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Project Report

On

GROUNDWATER ASSESSMENT OF DELHI

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By

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CERTIFICATE

This is to certify that SAKSHI SHARMA has carried out her minor project in partial fulfillment of the requirement for the degree of Master of Science in ZOOLOGY on the topic "GROUNDWATER ASSESSMENT OF DELHI" during February 2017 to April 2017. This project was carried out in the Groundwater Hydrology Division of the NATIONAL INSTITUTE OF HYDROLOGY (NIH), ROORKEE.

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Sakshi

Sakshi Sharma

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SUMMARY

Groundwater is one of the major sources for water supply in many parts of the country. In Delhi too groundwater contributes to substantial quantity of supply. Especially in new development areas groundwater is largely being utilised as a drinking water resource, mainly because of the insufficiency of the Yamuna water share for Delhi. Groundwater collects in the aquifers over thousands of years through infiltration and groundwater flow recharge. A particular amount of groundwater is replenished regularly through rainwater infiltration. Sustainable use of groundwater means withdrawal of groundwater at a rate at which it is replenished through recharge. According to the Central ground water board the recharge areas identified is the northernmost part of the city. Areas where the ponds already exist in the villages, the Najafgarh jheel and its surroundings and the region between the northern ridge can also be used as water recharge area. Faster withdrawal rates would lead to fall in water table and finally depletion of groundwater. Water level decline is a major issue in the northwest India particularly in Punjab, Haryana, Rajasthan and New Delhi. e.g. As per the data taken from Agriculture Department, Haryana shows that the water level has gone down by 1 to 25 m in last 4 decades. Data of Delhi and Sangrur has been compared (1983-1997) with present CGWB report which shows that water table in both areas declined but in last 35 years Delhi become the highly exploited area and need to manage water resources.

1. INTRODUCTION

Groundwater is the water present beneath the earth's surface. It is found in soil pores spaces and in rock fractures. There is a large storage of water beneath earth which is called aquifer. Groundwater is our most important natural resource. It provides drinking water to the rural population for more than 90 % percent who do not get their water delivered from city water department. Water under the Earth's surface present almost everywhere like beneath hills, mountains, plains, and deserts. But it is not always present in fresh water form for our use without any treatment. Groundwater is stored and moves slowly through highly permeable rocks which are called aquifers. The groundwater is much important for the existence of all living beings Groundwater is the major source of drinking water in both urban and rural India also it is an important source of water for the agricultural and the industrial field. Its availability depends on the rainfall and recharge conditions. Till recently it had been considered a good source of uncontaminated water. Monitoring of groundwater regime is an effort to obtain information on groundwater levels and chemical quality through representative sampling.

In India, most of the population is dependent on groundwater as the only source of drinking water supply. The groundwater is believed to be comparatively much clean and free from pollution than surface water. But prolonged discharge of industrial effluents, domestic sewage and solid waste dumping results in pollution of groundwater and health problems. The industrial waste water, sewage sludge and solid waste materials are currently being discharged into the environment indiscriminately. These materials enter subsurface aquifers resulting in the pollution of irrigation and drinking water (Girija et al., 2007).

Natural phenomena such as volcanoes, algal blooms, storms, and earthquakes also cause major changes in water quality and the ecological status of water. As per the latest estimate of Central Pollution Control Board (CPCB), about 29,000 million litre/day of wastewater generated from class-I cities and class-II towns out of which about 45% is generated from 35 metro-cities alone (Mangukiya et.al, 2012).

As of April 2015, the annual water availability of the country in terms of natural runoff in rivers is about 1,869 BCM /year and the usable quantity have been estimated around 1,123 BCM/year. From the total of 1,123 BCM/year, the quantity of surface water and groundwater is 680 BCM/year and 432 BCM/year, respectively. And the net annual groundwater availability for the country is 397 BCM. The overall contribution of rainfall to the country's annual groundwater resource is 68% whereas 32% is from others, such as canal seepage, return flow from irrigation, recharge from tanks, ponds and water conservation structures. The national per capita annual availability of water has reduced from 1,815 cumec in 2001 to 1,543 cumec in 2011 due to the increasing population in the country. It shows that India is fast moving towards crisis of groundwater overuse and contamination. Overuse also called overexploitation and defined as the condition in which average extraction rate is greater than the average recharge rate. Similar observations were reported in National Capital Territory, Delhi. Therefore, the present work is undertaken to assess the groundwater condition of Delhi.

OBJECTIVES

The study was taken up with the following objectives:

(i) to reappraising the occurrence of groundwater

(ii) to assess the seasonal water level fluctuation of groundwater

(iii) to carry out hydro-geochemical characterization

2. LITERATURE REVIEW

In India, the availability of surface water is greater than groundwater. However, it is easily accessible and forms the largest share of India's agriculture and drinking water supply. 85% of groundwater extracted is used in the irrigation sector, making it the highest category user in the country. This is followed by groundwater for domestic use which is 9% of the extracted groundwater. Industrial use of ground water is 2%. 50% of urban water requirements and 85% of rural domestic water requirements are also fulfilled by groundwater (CGWB, 2011). In almost countries, where fertilizers are used there are reports of contaminations of groundwater as well as surface water. Over 90% of rivers in European countries have high nitrate concentration which is mostly from agrochemicals (WHO, 1999).

Anthropogenic activities such as over withdrawal of groundwater, leaching of fertilizers and accidental spillages also influences the quality of groundwater. The contamination in groundwater persists for longer duration due to low flow rate of groundwater in aquifer system. Chemical characteristics of groundwater determine the suitability of water for domestic, agricultural or industrial use (Mondal et al., 2010; Li et al., 2012; Roques et al., 2014; Kumar and Singh, 2015).

