GROUND WATER STATUS- A CASE STUDY OF ALLAHABAD, UP, INDIA

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ABSTRACT
The ground water study is essential for assessing the ground water quality. These studies are of vital importance from the point of view of development of water-logging. Vast area of state of Uttar Pradesh is already water-logged, and any addition to such area is not in the interest of the state. It therefore, becomes imperative to have a careful watch over the behaviour of ground water table since rise of ground water can be permitted only to a certain extent. More than 90% of rural population uses ground water for domestic purpose. It is therefore extremely important to have detailed information and knowledge about the quantity and quality of ground water. In the present research work we have discussed about the groundwater scenario which includes the data of groundwater availability in different blocks, groundwater quality of Allahabad district.

KEYWORDS: *Alluvial, Chaka, Ganga, Groundwater, Vindhyan.*

I. INTRODUCTION

Ground water is an important component of the water system for domestic, industrial and agricultural purpose. It is commonly used source for drinking water for urban and rural sectors in India. Ground water is a renewable natural resource with a relatively short and shallow circulation with close dependence on precipitation and surface water. Ground water once was supposed to be the hygienic, secure and safe for human consumption. Groundwater is now being gradually polluted by human being because of the intense industrial activities. The quality of ground water depends upon the characteristics and type of the subsurface soil and nature of recharge water.('Srinivasa CH, 2000')
Today the accelerated pace of development, rapid industrialization and population density have increased demand of water resources. Ground water, a gift of nature, is about 210billion m^3 including recharge through infiltration, seepage and evaporation. Out of this nearly one third is extracted for irrigation, industrial and domestic use, while most of the water is regenerated into rivers. Over 98% of the fresh water on the earth lies below its surface. The remaining 2% is what we see in lakes, rivers, streams and reservoirs. Of the fresh water below the surface, about 90% satisfies the description of ground water, that is, water which occurs in saturated materials below the water table. About 2% water occurs as soil moisture in the unsaturated zone above the water table and is essential for plant growth. The crucial role that the ground water plays as a source of drinking water for millions of rural and urban families cannot be neglected. According to some estimates it accounts for nearly 80 percent of the rural domestic water needs and 50 percent of urban domestic water needs('Kumar M. Dinesh, 2004')India receives annual precipitation of about 4000 km^3, including snowfall rain. India is gifted with a river system comprising of more than 20 major rivers with several tributaries. Many of these rivers are perennial and some of them are seasonal. India occupies 3.29 million km^2geographical area, which forms 2.4 percent of the world's land area and having 4 percent of world's fresh water resources. Monsoon rain is the main source of fresh water, with 76 percent of the rain fall occurring between June to September. The Precipitation in volumetric terms is 4000 Billion Cubic meters (B.C.M.).The average annual flow out of this is 1869 B.C.M. The rest of water is lost in infiltration and evaporation. Due to topographical and other constraints only 600 B.C.M., can be utilized.

Ground water is generally less susceptible to contamination and pollution when compared to surface water bodies. Also the natural impurities in rain water which replenishes ground water system get removed while infiltrating through soil strata. But in India, where ground water is used intensively for irrigation and industrial purposes, a variety of land and water based human activities are causing pollution of this precious resource.

In many parts of country available water is rendered not-potable because of the presence of toxic material in excess. The situation gets worsened during the summer due to water scarcity and rain water discharge. Contamination of water resources available for household and drinking purpose with toxic element, metal ions and harmful microorganisms is one of the serious major health problems. As a result huge amount of money is spent in India for chemical treatment of contaminated water to make it potable.

Ground water contamination includes spillage or disposal of pesticides, fertilizers, petroleum by carbon industrial chemicals, and waste products. Contamination can also respect from change in land use pattern. The contaminated ground water system can pose a threat to other connected ecosystem. The contamination can be described as coming from either point sources or diffuse sources. Point source contamination may range from land fill sites on the other hand diffuse source contamination includes the spreading of fertilizer to agriculture land, urban runoff, and the fallout from industrial smoke stacks. When ground water becomes polluted it is difficult or impossible to clean it up completely. The slow rates of ground water flow and low microbial activity limits any self-purification process which takes place in days or weeks in surface water system may take decades to occur in ground water. In addition the coasts of remediating ground water system are very high. It is therefore better to prevent or reduce the risk of ground water contamination than to deal with its consequences. This large use and dependency upon ground water dictates that these resources are valuable and must be protected for both present day and future use (‘Donald K., Keech, 1979’). The ground water of the region has also been classified and characterized on the basis of hydro chemical facies and their quality for agricultural use. [‘Jain C.K. et al (2000)’].

