Problems and Perspectives of Groundwater Management in Delhi

Dr. Kiran Dabas

Department of Geography, Swami Shraddhanand College, University of Delhi

Abstract

The National Capital Territory of Delhi, a fast expanding urban agglomeration, relies on groundwater as one of its significant sources of water supply. The supply of groundwater in the Delhi region is influenced by the hydro - geological processes or conditions, which are determined by numerous geological formations. In Delhi, water may be present in depths of 64 meters as in some parts of Ridge area or as shallow as 1.2 meters as in the Yamuna river flood plain. The majority of Delhi's areas are experiencing groundwater depletion as a result of resource exploitation. The quality of the groundwater varies both horizontally and vertically in space. In alluvial areas, the deeper aquifers are generally covered by saltwater. Groundwater contamination from fluoride is widespread in some parts of North-west, South-west and West districts of Delhi. The management of groundwater in Delhi strongly need to emphasis on augmenting groundwater resources, improving groundwater quality and conserving groundwater by restricting withdrawal in overexploited regions and selectively developing the city's prospective aquifers to increase drinking water supply. The study elaborates on Delhi's groundwater status and groundwater management issues.

Key Words:- Groundwater, Depletion, Exploitation, Contamination, Urbanization, Management.

1. Introduction:

The world's biggest freshwater reserve, groundwater, is crucial to the survival of a variety of ecosystems and is a key factor in the debate over food poverty and water shortages, especially in semi-arid countries. It accounts about one-third of withdrawals of all fresh water from the surface of the planet, making it a crucial renewable source of fresh water. Groundwater depletion is anticipated to worsen in the future as a result of industrial activities and climate change. Because of its ubiquitous nature, groundwater resources are thought to be more evenly distributed than surface water and account for up 90% of the world's readily available freshwater (Shiklomanov and Rodda,2003). One amazing quality of groundwater is that it is a very dependable and secure source of water supply. This has contributed to the unchecked exploitation of groundwater during the past several decades due to widespread rural electrification in India and freely accessible financing through financial institutions.

Groundwater use is desired not just in rural regions but as well as in urban areas. Urban consumption currently accounts for 10–20% of water extracted from river basins in developing nations (Gleick et al.,2002). Due to inadequate management of the limited resources, inadequate fresh water supply in urban areas and decreased groundwater recharge, the depth of the groundwater table has sharply increased in Asia's major megacities.

