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Ground water potential estimation of alluvial terrain of Saharanpur City and adjoining region, Uttar Pradesh, India

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ABSTRACT

The estimation of ground water potential based on the hydrodynamic method in respect of alluvium terrain of Saharanpur city and adjoining area, located in the western Uttar Pradesh, is recorded herein. Geologically, Saharanpur region is occupied by the Siwalik rocks of Mio-Pliocene age on the northern fringe and the alluvial deposits of Pleistocene to Recent age cover the rest of area. Ground water occurs under unconfined as well as confined conditions in the Saharanpur study area.

The examination of open dug wells reveals that depth of water in open dug wells ranges from 4.2 m to 12 m b.g.l. The estimated value of ground water recharge (9120 x 10^4 m^3) and annual draft (3890 x 10^4 m^3) reveals that there is balance of ground water by 5239 x 10^4 m^3 in Saharanpur study area. The present trend of inadequate water supply particularly during summer period is causing the problem of depletion of the ground water levels, which is mainly due to increasing demand of water supply for the populace, development of agriculture or irrigation and industrialization. The appropriate measures for abatement of decreasing trend of water supply and enhancing the ground water potential are suggested herein.

Keywords: Ground water potential, alluvial terrain, Saharanpur, Uttar Pradesh, India

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INTRODUCTION

Ground water is a dynamic earth resource occurring in the form of water occupying voids within a geological stratum. Water bearing formation of the earth crust acts as conduits for transmission and as reservoirs for storing water. The occurrence of ground water in a geological formation and its scope for exploitation mostly depends on the porosity and permeability of formation. In the presence of interconnected fractures, cracks, joints, crushed zones or solution cavities, rainwater generally, percolates through them and is added to ground water (Todd 1980). The conventional methods of ground water potential estimation are based on ground data such as the characteristics of slopes, weathering, fractures, surface water structures, canals, and irrigated fields.

Ground water is a vibrant, precious, renewable earth resource that acts as an only viable substitute of surface water supply almost through out the world. It is one of the most important natural resource with vast economic values and sociological importance. The ground water is a major source of agricultural and domestic applications in almost all parts of the country. Hence, exploitation of ground water should be planned in such a way that a depletion of this resource is avoided and adverse environmental implications are restrained within the acceptable limits. The availability of ground water depends on porosity and permeability of water bearing formations and it plays a governing role in the optimum development of agriculture, industries and socio-economic growth of a country. It is essential to maintain the ground water reservoir in a state of dynamic equilibrium over a period of time and the water level fluctuations have to be reserved within a particular range over the monsoon and non-monsoon seasons. The prime objective of paper is concerned with estimation of ground water potential of Saharanpur City and adjoining area for varied applications.

DESCRIPTION OF STUDY AREA

The study area situated in Saharanpur district of Uttar Pradesh, is confined to latitude 29° 50' to 30° 05'N and longitude 77° 30' to 77° 40'E, and constitutes a part of the Survey of India Toposheet no 53 G/9 and 53 F/12 (Fig. 1). The study area is located in and around Saharanpur City at an elevation of 270.8 meter above mean sea level, bordered by Behat and Chakrota in North, Deharadun in North East, Delhi in South, Ganga in South West, Haridwar in East, Muzaffarnagar in South East, Ambala in West, Chilkana and Sultanpur in its North West. Saharanpur

City is situated at a distance of 120 km and 164 km to Delhi, the capital of India and 522 km from Lucknow, the state capital of Uttar Pradesh. Saharanpur City is sited on Meerut -Ambala railway track and is approachable both by rail and road all through the year (Fig. 2).

The Saharanpur district constitutes the part of upper Doab of the Ganga and Yamuna rivers forming the eastern and western boundaries respectively. These rivers also mentioned in the Rig-Veda. Saharanpur is one of the most important agricultural production centre of Uttar Pradesh with fast growing population and increasing urbanization, consequently rising water demand in the cities and industries. There is a increasing need for adequate water supply mainly during the summer season due to depletion of ground water levels in the area.

