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## Assessment of the Water Supply System in Jaipur City: Challenges and Future Prospects

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### Abstract

*Water is an essential natural resource for sustaining life, and its demand has increased significantly due to rapid population growth, urbanization, and industrial development. Jaipur, one of the major urban centers in India, faces serious challenges in meeting its water requirements. The region lacks perennial river systems, and many traditional surface water sources have deteriorated over time due to neglect and overuse. At present, the city primarily depends on the Bisalpur Dam, which was commissioned in 2009 and is highly dependent on rainfall variability. In the absence of adequate surface water resources, groundwater has been extensively exploited. According to the Central Ground Water Board (2020), the district has an annual groundwater recharge of 77.71 million cubic meters, while the gross annual groundwater draft is 1617.21 million cubic meters, indicating a severely overexploited condition with a recharge stage of 231.21%. This overexploitation is particularly severe in areas such as the Jhotwara block, posing a major threat to long-term water sustainability. Urban expansion and increasing surface concretization have further reduced natural groundwater recharge by limiting rainwater infiltration. As a result, aquifer replenishment has declined significantly. In addition to quantity issues, water quality has also become a major concern. Many residential areas receive limited or irregular water supply, often of poor quality. Industrial and domestic wastewater discharge has led to severe pollution of local water bodies. For example, groundwater in Sanganer is affected by high fluoride levels, while parts of the old walled city of Jaipur experience elevated salinity. Overall, Jaipur is facing a dual challenge of declining groundwater levels and deteriorating water quality. This highlights the urgent need for sustainable water resource management, conservation strategies, and improved pollution control measures to ensure safe and reliable water supply for the future.*

**Keywords:** Water supply system, Groundwater depletion, Urban water management, Water scarcity, Jaipur city, Bisalpur Dam, Water quality, Overexploitation, Urbanization, Sustainable water resources.

### Introduction

Water is an essential resource for life, and it is difficult to imagine a world without it. However, inadequate efforts toward its conservation and quality maintenance have led to increasing concerns regarding sustainability. Sustainable development emphasizes the availability of clean air, water, and land, with Sustainable Development Goal 6 specifically focusing on ensuring access to clean water and sanitation for all. Rainwater is the primary natural source that replenishes groundwater aquifers and fills rivers, lakes, ponds, and reservoirs. Failure to conserve rainwater leads to surface runoff and reduces groundwater recharge, ultimately lowering the water table. The present study focuses on Jaipur, the capital city of Rajasthan, which had a population of approximately 3,258,299 according to the 2011 Census. Historically, Jaipur was preceded by Amer (Amber), located about 11 kilometers away, which was designed with advanced water management systems to ensure a reliable water supply for both residents and military needs. Natural

and artificial water structures such as Maota Lake, Jaigarh Fort tank (Tanka), and numerous baoris (stepwells) played a significant role in traditional water harvesting and storage.

When Jaipur was established in 1727 by Sawai Jai Singh II, it was planned with a strong emphasis on water conservation. Underground reservoirs such as kunds at Badi Chaupar and Choti Chaupar were constructed to store water. However, over time, many of these traditional water systems have deteriorated due to neglect and urban expansion. The once-important Ramgarh Dam, which supported both drinking water supply and irrigation, has remained dry since 2000.

At present, the Bisalpur Dam, located in Tonk district, is the primary source of water for Jaipur, Ajmer, and Tonk districts. It began supplying water in 2009 and is the largest masonry concrete dam in Rajasthan. However, its distance of about 120 kilometers from Jaipur creates several distribution challenges, including pipeline leakage, low water pressure at consumer ends, and incomplete pipeline connectivity across all tehsils. As a result, many rural and peri-urban areas not connected to the system face acute water shortages, particularly during summer months. Overall, the study highlights serious concerns regarding water resource sustainability in Jaipur, emphasizing the need for improved conservation, infrastructure development, and efficient water management systems.