The level of groundwater development is very high in the states of Delhi, Haryana, Punjab and Rajasthan, where ground water development is more than 100%. This implies that in these states, the annual groundwater consumption is more than annual groundwater recharge. In the states of Himachal Pradesh, Tamil Nadu and Uttar Pradesh and the Union Territory of Puducherry, the level of groundwater development is 70% and above (CGWB 2012).

In rest of the states, the level of groundwater development is below 70%. Over the years, usage of groundwater has increased in areas where the resource was readily available. This has resulted in an increase in overall groundwater development from 58% in 2004 to 62% in 2011. Areas of South Delhi include ridge parts which are considered as recharge zones for groundwater, but face uncontrolled groundwater extraction, leading to deeper water levels (Gupta & Sarma, 2014). Chatterjee et al. (2009) also found deep water table in the ridge area.

About 60% area comprises low EC value (846.2) distributed partly in the districts of Delhi similarly TDS and hardness show low concentration value (Gupta and Sarma, 2016). Similar trends were also reported by Saka et al. (2013). Dash et al. (2010) reported high salinity in some areas of Delhi with minimal groundwater depth. Primary data collected from Delhi seasonally during 2012–2014. Physico-chemical parameters were correlated with each other and groundwater depth. All the parameters were found to be negatively correlated with groundwater depth. Results showed that maximum concentration of most parameters was found in the northern parts of the study area, while maximum depth was reported from the southern part. Maximum area of around 59% of total area of Delhi has low electrical conductivity, TDS, and hardness values. With groundwater depth improving toward north Delhi, groundwater quality is found to be improving toward south parts of Delhi (Gupta et al., 2016).

Study Area:

Delhi the capital of India and the second most populated city in the country lying on the 28.61°N latitude , 77.23°E longitude is bordered by Haryana on three sides –north, west and south and by Uttar Pradesh in eastern side. The National Capital Territory of Delhi (NCT) has a geographical area of about 1483 sq. km. and estimated to have population of 18,686,902 in the year 2016 against the population count of 16,753,235 in the year 2011 (Census, 2011). It is also projected that NCT Delhi may have about 23 million population by 2021, 25 million by 2031, and 27 million by 2051 (Safe Water Network, USAID, 2016).

Two prominent features of the geography of Delhi are the Yamuna flood plains and the Delhi ridge. The Yamuna river was the historical boundary between Punjab and UP, and its flood plains provide fertile alluvial soil suitable for agriculture but are prone to recurrent floods. The Yamuna, a sacred river in Hinduism, is the only major river flowing through Delhi. The Hindon River separates Ghaziabad from the eastern part of Delhi. The Delhi ridge originates from the Aravalli Range in the south and encircles the west, north-east and north-west parts of the city. It reaches a height of 318 m (1,043 ft) and is a dominant feature of the region.

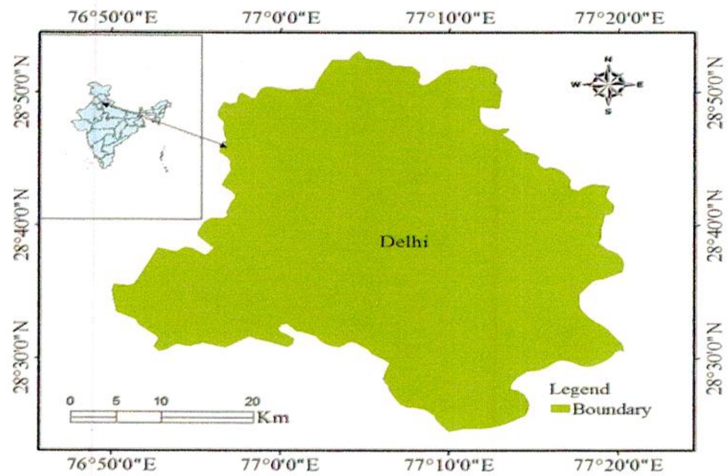


Fig. 1:- Location of study area Delhi, India

3. MATERIALS AND METHODS

3.1. Data:

A Central groundwater board report of Delhi has been used for the information used in this study. Global information system (GIS) has been used to prepare different maps to understand the information. A previous data of groundwater of Delhi has been used to compare so that to find out water status of Delhi in present scenario. The groundwater status reports of nearby states have been used for the comparable study. Previous as well as present CGWB reports are used for the comparable study. Data of Haryana district was taken from State Agriculture Department, Panchkula. A number of samples are collected from different sites of Delhi as shown in the figure 2 and analysed for various hydrochemical features by CGWB.