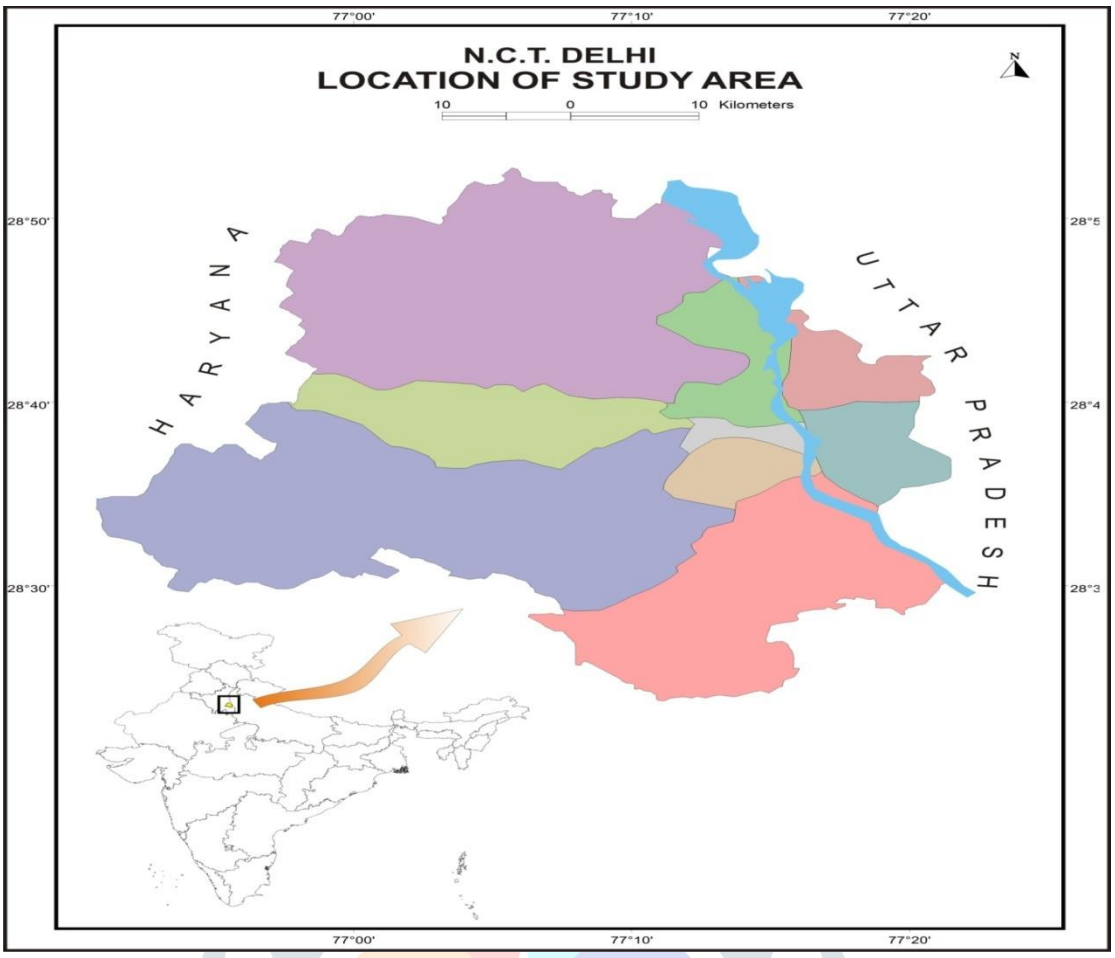
Furthermore, the surrounding regional anthropogenic activities, which have the potential to seriously harm the environment, have a significant impact on the chemical composition of groundwater (Hermides et al.,2020). One of the biggest users of the unevenly distributed groundwater resources in the world is India. Due to the poor knowledge of the mechanisms involved in the recharging and outflow of subsurface water in India, scientific data are few and are often estimates. The volume of groundwater withdrawal infrastructure has rapidly expanded, causing overuse and resource depletion (Singh & Singh,2002).

The population of Delhi has increased from 0.44 million in 1911 to 16.72 million in 2011, placing an escalating strain on the city's water supplies. In comparison to the state of Delhi's daily requirement of 1476 million m^3/day, about 1066 million m^3/day of potable water being delivered (Shekhar and Prasad,2009). In line with the city's population expansion, the need for household water is growing exponentially. Utilizing readily accessible groundwater resources leads for the reduction of the individual level water supply deficit. Because of this, groundwater supplies have been overused in seven out of Delhi's nine districts (Chatterjee et al.,2009).

According to Das (2011), the uneven alluvial plains of Delhi is a potential reservoir of groundwater for the city and the area's varied geology and topography significantly influence groundwater flow. The capital of India is experiencing a severe water crisis due to the ongoing and significant population growth (CGWB, 2006). The water distribution system operated by the Delhi government has consistently failed to meet the needs of the population. Even while household users and industry still use the aquifer to supplement Delhi's inconsistent water supply, groundwater is officially responsible for 14% of the city's water needs. Delhi's groundwater has been misused because of a growing population without a matching rise in the availability of raw water. Due to the disruption of the hydrological equilibrium, there has been a decline in tube well productivity, an increase in pumping expenses, and a rise in energy consumption. It has been noted that the groundwater is unfit for drinking at a number of areas. The study elaborates on Delhi's groundwater status and discuss various aspects of groundwater management in detail .