### **Study Region**

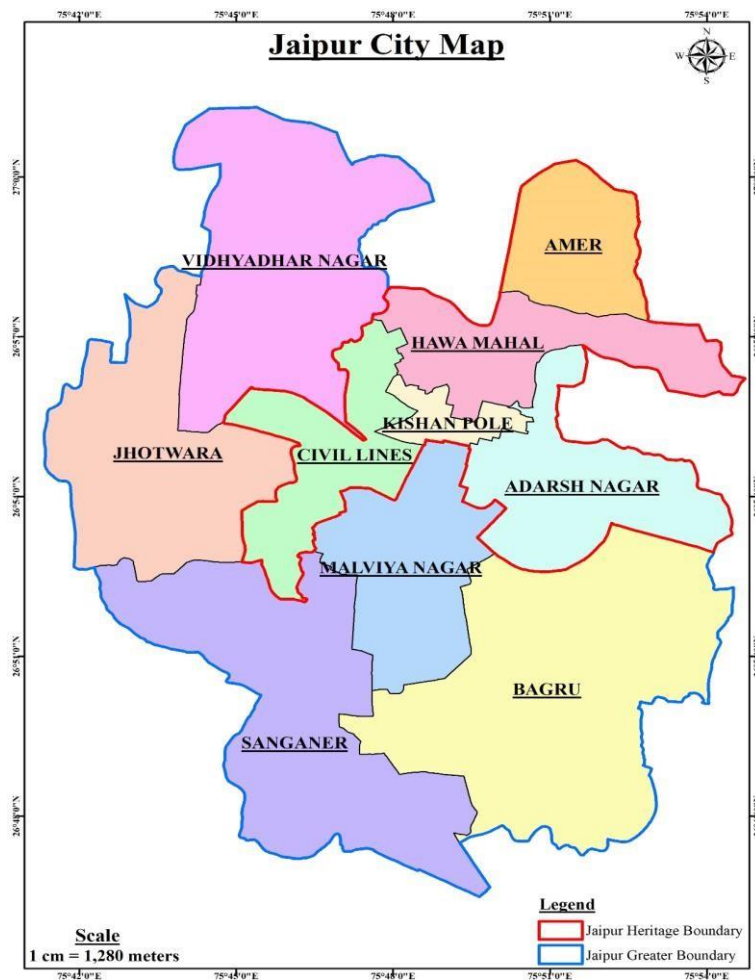
The city of Jaipur was established on 18 November 1727 by Sawai Jai Singh II, who was patron of mathematics and astronomy. The city is one of the planned cities of medieval India having a latitude of 26°9'N and a longitude of 75°8'E with an average altitude of 431 meters. The city is built on the grid pattern which shows the acumen of the ruler in geometry and architecture.

The city is surrounded by Nahargarh hills in the North and Jhalana hills in the East. In the south, it opens into a plain. The city is densely populated with a population of 4.008 million in 2021. It is situated in the eastern part of the state and is one of the fastest growing cities of India.

**Climate:** The city experiences semi-arid climatic conditions. The summer season commences from April and the temperature rises to a peak of 45 ° Celsius in summer in May -June. Summers are followed by monsoon which begins from first week of July and downpour is received till mid-September. The city receives its maximum rainfall in the monsoon. This rainfall is useful for recharging the aquifers and serve as a store house for use in agricultural and allied activities. Monsoon is succeeded by the winter season when the temperature dips and the lowest temperature is 10° celsius in January. Mawath, a local rainfall occurs in the winter season due to western cyclonic disturbances and it is good for wheat, a rabi crop.

### **Drainage**

The overall slope of the city is from hills in the north to plains in the south and then to the east. There are some seasonal streams in the region. The Dravyawati river rises from the Nahargarh hills in the North of the city. The dhund river rises from the east and flows from North to south at a short distance. Bandi flows in the north west of Jaipur city about 20 kilometers away from Jaipur. Pre independence all these rivers carried fresh water in them which was used by people for their consumption. But today due to increased anthropogenic interference the rivers look like a dirty nallah. Ramgarh dam once the major source of water supply in Jaipur city was constructed on Banganaga river, 30 kilometers away from Jaipur. The current water supply system is from the Bisalpur dam located 120 kilometers from Jaipur city built on the Banas River.



## Objectives

1. To study about the traditional water supply systems in the Jaipur city.
2. The paper will explore the water supply systems of Jaipur district post-independence and their present situation.
3. To analyze how the water management issue has become a big concern in the study region and how can the problem be minimized.