II. DESCRIPTION OF STUDY AREA

The district of Allahabad lies at tail end of Allahabad division to the south between latitude 24º 47’ and 25º 47’ N and longitude 81º 19’ and 82º 29’ E. On the North it is bounded by the districts of Pratapgarh and Jaunpur, the former being separated by the river Ganga for about one third of its boundary. On the East is the district of Varanasi and the district of Mirzapur on the Southeast. The southern boundary is formed by the State of Madhya Pradesh, and the district of Banda and Fatehpur bound it on the south-west and West. The length of the district from east to west is about 117 km and the breadth from north to south is about 101 km while the total area 7261 sq. kms. The district headquarters is located at Allahabad which is also known as Prayag, situated at the confluence of the great rivers the Ganga, the Yamuna and the mythical Saraswati. Allahabad is one of the most important towns which are situated along the river Ganga. This great city is famous for the annual MaghMela and for MahaKumbh, which is held at every twelve years interval, the biggest Mela in the World. The main town is bounded by river Ganga on Northern and Eastern sides, the river Yamuna and Doab plain forms its Southern and Western boundaries respectively. The Kanpur- Varanasi Road, in most of its length runs on the ridge line dividing the town in two parts. The area on the north of this road slopes towards Ganga whereas the area on the south side slopes towards river Yamuna. The general information about Allahabad is as given below:

2.1 Information Data

Table-1: Information

S.No	Parameter	Value
1.	Population	5,959,798 As Per 2011 Census
2.	Area	63.07 Sq.Kms
3.	Altitude	98 Meters Above Sea Level
4.	Temperature Summer	26.6 To 41.0 °C
5.	Temperature Winter	9.1 To 29.0 °C
6.	Rainfall	102.8 Cms
7.	Language	Hindi, Urdu & English

III. PHYSIOGRAPHY

The district is drained by river Ganga and its right bank tributary Yamuna and Tons broadly represents following geomorphic units:-

1. Ganga Alluvial plain
2. Yamuna Alluvial plain
3. Vindhyan Plateau

Topographically Allahabad can be divided into three parts- the trans-Ganga tract or the Gangapar plain, the doab and the trans-Yamuna tract. These are formed by the two main rivers, the Ganga and the Yamuna. The trans Ganga part consists of the Soran, Phulpur and Handia tehsils. It is plain area but there are long belts of Khadar land. The high banks of the Ganga are covered with poor sandy soil. Belts of loam and usar lands also exist in this part. The doab tract comprises the Chail, Manjhanpur and Sirathu tehsils and lies between the Ganga on the north and the Yamuna on the south. It is rich and fertile. The land is plain and it consists of alluvial and light loam soils. In the south west the soil is dark and it resembles the mark of the adjoining parts of Madhya Pradesh. The trans Yamuna tract lies to the south of the Yamuna and comprises the Karchhana and Meja tehsils. It forms a part of Bundelkhand region. The ridge formed by the Ganga and the Yamuna which lies in the north of Karchhana is crowned with light sandy soil. The Kachhar land lies near the confluence of the Ganga and the Tons. The central parts of karchanna tehsil and some parts old meja tehsil consist of upland. The ranges of the vindhyan series of the Deccan plateau also lies in this tract. The Panna range lies for about 16 km along the southern boundary of the district.