The discovery of ochre-coloured ware at Ambakheri, Bakarka, Budhi Khera, Gadharona, Ghathera, Hardakheri, Shikarpur and Thataula, Harappan Pottery at Ambakheri and Thataula and paented grey ware at Rasulpur and Sarsawa as a result of the explorations and excavations made at these sites during sixties of the present century, lends strong support to the traditional thought that a well developed society had existed in the remote past in the region now comprising of Saharanpur district. It can be remarked that both the Paondhoi and Dhamola rivers have given much physiographic variations in the Saharanpur city area. The surface slope is quite gradual, and provides an evidence of good drainage system. Both these rivers have a high capacity of flow of water, even in the heavy rainy season. The city cannot have a stop on flow of water during the rainy season for so many days (Singh 2007). According to 2001 Census of India, the population of city was 4, 69,764 covering an area of 3201 hectares.

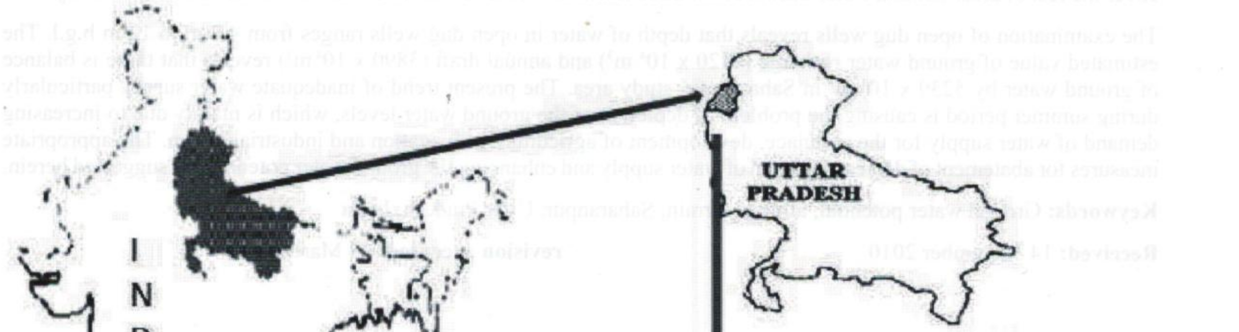

Fig. 1: Location map of the study area, Saharanpur district, Uttar Pradesh. A- Map of India, B- Location of Sahranpur in Uttar Pradesh, C- Locaton of study area in Saharanpur district, D- Study area, E- Satellite Image of study area