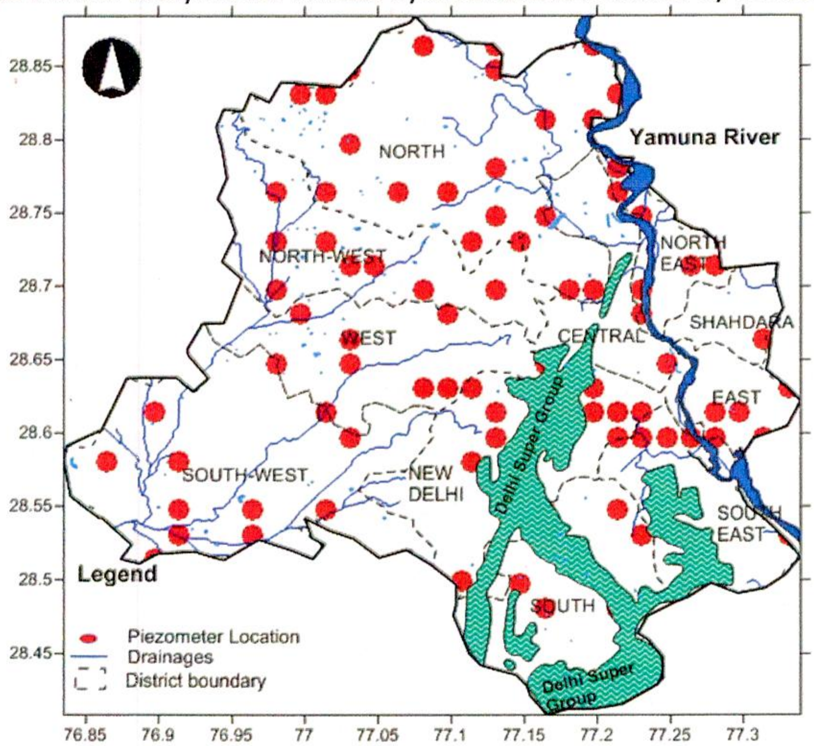


Fig. 2. Sampling sites and piezometer locations in Delhi

1.2. ARCGIS

ArcGIS is a geographic information system (GIS) for working with maps and geographic information. It is used for: creating and using maps; compiling geographic data; analyzing mapped information; sharing and discovering geographic information; using maps and geographic information in a range of applications; and managing geographic information in a database.The system provides an infrastructure for making maps and geographic information available throughout an organization, across a community, and openly .

2. RESULTS AND DISCUSSION

As per CGWB report (Table 1), East Delhi, North Delhi, South West Delhi and North West Delhi covers a geographical area of 984 km^2 and forms 66.30 % of total area of Delhi. The largest area is covered by North West Delhi (440 km^2). According to 2011 census, total population of these districts is 85, 34,767; North West Delhi has the highest population (Fig. 3).

Table: 1. General information, Delhi (CGWB)

S.N.	Parameters	Delhi_East	Delhi_North West	Delhi_North	Delhi_south west
1	Area (Sq. km)	64	440	60	420
2	Population(as per 2011census)	17,07,725	36,51,261	8,83,418	22,92,363
3	Normal Annual Rainfall (mm)	451	581	887	794
4	Normal Monsoon Rainfall (mm)	365.31	470.61	718.47	643.14
5	Normal Rainy days	27	27	27	27
6	Temperature (Mean Minimum) - °C	7.3	7.6	7.6	7.3
7	Temperature (Mean Maximum)-°C	46 or 47	46 or 47	46 or 47	46 or 47
8	soil type	Silty-clay to clayey silt along with sandy loam	Sand and clay	Sand, silt and clay	Sand, clay & kankar.
9	Depth water level (pre monsoon) (mbgl)	3.60 to 15.74	2.23 to 16.32	2.14 to 11.54	2.40 to 53.17
10	Depth water level (post monsoon) (mbgl)	3.23 to 16.89	1.32 to 17.21	1.68 to 8.73	0.69 to 54.02
11	Net Annual Groundwater availability (ham)	1187.5	8023.771	1399.86	9127.013
12	Existing gross ground water draft	21.24	90.15	9.68	127.78
13	Stage of Ground Water Development (%)	178.87	112.36	69.18	139.99
14	GW Quality				
	(i) Water Type (Shallow Groundwater)	Ca, Na-Cl	Na-Cl, Ca-Cl	Na-Cl, Ca-Cl	Na-Cl, Ca-Cl & Mixed type
	(ii) EC (mS/cm)	550-5084	225-13340	600-5200	529-17240

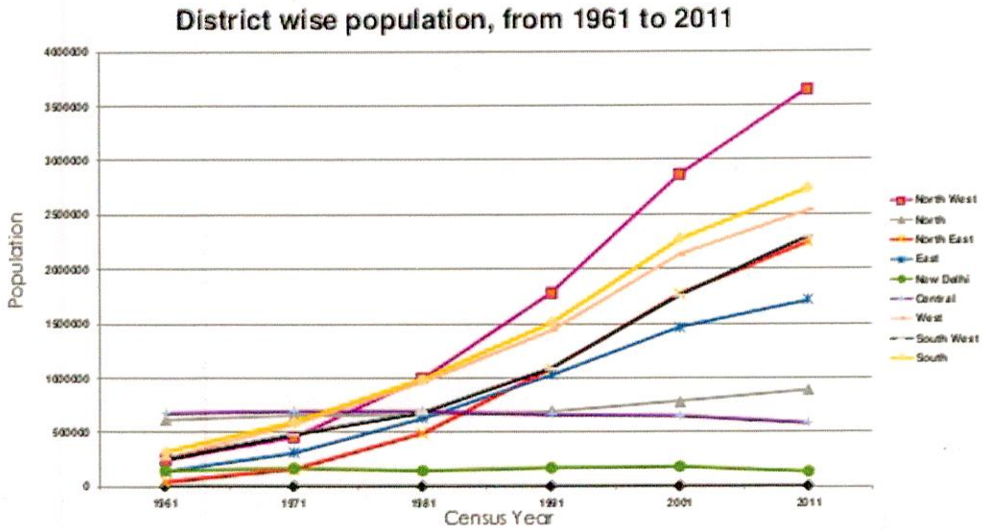


Fig. 3: District wise population of Delhi

4.1. Land use:

Large forest area reported in south west district whereas small forested area reported in East district. Water bodies cover a large area in South west district whereas small area is covered by water bodies in North district. The forest cover of the district is 41.80 km^2 and approximately, 6.16 km^2 area of the district is covered with water bodies. The east district has small forested area of 2.99 km^2 and approximately, 0.35 km^2 area of the district is under water bodies. The forest cover of the North-west district is 16.49 Km^2 and the area under water bodies in the district is 5.2 km^2. In North district the forest cover of the district is 4.81km^2 and approximately, 0.24 km^2 area of the district is under water bodies.