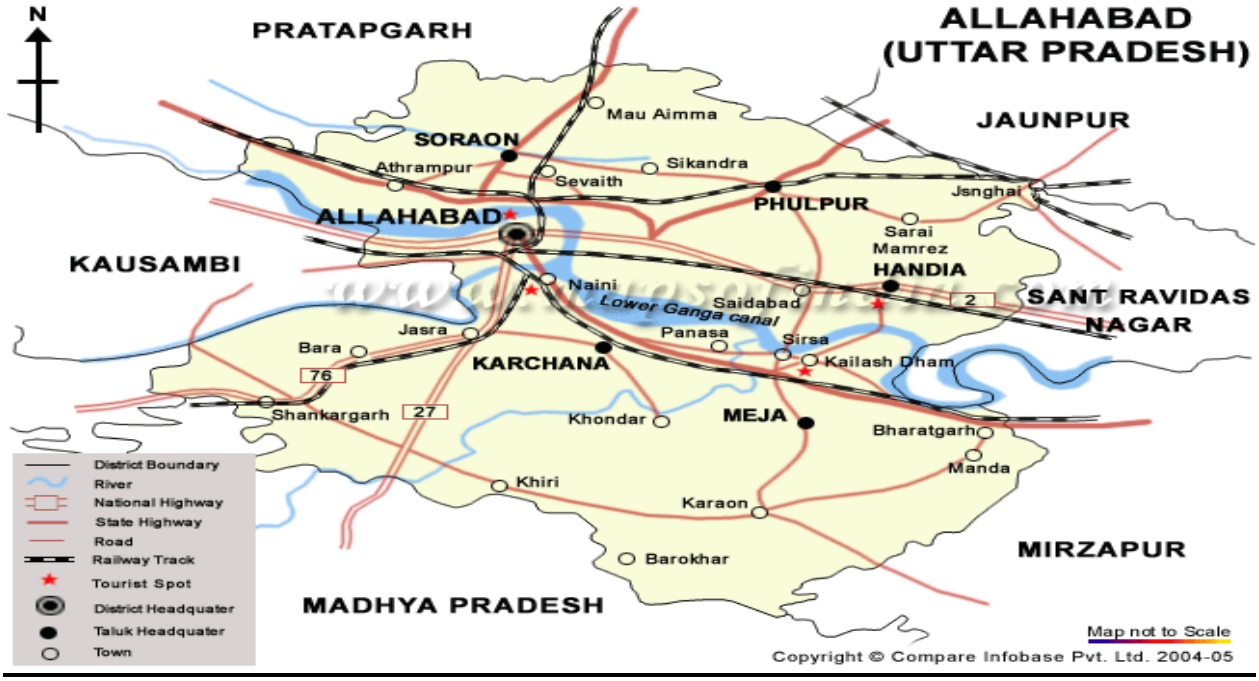

Figure 1. Allahabad district

IV. CLIMATE & RAINFALL

Allahabad district is continental. The climate of Allahabad is tropical with moderate winter and severe extended summer. The Allahabad experiences both very dry hot summer and very cold winter every year. During winter the temperature ranges from 9.5ºC to 26.2ºC whereas in summer it ranges from 29.5ºC to 48.0ºC. The average normal maximum temperature has been observed as 47.8ºC during June and minimum 3.5ºC during January. The district receives rainfall from south west monsoon from June to September. The average rainfall being 973.8 mm. Total evaporation of Allahabad district is 1476.9 mm. The maximum is observed during May and June which are the peak summer months.

V. HYDROGEOLOGY

Ground water in the district occurs both in alluvium and the weathered and joined sandstones in areas which are underlain by the hard rocks. Two broad based hydrogeological units, namely, unconsolidated (Alluvium) and consolidated (hard rock) are the major components. The Alluvial formations occur in the Trans-Ganga and Doab region. Localized patches of Trans-Yamuna region are also covered by unconsolidated formations. Occurrence of consolidated formations is restricted primarily to Trans Yamuna tract.

5.1 Alluvium Area

Field observations by government agencies indicates that depth of water table is less than 15 m during pre-monsoon in the Trans- Ganga region whereas in Doab it stands in the depth range between 5.5 and 20 m. During post monsoon period, however depth of water table in the Trans-Ganga region ranges between 0.65 and 12.0 mbgl. The Doab region indicates the depth of water table ranging between 4.2and 10.0 mbgl.

5.2 Hard Rock Area

The ground water in the widely covered Vindhyan Plateau region is primarily under unconfined condition. Exploratory data indicates that kaimur sandstones found at depths do have enough potentiality at favourable locations. These sandstones after leaching of cementing materials get disintegrated and reduced to silica sands which are loose and act as promising repository of ground water. The lithological characteristics of bore holes have clearly indicated the presence of loose silica sands.

