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204. Quantitative Ground Water Assessment of Lahore for Sustainable Water Management

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Abstract

Water resources of Pakistan are susceptible to the evils of urbanization, over population and climate change. Current resource estimation is the need of hour for sustainable water planning and management. It will in turn help design, implement and observe the efficiency of programs of water management, protection and conservation. Therefore, quantitative ground water assessment of Data Ganj Bakhsh Town, of metropolitan city Lahore was conducted. For this purpose, Surfer 8.0 and GIS were used to discover the fluctuations in ground water table for period 2004-2014.The study indicated the alarming depletion of the ground water as average depth of it has declined to 10m in study area. To stabilize the water table, measures such as artificial recharge, introduction of green belts, minimal abstraction, control and shifting of population, are suggested.

Keywords: Ground water; sustainable Lahore; water depletion;water table; quantitative analysis; Geographic Information system(GIS);Surfer 8.0

1. Introduction

For acquiring optimization and all-out efficacy in achieving maximum utilization of water resources in any area, quantization of its water table is considered as one of the fundamental requisites to be documented. Existence of regional scarcity of the precious resource of ground water (i.e. little portion of unfrozen water forming the water bed under the crust of the Earth) is comparatively a recently vocalized problem that is causing tremendous apprehensions worldwide [1]. In the past two decades, numerous arid or semi-arid nations are reported to be extensively suffering from the horrible depletion of the water reservoirs and this trouble is gaining momentum in an alarming pace [2]. Amongst the South Asian countries, realms that are heavily dependent upon agriculture and industrialization for economic benefits such as India, China, Pakistan etc.; unsustainable exploitation of aquifers are found to be even more rapid owing to the extreme usage of ground water not only for agricultural means but also for drinking purposes. Enhanced purity and limited exposure of the underground water with climatic conditions are the two basic reasons that enforces it to be more reliable drinking reserve than other available sources [3]. Pakistan, with 240mm of average rainfall and 180 billion cubic meter reservoirs of water in terms of Indus Valley system, also fall under the same tab of these arid countries and have been freshly described to be severely affected the worst possible water scarcity issues in Indus River aquifers at Indo-Pak borders by various researchers [1, 4-7].

Keeping in mind this horrendous issue, an effort has been devised to scrutinize the fluctuations in the water table at one of the main city of Pakistan that is heavily influenced by the water influx from the River Ravi. Lahore was elected as the study area and a quantitative survey over the span of ten years i.e. 2004-2014 was conducted. This study is highly significant as to the best of author's information; this is the first descriptive study that has been performed in this city of Pakistan with the specification of elected town and the time span regarding the water table fluctuations. Furthermore, factors affecting the availability of the water and their respective impacts were also highlighted with the help of the acquired data. Thirdly, recommendations and future directions for answering the underlined challenges were also

covered in the later sections. This study would also aid in encouraging other concerned individuals to architect direly required changes and schemes for attaining viable, productive and sustainable system for limiting the arising water scarcity.

2. Materials and methods

2.1. Specification of Study area

Elected city of Lahore for the exploration of the water table fluctuations is not only known as the provincial capital of Punjab but also is the second largest city of Pakistan. This city is extended up to the total area of 1,772km^2 and houses the human population of 10,052,000 [8]. Mainly, this city is divided into nine towns named as Ravi, Wagha, Shalimar, Aziz Bhatti, Gulberg, Data Ganj Bakhsh, Samnabad, Iqbal and Nishtar town. Out of these towns, we confined our study to the most populated and rapidly urbanizing town of Data Ganj Bakhsh (GBT) and acquired the relevant data regarding water catchments system from there. GBT is furthermore subdivided into six smaller subdivisions of Mozang, Anarkali, Ravi Road, Islampura, Gulberg and Shimla Hill. Figure 1 shows the map of the specified study area prepared by using GIS techniques.

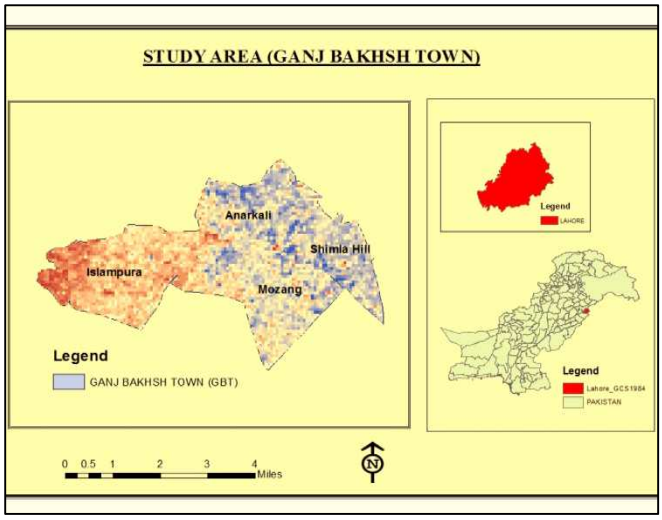

Fig 1. GIS description of study area.