## Data Base and Methodology

Both primary data and secondary data has been used to analyze the situation. Primary data has been collected through field visits to some selected sites like the ancient bawaris, old wells, Man Sagar Lake, Mawatha lake, Sagar Lake, Galtaji, Ramgarh dam, Bisalpur dam to get an insight to know about their present situation and how they were functioning before. Secondary data has been compiled from the government reports like reports of Public Health and Engineering Department, Reports of Central Ground Water Board, Report on the Aquifer Mapping and Management of Ground water Resources 2020, NGO reports etc. Both the primary and the secondary data has helped to analyze the situation of ground water reserve sin the study region.

## Hypothesis

Increasing urban population has an adverse effect on both the quality and quantity of both surface and ground water resources in Jaipur city.

There is a demand deficit of water supply in the city due to institutional failure.

## Results and Discussion

The city of Jaipur was established in such a way that the topography was utilized in the best possible manner to preserve water. The city is surrounded by the Nahargarh hills in the North, and Jhalana in the East, which

is a part of the Aravalli hill ranges, there are isolated and discontinuous hillocks in the west and the south of the city and towards the south there is open plain. So, the city being surrounded by the hills allowed for the natural recharge of the water. When the city of Jaipur was established, there was an increased focus on the canals, ponds, reservoirs, dams, tanks, kunds, wells, step wells, channels and aqueducts. This system was helpful in conserving the rain water and its distribution for catering the various human needs within and outside the city. The ruler of Jaipur was very much concerned with the water supply system that he had given enough attention on the problem of water resources since beginning.

There was an integrated system of water management in the city like kunds existing in the centre of Bari Chaupar and Choti Chaupar which were further linked to the wells and the stepwells. Several bawaris were constructed in and around the region which provided sweet water to the residents and also helped in recharging the aquifers. Some prominent bawaris include Pana Meena ki bawari, Kale Hanuman ji ki Bawari, Jagga Bawari, etc. The ancient capital Amber has a large number of water bodies like lakes, Kunds or tanks, Baolis or step wells. The most prominent being the Maota lake located below the Amber palace. Another is the Sagar Lake situated to the north west of Jaigarh fort. There are two bawaris named as Khasa bawari and the Panna Meena ka kund which are located in the

Amber. Similarly, there is an elaborate arrangement of water supply in the Nahargarh and Jaigarh fort which throws light on the fact that water was central to the planning of the city. Wells and open wells were once the important source of water supply like in 1700. The early water supply of Jaipur district initially relied upon the ground water but the topography of Jaipur was considered and the drainage pattern allowed for recharge of the ground water. The Dravayawati river was also dammed to utilize the water. However, this water system was able to meet the demand of the city until the first quarter of the 20<sup>th</sup> century.

villages. From 1925 onwards with the generation of the power system the water was brought to the Jaipur district. By 1931, water was reaching the Jaipur city through Amanishah Nallah system and the Ramgarh dam system. In 1953 the capacity of Ramgarh dam was increased from 9 million liters per day to 27 million liters per day. In 1963 the capacity of the dam was further increased from 27 million liters to 53 million liters. In 1976 the capacity was increased to 129 million liters per day. In the 1980's the Ramgarh dam started showing the downfall. After 1983-84, the water level in the Ramgarh dam never went above 54 feet. By 1999 there was no water recharging the dam. The dam was silted up to 14 feet which led to the reduction in its storage capacity. There was illegal encroachment in the catchment area of the lake which intercepted the flow of water into the dam.

Agricultural activities rose in the area. Thus, the failure of the Ramgarh dam to supply water led to over dependence on the ground water resources.