2.2. Climate and temperature:

The climate is mainly influenced by its inland position and prevalence of air of the continental type during major part of the year. Extreme dryness with intensely hot summer and cold winter are characteristics of the climate. The mean minimum temperature ranges between 7.3 to 7.6^{0}C whereas mean maximum temperature ranges between 46 to 47^{0}C in all these districts.

2.3. Rainfall:

Total annual rainfall in these districts is 2713 mm with total rainy days 27.

2.4. Hydrogeological condition:

Soil type is found different but clay is common in these districts; other major soils are sandy, sandy loam, silt and kankar.

4.4.1 Lithology

Lithologically (Table 2), the area is transected by a quartzite rocky ridge, a prolongation of Aravalli Hills extending along the southern border of Delhi and ending to the north on the west bank of the Yamuna river. The Ridge acts as a water divide between the eastern and western parts as shown in figure 4. The distribution of these soils divides into four geographical sub-regions. The north-west region is covered by calcareous, silty clay loam, the north-east soils are calcareous, silty, clay, and sandy-loam type, the southern region is occupied by the rocky Aravali ridge with dissected land spreads and the south-west zone is covered by sandy-loam (Kumar et al., 2006).

The alluvial deposits of Quaternary age are mainly composed of unconsolidated clay, silt, sand with varying proportions of gravel and kankar (pans of lime carbonate). The alluvial formation is further divided into Newer Alluvium, belonging to recent age and referring to the sediments deposited in the flood plains of Yamuna river and also along water courses of major streams flowing from the hills, and older alluvium which is the sediments deposited as a result of past cycles of sedimentation of Pleistocene age and occurring extensively in the alluvial plains of the territory

Newer alluvium, which is confined to the flood plains of Yamuna, is characterised by the absence of permanent vegetation (due to periodic flooding) and lack of kankar and is recent in age. It is mainly formed of sand, silt and clay lenses. The water bearing sands in the newer alluvium, lying in the east and south-east of the ridge, are in close contact with the sands of the Yamuna river bed. The thickness of the newer alluvium is not less than 122 m in any location. The newer alluvium along the surface water course consists of generally unconsolidated stream-laid silt, sand and kankar and is impregnated with salt.

The older alluvium occurs as interbedded, lenticular and interfingering deposits of clay, silt, sand and kankar ranging in size from very fine to very coarse with occasional gravel. The kankar or secondary carbonates of lime occur with clay/silt deposits and sometimes as hard/compact pans. The sand component ranges from 8.3% to 2.2% whereas the clay component ranges from 91.7% to 97.8%. The older alluvium occurs in the western part of the NCT of Delhi. Older alluvium is predominantly clayey in nature in major parts of territory excepting the nearly closed alluvial basin of Chattarpur where the alluvial formation is derived from the weathered quartzite rocks.

In the western and northern areas of Najafgarh, Kanjhawala and Alipur the thickness of alluvium is 300m and more. In the Chattarpur basin the alluvium thickness varies from a few meters near the periphery to 125m in the central part near Satbari bandh. In the City area between the ridge and river Yamuna and the northern parts of Mehrauli the thickness of alluvium increases away from the outcrops and is within 100m at most places. In the flood plains of river Yamuna, covering parts of Alipur, City and Shahdara, the thickness of alluvium varies from 66m to 300m. These areas exhibit predominantly clayey nature of alluvial formation generally beyond shallow depths. The top horizons in the depth range of 10m to 50m are generally sandy in nature (Kumar et al., 2016).

Table 2:- Distribution of lithology, Delhi

Age Group	**Lithology**	**Hydrological Condition**	**Groundwater Potential**
Newer Alluvium (Quarternary)	Yamuna sand, slit and clay with gravel	30-40 m thick unconfined to semiconfined aqifers	Very large field 100-280 m^3/hr
Older Alluvium (Tertiary)	Predominantly clay associated with fined grained aeolian deposits	Fairly thick regional extensive, semiconfined aquifers	Large field prospects 30-100 m^3/hr
Delhi super group (PreCambrian)	Mainly sand with minor silt, clay & kankar	Fairly thick regionally extensive aquifers	Low field prospects 10-30 m^3/hr