2. Study Area:

NCT of Delhi is situated between 76° 50′ 24″ and 77° 20′ 37″ East longitude and 28° 23′ 17″ to 28° 53′ 00″ North latitude (Fig. 1). It has a surface area of 1483 km^2 and is located between an altitude of 213 and 305 m. It is situated on the eastern bank of the Yamuna River. The distant inner position of the region and the prevalence of continental airflow have an influence on the climate, which is characterized by harsh winter in January (about 2–5 °C) and hot weather in June (around 40–45°C) and moderate mean annual rainfall (670 mm). This rainfall partly helps to the Yamuna river's flow. Nevertheless, the Yamuna river doesn't constantly have sufficient water to fulfill regional needs; as a result, Delhi primarily relies on its bordering states for its primary water supply to meet its annual requirements of water. Surface water and groundwater are Delhi's main water sources.



Source: Census of India, 2011.

Figure 1: Location of Study Area

2. Aims of the Study:

The key objectives are as follows-

1) To understand the status of groundwater resource availability and utilization in Delhi.

2) To assess the extent of contamination and exploitation of groundwater resources.

3) To suggest certain management strategies for the improvement of groundwater environment in Delhi.

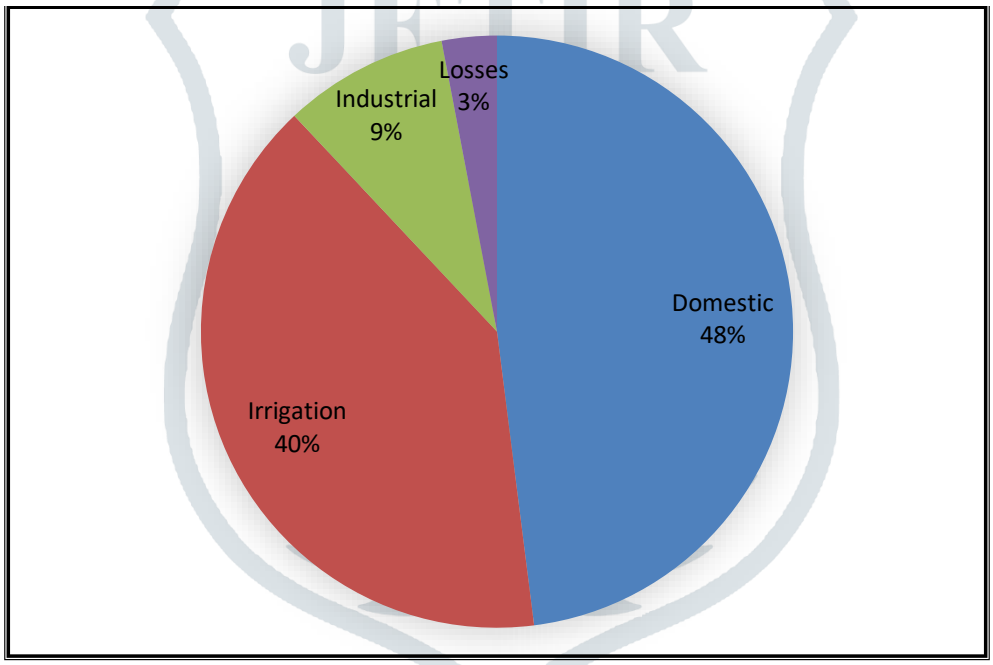
3. Database and Research Methodology:

The distinguishing foundation of any research is said to be comprised of databases and research technique. Central Groundwater Board publications, Delhi Jal Board reports, the GNCT of Delhi reports, the Directorate of Economics and Statistics, the Planning Commission reports etc. have been utilized for a thorough analysis of the research. A number of other periodicals, books, newspapers, magazines, and official websites were also referred. Tables, pie diagrams and map are used to display the data that was gathered.