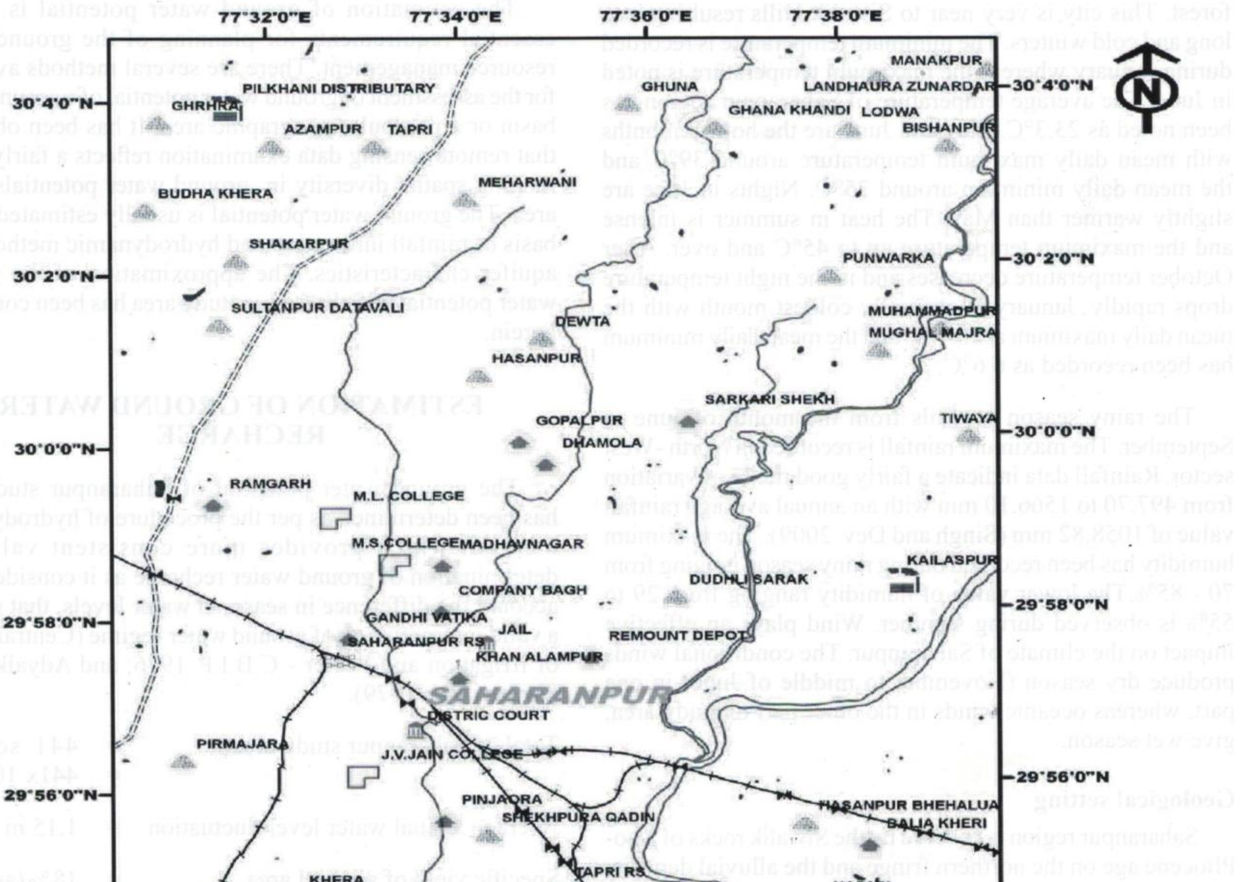

Fig. 2: Base map of Saharanpur City study area, Uttar Pradesh

The climate of Saharanpur City is mainly tropical and favourable for luxuriant development of vegetation and forest. This city is very near to Siwalik Hills resulting into long and cold winters. The minimum temperature is recorded during January whereas the maximum temperature is noted in June. The average temperature of Saharanpur region has been noted as 23.3°C. May and June are the hottest months with mean daily maximum temperature around 39°C and the mean daily minimum around 25°C. Nights in June are slightly warmer than May. The heat in summer is intense and the maximum temperature up to 45°C and over. After October temperature decreases and in the night temperature drops rapidly. January is generally coldest month with the mean daily maximum at 20.1° C and the mean daily minimum has been recorded as 6.6°C.

The rainy season prevails from the month of June to September. The maximum rainfall is recorded in North -West sector. Rainfall data indicate a fairly good range of variation from 497.70 to 1566.10 mm with an annual average rainfall value of 1058.82 mm (Singh and Dev 2009). The maximum humidity has been recorded during rainy season ranging from 70 - 85%.The lower value of humidity ranging from 29 to 55% is observed during summer. Wind plays an effective impact on the climate of Saharanpur. The conditional winds produce dry season (November to middle of June) in one part, whereas oceanic winds in the other part of study area, give wet season.

Geological setting

Saharanpur region is covered by the Siwalik rocks of Mio-Pliocene age on the northern fringe and the alluvial deposits of Pleistocene to Recent age extending over rest of the area. The fluviatile deposits of Indo-Gangetic plains exhibiting a fairly good variation both laterally and vertically influence the ground water conditions.

Hydrogeological set up

In Saharanpur study area, the ground water occurs both under unconfined as well as confined conditions. The. open dug wells reflect the depth of static water levels within the range of 4.2 m to 12 m b.g.l. The shallow wells are in abundance and the depth of wells ranges from 29 to 37 m. b.g.l. The ground water level contour map indicating reflects different trends of ground water movement (Fig. 3). The depth of tube wells ranges from 47.71 to 178.00 m b.g.l. The available bore hole logs have been displayed (Fig. 4).

The ground water is being principally discharged by means of manual and pumping operations from dug wells, shallow and deep tube wells, and hand pumps. The larger part of dug wells is lined with bricks and cement. The motors of variable powers are used for lifting of water from wells (Singh 2010). The rainfall is most important source of gfound water recharge besides the infiltration from rivers; canals and return flow from irrigation, and inflow from adjacent areas.

