at Babarmahal along with the backup soft copies in a DVD.