4. Results and Discussion:

4.1 Availability and Utilization of Groundwater:

In many areas of the nation, groundwater is the main source of water supply. The water supply from groundwater is also a significant contributor in Delhi. Groundwater is mostly used as a source of drinking water, especially in recently developed areas. According to the CGWB (Central Groundwater Board) estimates, the total groundwater potential was assessed to be 291.8 million cubic meters (MCM) in 2008, dropped from 427.08 MCM in 1983, indicating about 130 MCM drop and overdraft during the preceding 25 years. The depths at which groundwater investigation is done range from 50 to 150 meters. The depths at which groundwater investigation is done range from 50 to 150 meters. The primary groundwater storage area is in the Quaternary sediments. Over 47945.18 acre meters of groundwater is extracted annually in Delhi, according to estimates. Salinity and misuse have had a significant influence on water availability in different parts of the city and contributed to the resource's depletion. Figure 2 depicts the ground water usages in Delhi.



Source: CGWB, 2008.

Figure 2: Groundwater Usage in Delhi

The state's water supplies have suffered as a result of the growing urbanization. In most areas, the water table has dropped between 2 and 8 meters during the previous few decades. Tables 1 and 2 display the groundwater levels recorded by CGWB in 2003 at various sites which represent groundwater is not a uniform system in its lateral extent

Table 1: Pre Monsoon Groundwater Level in Delhi

Location	Level (meter below ground level)
Tughlakabad, Pushpvihar , Ladosarai, JNU, Balbrirnagar , Satbari, Asola Bhatti	40-60
Samalkha, NCERT, Ayanagar, , Shekhawati Line, R. K. Puram, Basant Gaon, Vasant Kunj. Palam Road.	30-40
Northern part of Najafgarh Jheel, , Central Parts, South-East part of West District.	10- 20
Alongside Yamuna river, North-western parts, Northern Parts.	5

Source: CGWB, 2003

Table 2: Post Monsoonal Groundwater Level in Delhi

Location	Level (meter below ground level)
Tughlakabad, Pushpvihar, Ladosarai, Asola Bhatti, Balbrirnagar,Ghattorni, Kabul Line, Chanakyapuri, IIT Gate, Lado Sarai, R. K. Puram, Palam Road, , NCERT, Vasant Kunj, Ayanagar, Shekhawati Line, Samalkha	20-40
Northern parts of West district ,North-West district.	5-10
Samalkha, Dwaraka, Naraina belt, south eastern Part of West districts, Central parts, Mahavir Banasthali, Conaught Place, Kidwai Nagar.	10-20
Alongside Yamuna, Haroli, Libaspur ,parts of North, KheraKalan	< 2
Najafgarh Jheel, North westesrn parts, North East	< 5

Sources: CGWB, 2003.

In general, rainfall during monsoons recharges 44% of the groundwater, whereas other sources during non-monsoons recharges 31%, other sources recharge 19% groundwater in monsoon and rainfall during non-monsoons recharges 6% of groundwater. Recharge of groundwater is fairly little as a result of urbanization's significant reduction of the uncovered land surface for direct penetration of precipitation.

4.2 Quality of Groundwater:

Several types of pollutants are transported by groundwater through particular flow routes. During the lean flow period, a lack of civic facilities causes the waterways to accumulate a lot of trash and filth, which contributes to the

degradation of the groundwater. A significant portion of the western part of Delhi is affected deeply by nitrate and fluoride contamination in groundwater exceeds the World Health Organization's prescribed highest permissible limit in drinking water. Groundwater pollution is caused by hazardous substances in the soil from dumping sites as well as penetration of agricultural/urban effluent from the nearby peri-urban areas. (**Figure 3)**