2.2. Employed methodologies

Ten years (2004-2014) data of ground water levels in 144 tube wells located in six subdivisions of Ganj Bakhsh Town (GBT) were collected from Water and Sanitation Agency (WASA) as water level in the tube wells directly provide a mean for measuring the ground water table positioning. For revealing geographical information and temporal variation, Geographical Information System (GIS) and SURFER 8.0 were employed. The wells located in GBT were digitized through Arc GIS 10 and afterwards special fields such as year of installation, serving areas, status of tube wells, subdivisions with respect to area were also added to these digitized maps (as shown in Figure 1.2 a, b, c and d). Elevation contour maps for exploiting the water table existing level were engineered by using SURFER 8.0. For this purpose, water level elevation was plotted on the base maps and linear interpolation of data between measuring points was made to construct contour of equal elevation. Interpolation is applied to calculate the unidentified heights of points of interest by using the known heights of nearby points.

3. Results

Exquisite surveys to the geological site along with the data acquired from WASA cemented that the record of total of 144 wells was found with respect to the elected site that can be potentially exploited by the consumers for fulfilling their water based needs (presented in figure 2 a). After that information associated with the installment years was gathered and acquired data was incorporated into the digitized maps of the study area. It is worth mentioning that attention was focused on only newly installed tube wells that were introduced into the area during the years of 2004-2014. Installment year of each and

every well was not figured out as it doesn't affect the scope of our study (consult figure 2 b). Status of the aquifers i.e. whether the wells were operational or not could be considered as the most significant factor of all as it is a direct indicative of population growth and urbanization. It was established that only 67 tube wells out of 144 were operational while remaining were either already dried out or were not deep enough to act as water pumping site to serve the drinking and domestic needs of the living population there (see figure 2c). Similarly, serving areas of the wells were also figured out and was shown in incorporated form over the digitized map in figure 2d.

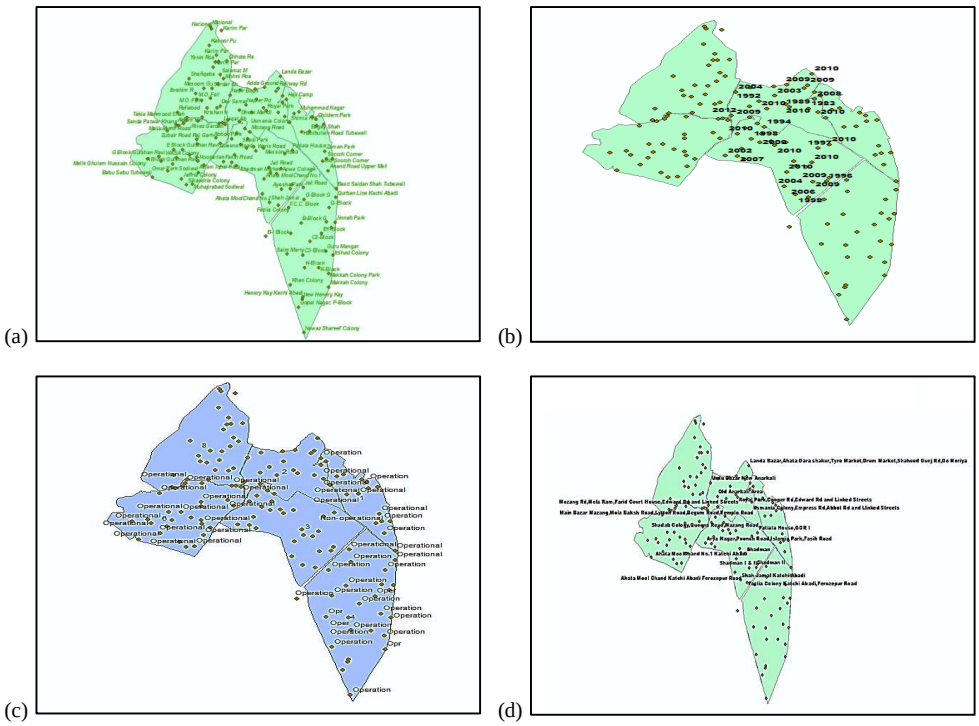

Fig 2 Digitized maps of study area (a) location of tube wells (b) year of installment (c) status of tube wells (d) serving areas

Next to GIS mapping, contour mapping was performed over the entire GBT area for each and every year starting from 2004 to 2014. Figure 3a to 3k covers all contouring aspects of the carried out work. From these contouring maps, individual depth of these 67 operational wells was evaluated for every year. After that fluctuation/variation in the depth of water table was studied individually for each well by plotting static water level recorded in meters against the yearly span. Only operational wells of GBT were considered for exploiting the impacts of basic predictors such as uncontrolled and unplanned explosion of population, temporal changes, rain fall variations particularly yearly monsoon increment, industrialization rate and agricultural requirements etc. that were found to be generally responsible for influencing the level of water table in any community [9]. Same comparison has been drawn in the next section in terms of GBT for studying the water table fluctuations.

In the subdivision of Mozang (as shown in figure 4), thirteen functional tube wells were documented. The names of these tube wells were Shah Jamal well, Ahata Mool Chand No.1 well, Shadman drain, Shadman Mental Hospital drain, Jail road tube well, Masoom Road well, Waris road drain, Queen road well, Shadman market well, Lytton road well, Sadi park well, Baagh Gull Begham well and Ahata Mool Chand No. 2 tube well. It could be established from the various graphs drawn that the depth of water table for each water drain was increased over the span of ten years.