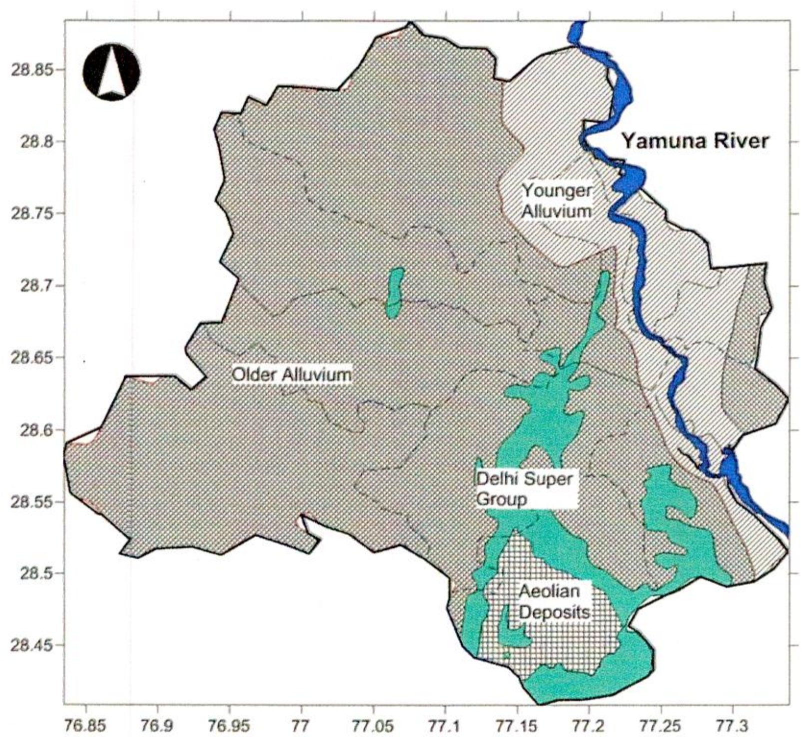


Figure 4: Lithology of Delhi

4.4.2 Groundwater availability

The gross groundwater draft is maximum in Delhi south west district i.e., 127.78 MCM whereas minimum in North district i.e., 9.68 MCM. Dynamic groundwater resources in Delhi have been assessed by the Central Ground Water Board (CWGB) as 292 MCM, while the present withdrawal is 7% above it. Seven of Delhi's nine districts are categorized as overexploited with respect to dynamic groundwater resources indicating that groundwater recharge is much lesser than withdrawal. The availability of groundwater in Delhi is controlled by the hydrogeological conditions characterised by the city's different geological formations–be it alluvium formations or quartzite hard rocks. The city's deeper aquifers in the range of 30-60 m are mostly underlain by saline water, limiting the availability of groundwater.

The Delhi Jal Board (DJB) supplies 815 MGD (including around 100 MGD from groundwater). The deficit in drinking water supply works out to be 112 MGD. The groundwater resources of the district though over exploited, it can partially meet deficit in drinking water supply (Shekhar et al., 2009).

On an average they get as low as 15 litres per capita per day and very often have no dependable water supply. Many have resorted to groundwater extraction, but usually do not use it for cooking, drinking or bathing purposes, as they find its quality very poor. However, very often, they do not have a choice. Even in the best of times, the poor in Delhi get no more than 40 litres of water per capita per day. Typically the groundwater depth in the city ranges from 1.2 m in the Yamuna flood plain to more than 64 m in the southern part of the Delhi ridge. The area across southern Delhi ridge is characterized with marginal alluvium deposits where depth of overburden ranges from 60m to 94m (Singh et al., 2017).

Depth to water level of the districts shows large variation. Pre-monsoon and post-monsoon water level data are collected during May and November months, respectively and shown in Table 3 and figures 5 & 6. The depth to water level during pre monsoon water level in the east district varies from 3.60 to15.74 mbgl and post monsoon water level varies from 3.23 to 16.89 mbgl. The pre monsoon water level in the north-west district varies from 2.23 to 16.32 mbgl and post monsoon water level varies from 1.32 to 17.21 mbgl. The depth to water level in this north district ranges from 2.14 to 11.54 mbgl in the pre monsoon period and 1.68 to 8.73 mbgl during the post monsoon period. Depth to water level during pre monsoon period in the south west district ranges from 2.40 to 53.17 mbgl and during post monsoon period, it varies from 0.69 to 54.02 mbgl. The depth to water levels during pre monsoon period in the area varies between 3m-48 mbgl giving rise to a depth difference of 45 m. As shown in the figure 5 in New Delhi area water levels ranges between 15–36 mbgl whereas in Central Delhi the water levels ranges between 6 – 12 mbgl. The water levels are deepest in South Delhi ranges between 36-48 mbgl and in South East water level ranges between 10- 45 mbgl. The water levels rest are at shallow levels being 3 -15 mbgl. In South west district while in North and North west district water level ranges between 3- 9 mbgl. The depth to water levels during post monsoon period varied between 46 m in South district and 40 m in South east part. The map of post monsoon indicated no major changes in pattern of depth to water levels as compared to pre monsoon period.

In Delhi east, north-west, south west district as a whole are categorized as over exploited with stage of groundwater development. This indicates the reality that the groundwater resources of the districts are stressed.

Table 3: Change in water level during pre and post monsoon.

		Pre-monsoon (mbgl)	Post-monsoon (mbgl)
1.	Min	3	3
2.	Max	48	40

4.4.3 Water level fluctuations

A comparison of water levels from 1962 to 1977, 1977 to 1983 and 1983 to 1995 brings out a clear picture of water level declines in major parts of the territory. During 1977, the water table was within 6m below ground level in major parts of the territory deepest being 23 mbgl at near Quatab minar in Mehrauli Block. In 1983 the depth to water level declined to 10 mbgl in major parts with the deepest level being 26 mbgl at Mehrauli in Mehrauli Block. In 1995 the extent of area with water levels in the range of 10 to 20 mbgl has substantially increased and the deepest water level is about 35 mbgl in Chattarpur basin of Mehrauli block.

During 1962 – 1977, the water level have declined by 2m or less in most parts of Delhi, rise being confined to northern parts of Mehrauli block and south western parts of City block. In the Central Najafgarh block and south – eastern part of Chattarpur basin in Mehrauli block, a fall of 2m to 6m is observed. During 1977-1983, water table declined by 4m or less in most parts of Delhi and rise being confined to small areas in northern Delhi and in the southern part of Chattarpur basin (Rainwaterharversting.org). If compared to nearby area of Delhi i.e. Sangrur district of Punjab in 1982 water level declined by 3-4 m and a decline upto 25 m in last 4 decades was observed in Haryana state.