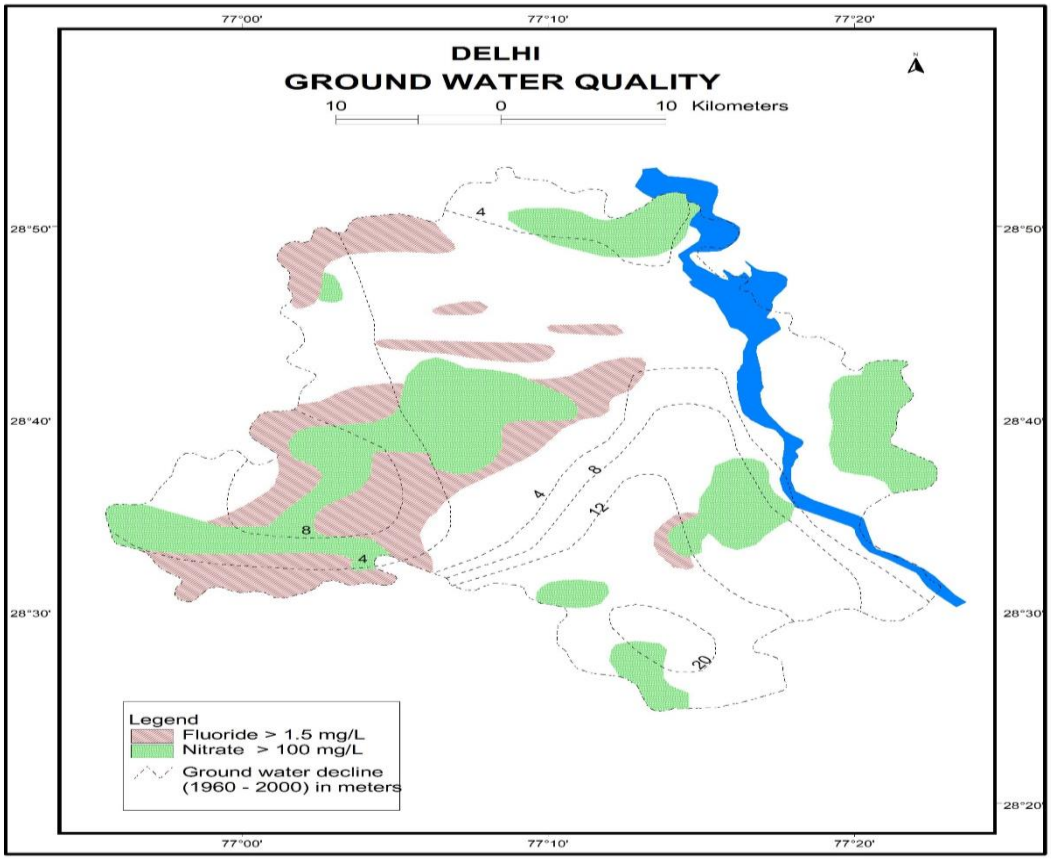


Figure 3: Quality of Groundwater in Delhi

Besides these issues, more than 70% of Delhi's populace relies directly or in-directly on groundwater to meet daily raw water needs, assuming it is both safe and abundant. Unfortunately, due to anthropogenic hazardous waste sources, groundwater is rapidly running out and becoming badly polluted with nitrate, fluoride, pesticides, and heavy metals. This results in additional ecological issues. It is almost clear that Delhi cannot be spared from a water shortage in the case of a monsoon failure.