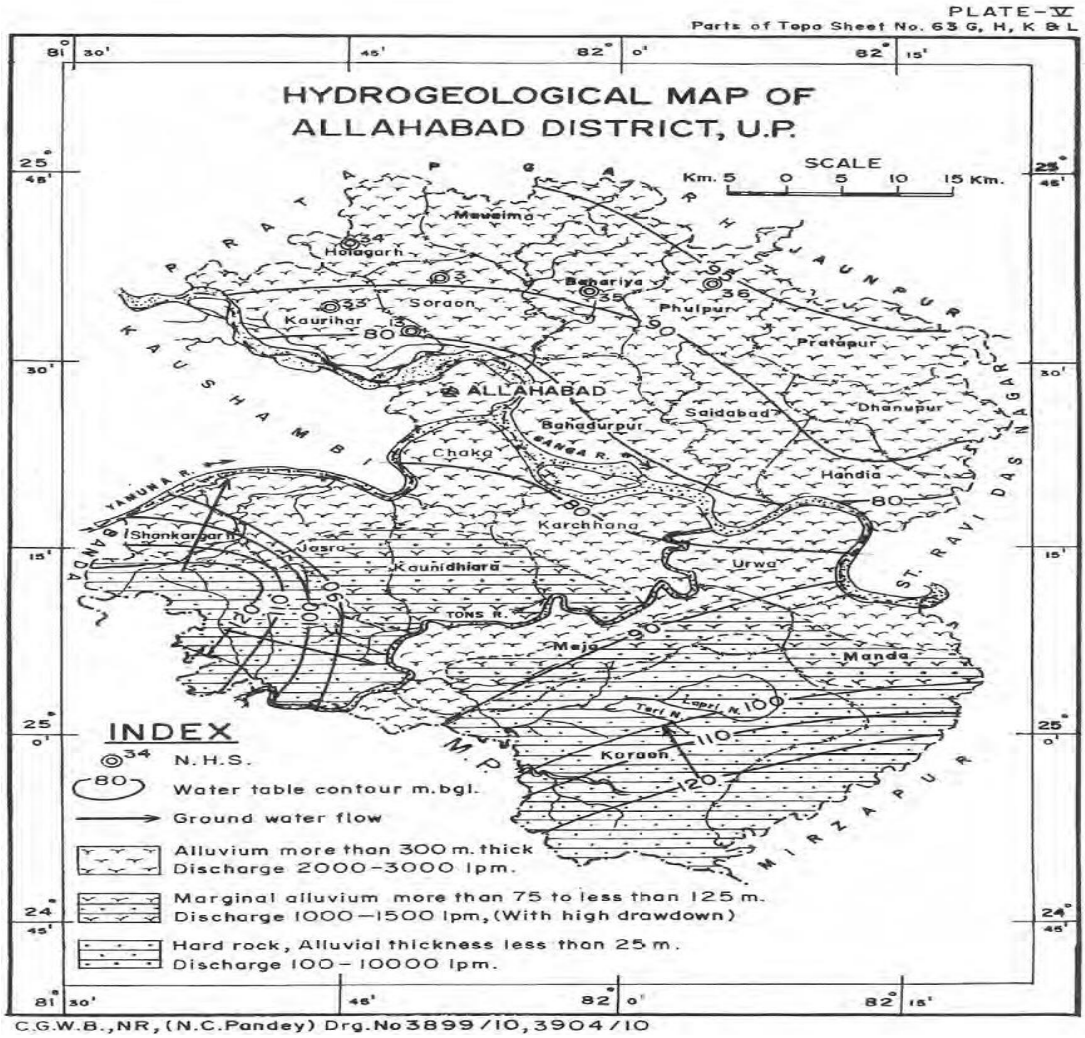

Figure 2 . Hydrogeological map of Allahabad, UP, India

VI. WATER EXTRACTION SOURCE

Table-2: Overall Status of Water Supply

S.No.	Nature of Water Extraction Source	Quantity in Nos.	Amount of Water Extraction in MLD
01.	Deep Tube wells	147	137
02.	Mini Tube wells	85	25
03.	Hand Pumps	2448	10
04.	Yamuna River	-	80

(Source: U.P Jal Nigam)

Overall Status of Water Supply**:**
The total length of distribution pipeline is 1055 Kms. There are three zonal service reservoirs which are located at Daraganj, Bhardwaj Ashram and Mayo Hall having capacity of 1.8 ML, 1.35 ML and 2.7 ML respectively. In addition to these three service reservoirs, there are 34 Over Head Tanks (OHTs) which store the water before supply. Unaccounted flow of water is about 30% of total water supply.