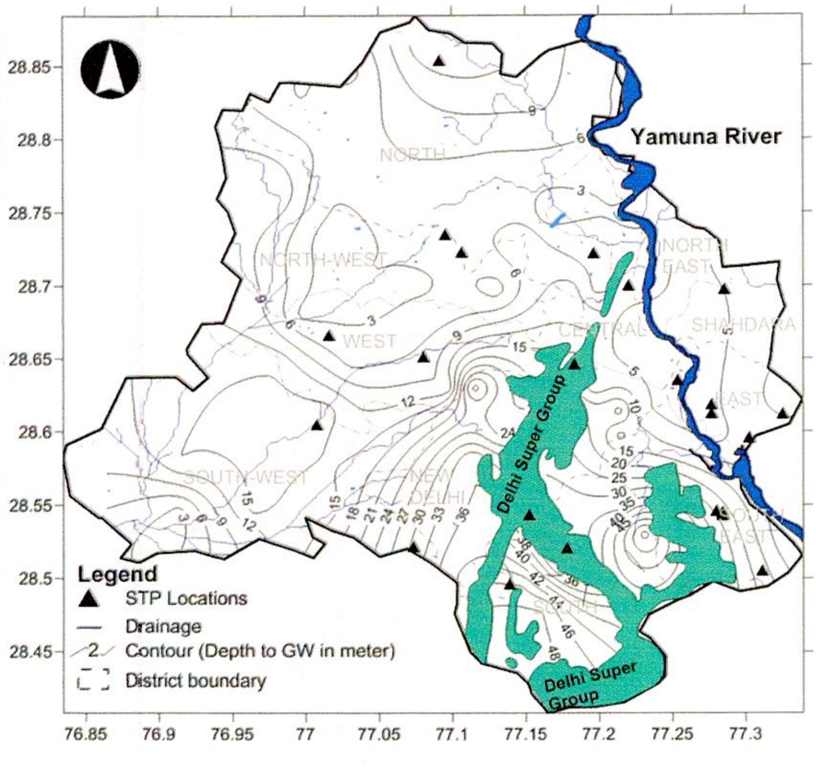


Figure 5: Water level variation during pre-monsoon

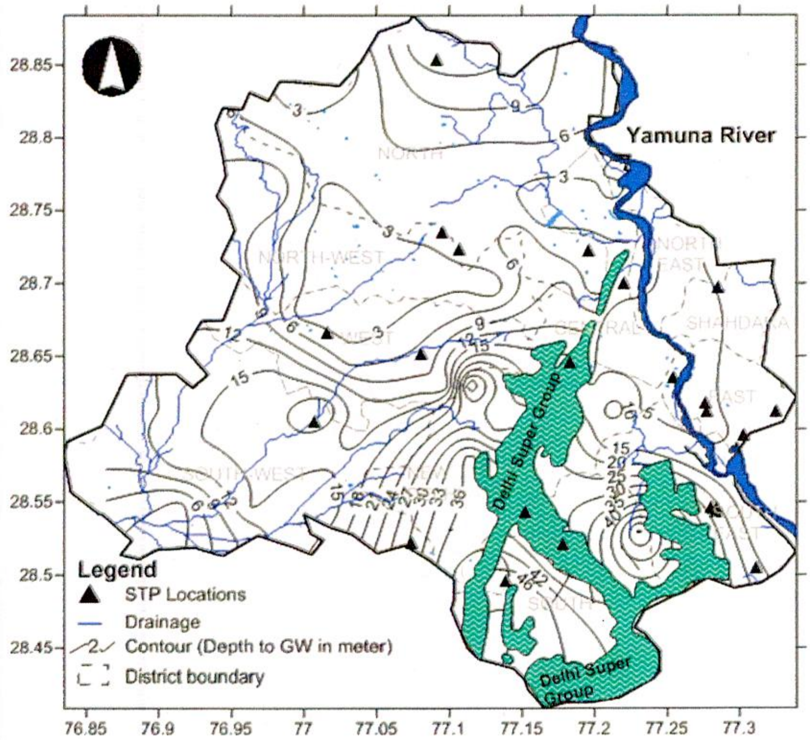


Figure 6: Water level variation during post-monsoon

4.4.4. Groundwater quality

Quality of groundwater is fresh upto 40 mbgl. Below this depth, groundwater is moderate to highly saline. Reported Iron content is 1.45 mg/l. The general ranges of various important chemical constituents in the ground water samples collected from New Delhi district are given in Table 4.

Table 4: General ranges of various chemical constituents in ground water

Chemical Constituents (mg/l)	**Range**	**Permissible limit (IS 10500-2012)**
Bicarbonate	119.26-305.85	600
Chloride	46.70-592.57	1000
Nitrate	12.7-373	45
Sulphate	50.3-750	400
Fluoride	0.42-1.42	1.5
Calcium	36.36-195.5	200
Magnesium	23.84-202.65	100
Total Hardness as $CaCO_3$	211.31-1333.9	600

Sodium	50.91-789.1	200
Potassium	0.98-104.1	
Iron	1.45-1.47	No relaxation

4.4.4.1. pH

The pH level in east district ranges between 8.41-8.95. The pH level in north-west district ranges between 7.3-9.47. The pH level in north district ranges between 8.13- 8.87.The pH level in south west district ranges between 8.15-9.38.

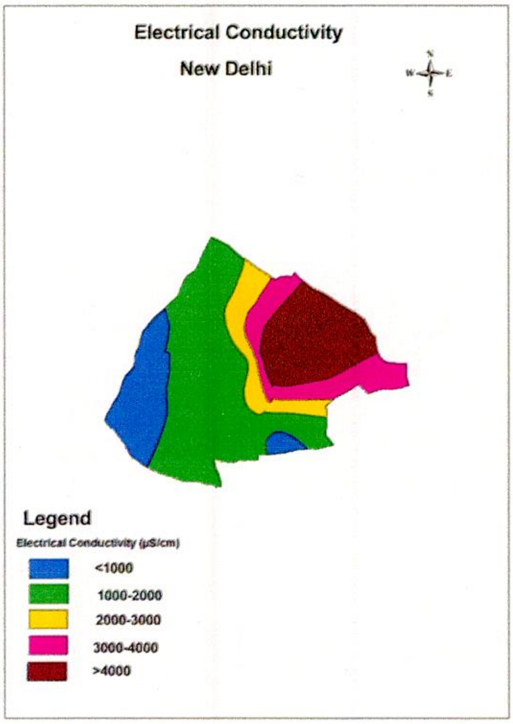
4.4.2. Electrical conductivity

Electrical conductivity vary from district to district as shown in figure 7.Electrical Conductivity in the East district has been found to vary from 550 to 5084 μS/cm at 25^0C. EC in major part of the district is within 3000 μS/cm at 25^0C. EC in excess of 3000 μS/cm at 25^0C has been observed in the northern part of the district. Electrical Conductivity in the north west district has been found to vary from 225 to 13340 μS/cm at 25^0C.