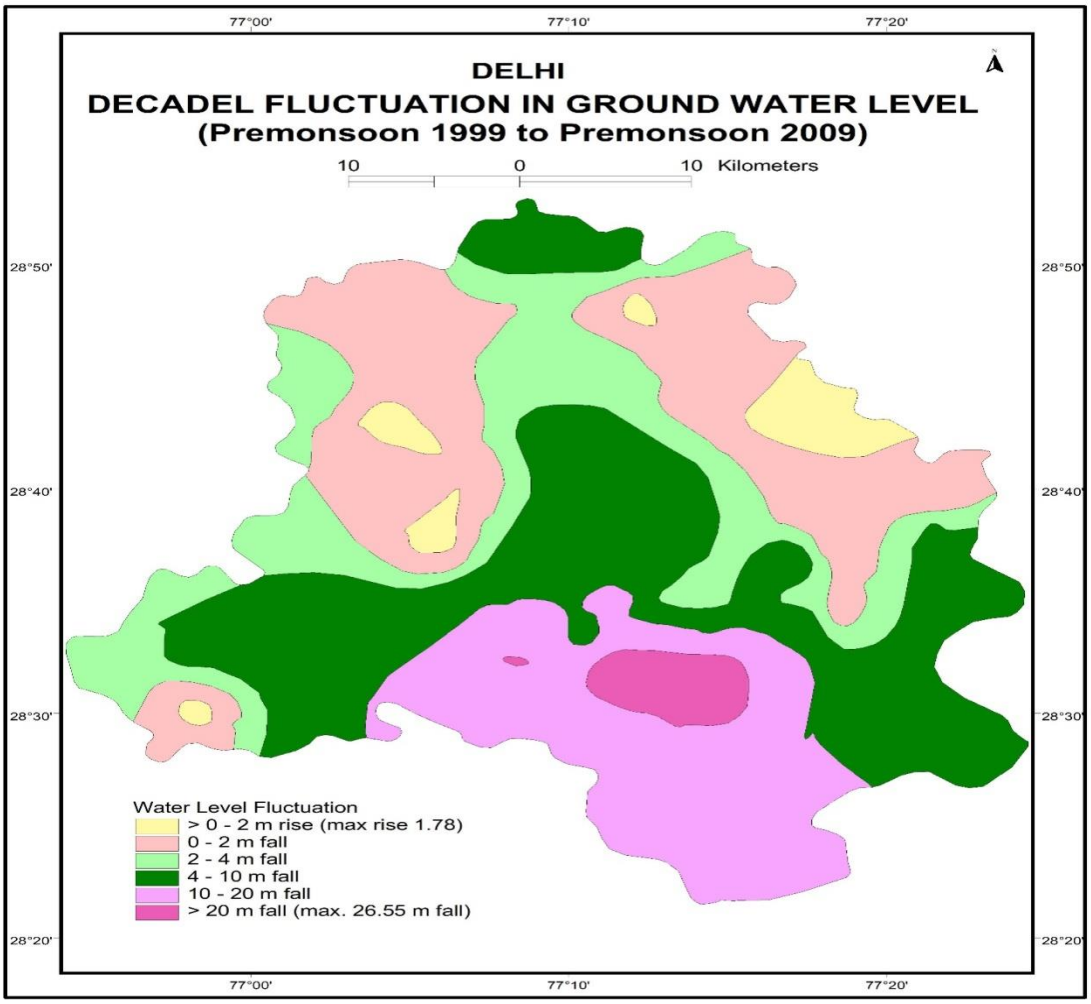
4.3 Groundwater Exploitation:

The unregulated groundwater exploration is one important aspect of Delhi's water crisis. Officially, groundwater supply fulfills 14% of the city's water needs. However the withdrawal is massive. The Delhi jal Board had around 21 rainy wells and 3000 tube wells near or on the river bed of Yamuna in March 2014. In addition, 449 deep bore hand pumps had been drilled. The government planned installing 560 deep bore hand pumps, re-boring 221 tube wells, and adding 84 more in 2015–2016.(DJB, 2018). There have been a rising number of unlicensed, Ad

hoc, and private unregulated tube wells added to this list; nevertheless, it is unknown with certainty how much water these wells really draw from the ground. As per the estimates of Centre for Science and Environment (CSE), in 2005–2006, there were around 100,000 legally registered private tube wells; however, the true number was likely between 200000 and 400000.

The city's water table has dropped by 1 meter in a decade as a result of impulsive and uncontrolled groundwater exploration. Yet, inside the capital, this rate of exploitation differed from one area to another. As stated by Central Groundwater Board (CGWB) in 2010, the water table has decreased by 2 to 20 meters in several areas of south and south-western Delhi where the growing residential demand was not being supplied by the official piped supply. (Fig. 4).

Uncontrolled water exploitation is mostly to blame for the decline in groundwater levels. The Central Groundwater Board designated south and south-west Delhi as a "Dark Zone" in 1999 due to the chronic reduction of groundwater levels, which implied a prohibition on drilling. According to the CGWB, groundwater levels in Lado Sarai have dropped an average of 10 meters or 33 feet, during the past ten years. In addition, they have decreased in east Delhi by 20 to 30 feet, in New Delhi by 50 to 60 feet, and in south Delhi by 60 to 70 feet.