Due to the drying up of the Ramgarh dam, emergency measure was sanctioned in 1989-90 which led to the installation of 202 handpumps and 31 tubewells, later these handpumps became abandoned or dried up. Thus, there was a need for a new water supply system for Jaipur. The Bisalpur project came up in 1990 after other investigated sources were found to be inefficient. The Bisalpur dam is located in the Tonk district about 150 kilometers from Jaipur and supplies water to Jaipur, Tonk and Ajmer district. It started supplying water to Jaipur since 2009. The capacity of Bisalpur dam is 1095 million cubic meters. The Bisalpur system consists of two parts: a transmission system and transfer system. The Bisalpur project is conceptualized in such a manner to meet the water needs of a fast-growing city and to reduce its over dependence on the ground water reserves. Phase 1 of the Bisalpur project was designed in such a manner to supply 400 MLD with 360 MLD for Jaipur city and 40 MLD for the rural areas. The Phase 1 expansion program is designed in such a manner to provide a total of 540 MLD of treated water to Jaipur city and 60 MLD to the rural areas. Rainwater which recharges the aquifer is still the significant source of water supply and is used in the agriculture, industrial and domestic sector. Public Health and Engineering department is responsible for supplying potable water to the people here. According to the PHED report (2012), there are a total of 390,893 water

connections with 352,393 working connections, 384,058 metered connections, 6835 flat rate connections, 329,093 domestic connections, 51246 non-domestic 1 connection, 3719 industrial connections and 1170 public stand post. Another common source of water supply to the areas where PHED does not supply water is through tanker transportation.

Since post-independence there has been rapid population growth in the Jaipur city in 1911 and 1921 the population rate was in negative due to epidemics throughout the country. Since 1951 the population has been growing rapidly. During 1951-61 the population growth rate slowed down due to change in the definition of the urban areas but since then it has been increasing.

**This urbanization has posed serious impacts in the following ways:**

#### **Urban Impacts on Hydrology**

In the initial stages of the expansion of the city, the expansion took place in the foothills and thus it could not distort the surface drainage patterns. When the expansion took place, people began to fill, block and divert the streams of Jaipur. There were around 518 rivulets originating from the Aravallis. 398 1<sup>st</sup> order stream, 92 2<sup>nd</sup> order stream and 25 3<sup>rd</sup> order stream and 3 4<sup>th</sup> order streams. Many streams were used for dumping garbage and many streams have been blocked or have been filled for the construction purposes.

#### **Urban Impacts on the Surface water Degradation in the Quality of water**

Industries around the prominent water sites have greatly degraded the quality of surface water. The Amanishah Nallah has become so foul smelling that it is difficult to stand by the side of it. Chandlai lake located in the Chaksu block is heavily polluted. These polluted water resources not only become the breeding ground of mosquitoes but also pollute the ground water by direct seepage to the aquifers.

Depletion of surface water: A look at the land use change in the Ramgarh dam area

Indicates that the agricultural activities which greatly increased in the region led to a reduction in the water capacity of the dam.

#### **Urban Impact on Ground water**

Jaipur's ground water resources exhibited high water table and good quality originally. Today the ground water reserves have depleted beyond a critical limit. Urbanization and industrialization have led to the overexploitation of the water resources.

#### **Destruction of Ground water Recharge System**

Anthropogenic activities like deforestation, destruction of local water systems, stoppage of river flows and paving/concretization has led to the destruction of the natural recharge systems.

Deforestation results in the loss of the top most soil and thus reduces infiltration. As the built-up land increases the recharge to the ground water is reduced. Thus, the land use change greatly affects the recharge potential of an area. The alluvium areas contribute to the recharge and are now considerably reduced.

**Table 2: Status of Ground water extraction in Jaipur**

| Assessment Name | Unit | Total Annual GW recharge (in Ham) | Stage of GW extraction (%) | Categorization |
|-----------------|------|-----------------------------------|----------------------------|----------------|
| Amber           |      | 4181                              | 224.04                     | Over exploited |
| Bassi           |      | 5602.07                           | 230.86                     | Over Exploited |
| Chaksu          |      | 6076.9                            | 238.47                     | Over Exploited |
| Dudu            |      | 1003.26                           | 115.31                     | Over Exploited |
| Govindgarh      |      | 5329.25                           | 332.59                     | Over Exploited |
| Jalsu           |      | 4316.62                           | 214.59                     | Over Exploited |
| Jamwa Ramgarh   |      | 7774.81                           | 153.76                     | Over Exploited |
| Jhotwara        |      | 4882.87                           | 474.95                     | Over Exploited |
| Kotputli        |      | 2750                              | 282.62                     | Over Exploited |

|            |          |        |                |
|------------|----------|--------|----------------|
| Paota      | 3268.73  | 260.65 | Over Exploited |
| Phagi      | 5402.76  | 118.70 | Over Exploited |
| Sambhar    | 5958.32  | 280.37 | Over Exploited |
| Sanganer   | 4387.4   | 272.48 | Over Exploited |
| Shahpura   | 2999.1   | 316.67 | Over Exploited |
| Viratnagar | 4776     | 174.97 | Over Exploited |
| District   | 77715.17 | 231.21 | Over Exploited |

From the above table it can be seen that all the blocks in Jaipur district are in the over exploited category and Jhotwara block shows the maximum extraction of ground water reserves. Nearly all the blocks are overexploited.