EC in excess of 3000 μS/cm at 25^0C has been reported from the district except south eastern and northwestern parts. Electrical Conductivity in the North district has been found to vary from 600 to 5200 μS/cm at 25^0C. There is wide variation of Electrical Conductivity in the district. EC in excess of 3000 μS/cm at 25^0C has been observed in the southern part of the district. Electrical Conductivity in the South West district has been found to vary from 529 to 17240μS/cm at 25^0C.

4.4.4.3 Anions (Bicarbonates, Fluoride, chloride, nitrate, sulphate)

Concentration of sulphate and nitrate are found greater than the permissible limit (IS 10500-2012). Sulphate ranges between 50.36-750 mg/l whereas nitrate ranges between 12.7-373 mg/l. Spatial variation on nitrate in Delhi is shown in Fig. 8. Concentration of chloride ranges between 46.7 – 50.27 mg/l while of bicarbonate ranges between 119.26-305.85 mg/l.



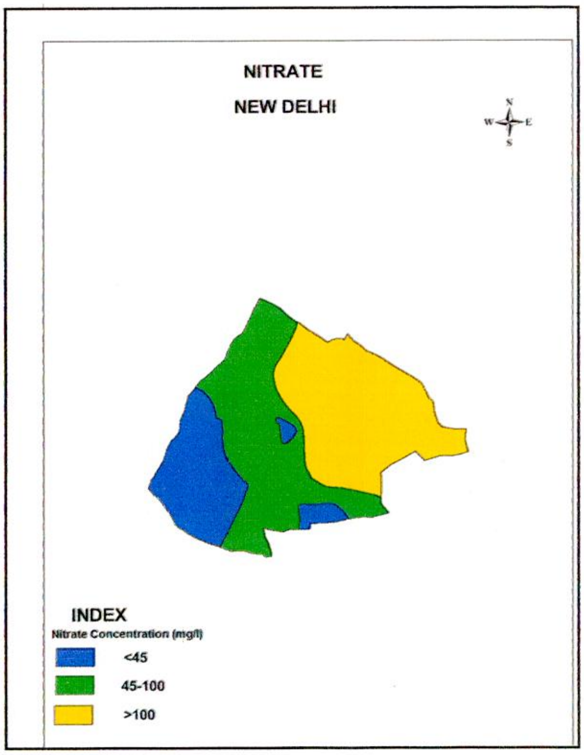


Fig. 7: Electrical conductivity variation in Delhi Fig. 8:- Nitrate concentration variation in Delhi

4.4.4.4 Cations (Calcium, Magnesium, Sodium, Potassium)

The concentration of Calcium, magnesium, sodium, potassium range between 36.36-195.5, 23.84-202.65, 50.91-789.1, 0.98-104.1 mg/l, respectively in which magnesium and sodium are above their permissible limit.

4.4.4.5 Total Hardness

Total hardness value ranges between 211.31-1333.9 mg/l and found more than its permissible limit which is 600 mg/l. The city's groundwater is getting contaminated by inadequate sewage treatment and disposal. A study by CGWB (2013) indicated high water contamination. The report based on a study of groundwater samples taken from observation wells, indicates high nitrate concentrations at 1500 mg/l--way above the BIS IS 10500 (2012) standard of 45 mg/l known to cause baby blue syndrome. The rising nitrate levels as per a Down to Earth can be attributed to the combined effect of contamination from domestic sewage, livestock rearing, landfills and runoff from fertilised fields, unlined drains and cattle sheds. This is, in particular, alarming. Reports also suggest that Delhi's groundwater has more fluoride and arsenic content than permissible limit. Craig and Anderson (1979), Miller (1979), and Kumar et al. (2009) reported breakdown of organic substances from soil and leachable sulfate from anthropogenic activities as sources of sulfate in groundwater.

Generally, groundwater in north district is potable at all depths. Pockets of brackish water in northern part of the district are observed. Potable water at all depth is only found in north district while in all other 3 districts high salinity of water is found in depths, respectively. Salinity of water in northwest increases with depth and there is no fresh water aquifer at deeper depths. Maximum reported value of Iron is 15 mg/l at some places. Ground water is saline at deeper depths in Delhi south west. Higher Iron content of 14 mg/l has been reported at Daulatpur. Higher fluoride content of 2.05 mg/l is observed at Najafgarh (CGWB 2012). Groundwater quality in East Delhi is generally fresh upto 25m depth moderately to highly saline in deeper aquifers.

5. Conclusions

The depth to water levels during pre monsoon period in the area varies between 3-48 mbgl giving rise to a depth difference of 45 m. In New Delhi, water levels ranges between 15 – 36 m bgl and in Central Delhi the water levels ranges between 6–12 mbgl. The water levels are deepest in South Delhi ranges between 36-48 mbgl . In South East water level ranges between 10- 45 mbgl. There is seen a difference in surface water bodies during pre-monsoon and post-monsoon period as shown in figures 9 & 10. During pre-monsoon period the no. of surface water bodies are 49, while during post-monsoon period no. of surface water bodies found are 126.
Present study shows that in last 35 years water level of Delhi decreased by 35 m, however on comparing this data with the data of Sangrur where water level decreased by 15.30 m shows that Delhi is much exploited area than Sangrur. But a decline upto 25 m is found in the Haryana area in last 4 decades.