VII. GROUND WATER RESOURCES

To facilitate the ground water development the ground water resources of the district have been worked out and are as follows

Table-3: Block wise ground water resource of Allahabad district

Sl. No.	Assessment unit (Blocks)	Ground Water Availability (Ham)	Ground Water Draft (Ham)	Level of development (%}	Category as on 05/2013	Balance Ground Water (Ham)
1.	Bahadurpur	6269.09	552.88	82.64	Safe	5212.89
2.	Baharia	8923.83	2509.56	81.44	Safe	4778.45
3.	Chaka	2545.76	403.23	75.68	Safe	2123.22
4.	Dhanupur	4743.23	854.79	87.12	Safe	3387.86
5.	Handia	4834.02	1025.95	71.22	Safe	3232.22
6.	Holagarh	7023.11	2544.43	69.82	Safe	2389.99
7.	Jasara	5904.15	1634.21	57.00	Safe	2756.66
8.	Kaundhiara	6952.68	1822.22	84.21	Safe	3154.32
9.	Karchhana	6300.47	1263.39	89.79	Safe	3989.25
10.	Kaurihar	5933.43	1309.67	75.12	Safe	3909.24
11.	Koraon	8512.02	2605.88	34.54	Safe	5124.78
12.	Manda	3633.87	764.60	69.89	Safe	2467.55
13.	Mauiama	5754.46	1588.20	82.13	Safe	2971.35
14.	Meja	4533.22	987.44	53.33	Safe	3103.38
15.	Phulpur	5998.23	1102.93	63.33	Safe	4455.33
16.	Pratapur	5331.22	1122.74	75.08	Safe	3487.90
17.	Saidabad	5334.67	1205.76	73.05	Safe	3212.21
18.	Soraon	4654.23	1190.98	67.19	Safe	2690.09
19.	Shankargarh	3278.34	671.56	33.03	Safe	2012.08
20.	Urva	5278.55	744.22	69.17	Safe	4232.33
	Total	**111738.19**	**24775.88**			**68682.32**

(Source: U.P Jal Nigam)

VIII. GROUND WATER QUALITY

8.1 Quality of shallow ground water

The chemical analysis of shallow ground water consists of pH, E.C., Na, K, Ca, Mg, HCO_3, CL, SO_4, NO_3, F and TH as $CaCO_3$ reflects that there is no contamination of the shallow ground water in the

district and all the constituents are well within the range. The chemical data of shallow aquifers reveals that the ground water quality is more deteriorated in canal command area. The map of E.C. and Chloride show that in most of the area E.C. varies from 180-1780μ siemens/cm at 25°C. It is interesting to find that different radicals in the shallow ground water have not changed over the year's in spite of upcoming canal irrigation and use of fertilizers.

8.2 Quality of Deeper Aquifers

Data of water samples from deeper aquifers are few but there analysis reveals that the water is safe and potable. It is observed that the E.C. and other salts are in higher concentration in alluvial area than hard rock area. The quality in hard rock area is inferior near the stream than away from the stream.

IX. RECOMMENDATIONS

1. Variation in water quality was observed during both the periods of the study i.e. per-monsoon and post-monsoon period.
2. Ground water quality varies from place to place with the depth of water table which is reflected from the values obtained at same locations with different sources.
3. Water source should be thoroughly investigated before recommending it for use, whether it is private or government boring.
4. Periodical investigation should be conducted every two to three years on quarterly basis to evaluate the level of ground water contamination.
5. Ground water withdrawal should be minimized in Bahadurpur and Chaka blocks immediately.
6. Alternative drinking water source may be provided along the river bank because people residing nearby are using hand pump water for drinking and other domestic purposes.
7. Public awareness should be created among the masses particularly for the people residing along the bank of the river Yamuna for consumption of safe drinking water.
8. It is suggested that some low cost and easy to implement technique may be provided to the consumers for removing hardness, total dissolved solids and chloride in water where the values exceed the permissible limit.

X. CONCLUSIONS

The stage of groundwater development in the district is 69.73%. Maximum groundwater development in Karchhana block (89.79%) and minimum is in Shankargarh i.e. 33.03%. In five blocks viz: Bahadurpur, Baharia, Dhanupur, Kaundhiara, Mauiama the stage of groundwater development is 80% to 90%. In five blocks viz: Chaka, Handia, Kaurihar, Pratappur and Saidabad, the stage of groundwater development is 70% to 80%. All the blocks fall under "SAFE" category. Construction of canals or strengthening of the existing canal system should be emphasized in four blocks viz: Bahadurpur, Chaka, Kaundhiara, and Meja. In rest of the blocks, emphasis may be given to irrigation through groundwater development either by medium to shallow or deep tubewells. There is no block in the district identified under polluted area but localized area like Chand Khamria (Meja), Naini Industrial area and Shankargarh (part) where E.C., NO_3 and Fe has increased the permissible limit. Ground water quality in general is fresh and potable except few pockets. Deeper aquifer also reveals that there is no contamination or pollution of groundwater.

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