Source: Shekhar, S., Purohit, R. R. and Kaushik, Y. V. (2009), Groundwater Management in Delhi.

Figure 4: Decadal Fluctuation in Groundwater Level in Delhi

5. Suggestions for Groundwater Management:

1. Rain water harvesting: Rain is a free supply of water. The goal is to stop this water from draining into them and direct it into bore wells that will transport it underground. Thus, the pipes on terrace in residential or business buildings need be linked to a bore well. It is known as "recharging of groundwater" . Delhi is 1483 square kilometers in area and average annual rainfall of 161 cm. Delhi has a water collecting capacity of 450 billion liters per year, even with rainwater harvesting equipment operating at 50% efficiency This is equivalent to around 35% of the city's overall consumption of water. For raising the level of groundwater at local level, the government should encourage individual rainwater collection initiatives at the colony and household levels. It is also recommended that harvesting should be mandatory for all commercial users and strongly enforced by legislation. The general public should be made aware of the idea and advantages of RWH, and the government should offer towns and families the required technical and financial help to establish the RWH system.

2**. Use of Scientific Techniques**: The CGWB should use scientific techniques to monitor groundwater conditions and release its results. They should have access to the aquifers' typical yearly recharge rate and be in charge of creating a proper strategy and set of rules for aquifer water management. By the use of advance instruments like remote sensing, geographic information systems, etc. combined with information technology systems, groundwater management might be significantly enhanced. By utilizing these tools, the groundwater management plan may be improved in terms of accuracy, comprehensiveness, and effectiveness. A "Pani Puraskar" may be presented to the areas where the groundwater table has been preserved or increased during the previous five years in order to encourage people to utilize water responsibly.

3. Development of Water Bodies: The increasing urbanization process has had an impact on the water bodies in Delhi's NCT. There are between 700 and 1000 ponds in the city, which need immediate attention for revival. These water bodies are part of the groundwater recharge plan since they are aquifer gateways. Raising the water table and improving the quality of groundwater hence requires maintaining quality and levels of groundwater in aquifers. Delhi's lost water bodies must be restored to the greatest degree feasible. Along with this, water bodies, significant depressions, and other groundwater recharge places should be identified and safeguarded against encroachment and filling at the time when Zone Developmental plan are being created.

4. Control of pollution: Pollution decreases the amount of usable water and raises the cost of water treatment. Non-action on pollution has a huge financial cost, and certain effects could be permanent (contamination of groundwater, drinking water, ecosystem losses). Although Delhi has passed legislation to safeguard its water resources, its execution sometimes lags. The "polluter pays" theory can encourage a shift in perceptions about pollution and increase the amount of waste water that is recycled.

6. Conclusion:

Groundwater is an important sources of water for a number of human endeavors. In Delhi, both urban and rural regions are experiencing growing reliance on groundwater supplies as a result of the diminishing quality of surface

water. As a result of resource overuse, both the quality and quantity of groundwater are always under danger. Because of rising needs of Delhi's growing population, aquifers have been overused. Another effect of Delhi's growth is the contamination of aquifers by garbage. The general groundwater status in the majority of the city points to a drop in levels of groundwater as well as decline in quality of groundwater. The appropriate distribution, management, and conservation of water resources are key components of the solution to the problem of water. Artificial recharge and proper functioning of rainwater harvesting infrastructure, pollution control and by reviving natural water bodies can be effective in preventing levels of groundwater from declining. The CGWB, DJB, CPCB and local municipal authorities must all work together under the current circumstances to implement comprehensive remedial actions. For these management strategies to be effective, stakeholders must be involved directly in the implementation process. Thus, there is a critical need for widespread public education and mobilization on the many aspects of groundwater management in NCT Delhi. The total water resources of the NCT of Delhi should be managed holistically, taking into account technical, ecological, social, and economic factors.

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