Electrical Conductivity (EC) in the district has been found to vary from 670 to 4984 µS/cm at 25ºC. EC in major part of the district is within 3000 µS/cm at 25ºC. EC in excess of 3000 µS/cm at 25ºC has been observed in the eastern part of the district. Fluoride concentration in groundwater in the district is within the maximum permissible limit of 1.5 mg/l. Nitrate concentration in excess of maximum permissible limit of 45 mg/l is found in entire district except in the western part.

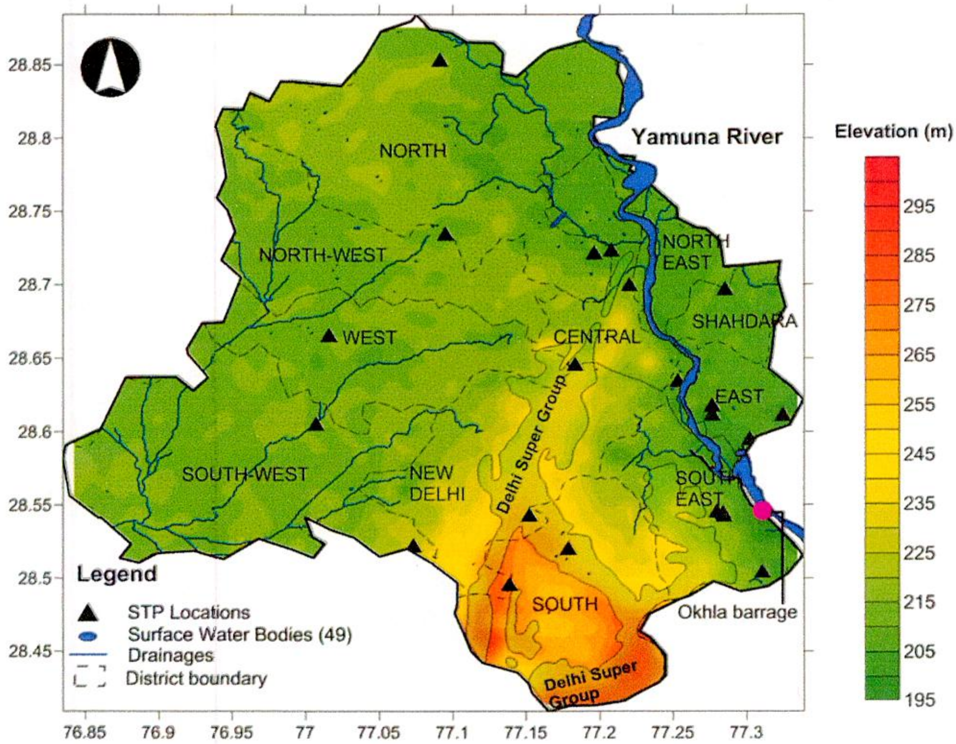


Fig. 9: Surface water bodies during pre-monsoon

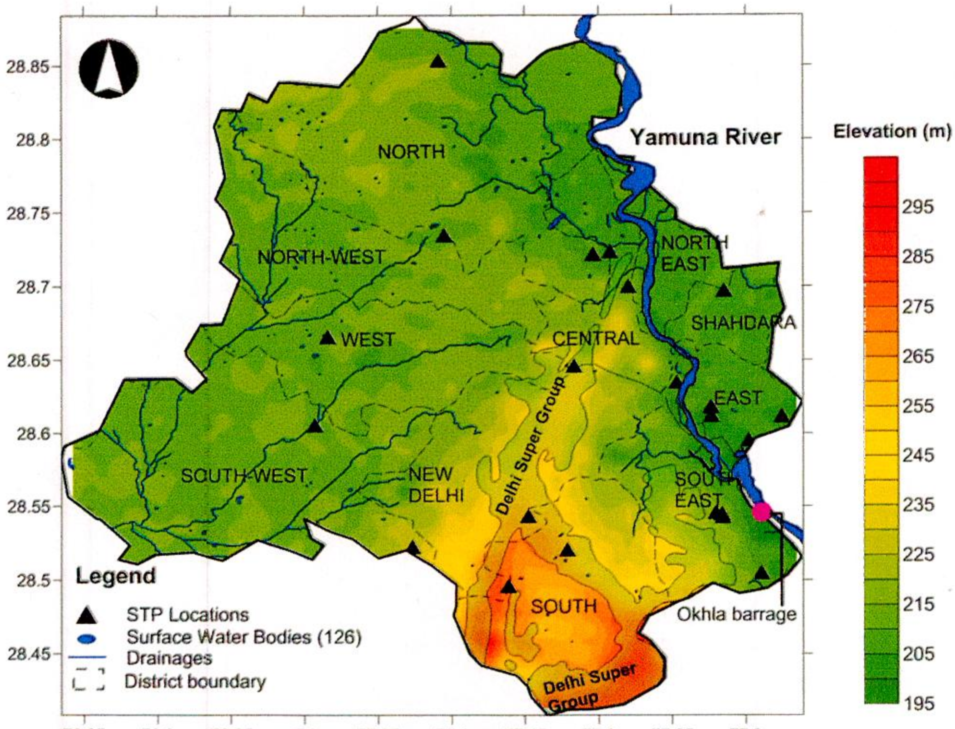


Fig. 10: Surface water bodies during post-monsoon

Recommendation

There is need for regular monitoring of groundwater quality of Delhi to estimate the presence or absence of contaminants.

The areas receiving drinking water supply from groundwater sources should be monitored rigorously for quality consideration. The contaminants, if in the manageable range, should be removed by various techniques.

The groundwater recharge areas need to be identified so that maximum recharge can be achieved. The recharge areas needs to conserved and preserved for the sustainable management of ground water and to maintain the potential of the ground water in Delhi.

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