METHODOLOGY

The estimation of ground water potential is one of essential requirements for planning of the ground water resource management. There are several methods available for the assessment of ground water potential of a ground water basin or a particular geographic area. It has been observed that remote sensing data examination reflects a fairly wide-ranging spatial diversity in ground water potentials in the area. The ground water potential is usually estimated on the basis of rainfall infiltration and hydrodynamic methods and aquifer characteristics. The approximation of the ground water potential of Saharanpur study area has been computed herein.

ESTIMATION OF GROUND WATER RECHARGE

The ground water potential of Saharanpur study area has been determined as per the procedure of hydrodynamic method, which provides more consistent value for determination of ground water recharge as it considers into account the difference in seasonal water levels, that reflects a valid interpretation of ground water regime (Central Board of Irrigation and Power - C.B.I.P. 1976; and Adyalkar and Shrihari Rao 1979).

Total of Saharanpur study area	=	441 sq. km.
	=	441×10^6 m^2
Average annual water level fluctuation	=	1.15 m. b.g.l.
Specific yield of alluvial area value after Charlu and Dutt 1982)	=	18 % (assumed
Ground water recharge level fluctuation × Specific yield.	=	Area × Water
Hence, ground water recharge	=	441×10^6 m^2 x 1.15 x 18 %
	=	441×10^6 m^2 x 1.15 x 18/100
	=	9129×10^4 m^3

ESTIMATION OF GROUND WATER BUDGET

The total dynamic ground water in storage has been computed by using the average saturated thickness of aquifer derived from the well inventory studies.

Total area of study	=	441 sq. km.
	=	441×10^6 m^2
Average Saturated Thickness	=	6.0 m
Specific Yield of Alluvial Area	=	18 % (assumed value after Charlu and Dutt 1982)

various sectors of the world. The demand target of human needs or enhancing the productive potential of the resource base can be achieved by considering prioritization to the sustainable development and management of water resources particularly in the areas where sufficient water is not available to meet all requirements throughout the year.

The main problems confronted in the water resource management include increasing competition for the restricted water supplies, pressure to gain effectiveness of water, and difficulties in sustaining the resource base. The constraints relating to water resource include inadequacy of water supply, water logging and salinity of soil, and other socio-environmental problems. Thus addressing the various water related issues for managing water in optimal manner has a great societal relevance.

The process of infiltration or additional water to an aquifer is well-known as the 'Artificial Recharge'. The ground water reservoir is augmented at a rate exceeding that under natural conditions of replenishment can improve storage in ground water system. The main objectives of artificial recharge of ground water involves the augmentation of ground water resource by employing engineering technology, to reduce seawater intrusion, to improve quality of water through soil-aquifer-treatment, to use aquifers as water delivery system, to reduce land subsidence and also to clean up the polluted aquifers.

The various methods of artificial recharge operations are grouped into four types: (1) Spreading method, (2) Pit method, (3) Induced recharge method and (4) Well method. The choice of a appropriate method is governed by the topographic and hydrogeologic aspects of a particular area. The quality assessment of water to be recharged is also essential because the polluted surface water is not feasible for recharge purposes. The estimation of benefit-cost analysis plays a significant role in conducting artificial recharge operations. The strategy of artificial recharge of ground water is receiving considerable importance in watershed management.

In Saharanpur study area, the augmentation of ground water system is recommended by means of construction of artificial recharge structures. The nala bund exists at Tapri. The other sites at company bag, Malhipur, Sultanpur and Tapri are considered more feasible for artificial recharge structures such as roof top harvesting, check dams etc as these are less cost effective. The awareness schemes regarding importance of saving water, control on its wastage and practice of drip irrigation should be launched in order to obtain sustained water supply.

CONCLUSION

Estimation of ground water has been more studied in recent years because of increased demand of water. The study has demonstrated the utility of traditional techniques in delineating ground water potential in study area. The estimated value of ground water recharge (9129 x 10^4 m^3) and annual draft (3890 x 10^4 m^3) is indicating prevalence of an ground water over draft by 5239 x 10^4 m^3. The excess need of water during summer season is causing the problem of ground water level depletion in the area, which can be reduced by augmentation of the ground water system.

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