### **Degradation in Ground water Quality Flouride Pollution**

Fluoride pollution is heavily seen in Sanganer village. There are many small scales dying industry in Sanganer which discharge their effluents in the Amnaishah nallah which seeps underground. Another reason is excessive ground water withdrawal which results in magnifying the inherent fluoride ions from the fluoride bearing rocks.

1. Nitrate pollution
2. Salinity
3. Heavy Metals

**Urban Impact on Natural gradient and Flood area** Local flooding has increased as there is fast urbanization in the Jaipur city and we have lost open spaces which are necessary for recharge of the ground water.

**An Overview of the Water Supply system in Jaipur** There is no single government entity that controls or manages the urban water supply. The PHED is mainly responsible for supplying water however Jaipur Municipal Corporation, Rajasthan water resources Department, the State Water resource Planning Department and others are also involved in water planning schemes in Jaipur.

Jaipur's water supply system is mainly dependent on tubewells. Many of the tube wells are fitted with power pumps which supply water to clean water reservoirs and five elevated storage reservoirs. According to a study by the PHED, there are 1340 tubewells scattered throughout the city and 1845 handpumps. There are estimates that there are 20,000-30,000 unaccounted for tube wells in Jaipur. The situation in Jaipur is critical as there are several places receiving erratic water supply for 30-40 minutes per day. Overall, the water quality in Jaipur is found to be acceptable however at some places there are issues of high fluoride and nitrate concentration. According to PHED, Jaipur has 100 online chlorination plants on direct supply tube wells and 12 electro chlorinators are pump stations to purify water from Bisalpur.

### **Future water Supply Scheme**

When the city of Jaipur was established, enough attention was made to ensure water availability throughout the region. We had several water harvesting structures like step wells, wells, kunds, lakes, reservoirs etc. But with the increase in the population the pressure on water resources increased and the dependence on the traditional water resources dwindled and these water harvesting structures fell into disuse. Today there is complete dependence on the ground water resources and no attention is made to recharge the aquifers. Thus, there is an immense need for switching over to the rain water harvesting systems. Roof top rain water harvesting should be given importance. The wells in the study region have become abandoned. Some new techniques like recharging wells through rain water harvesting is a new concept that was observed in the Chaksu block. Water conservation through rain water harvesting should be made as a mass awareness program and campaign. It is important to educate people in this regard. However, our city is facing the immense problem as it inhabits the maximum population. There are certain blocks like Jhotwara, Sanganer,

Khatipura which are heavily occupied with the industries like Sanganer has traditional printing mills. The tie and dye industry of Sanganer is contributing to the maximum discharge into a feeder of the Dravyavati river. The entire block of Sanganer has degraded ground water quality due to the discharge of the effluents from the industry. The old city of Jaipur is also no more an exception as it has immense urban population to support and houses several karkhanas or industries. The entire city receives water from the Bisalpur supply system but the supply is highly erratic and at several times it is supplied for a very less time. The crisis accentuates in the summer season when some places receive water after 2 days or more. The electric motors have tremendously increased the problem as the water is extracted with a very high pressure.

### **Conclusion**

Arid to semi-arid conditions prevail over Rajasthan. The state also faces uncertainty and unevenness of rainfall. The city of Jaipur is facing increasing water scarcity as the surface water sources have diminished and the ground water resources are getting fast exhausted. There is demand deficit in water supply. Several colonies report irregular and erratic water supply. So, there is a need to adopt integrated water resource management, research new ground water resources availability, rain water harvesting, water audit for domestic uses, treatment of industrial and domestic water through sewage treatment plants. Higher tariffs prevent excessive consumption pattern. In turn it will change the practice of water consumption. So proper measures be taken by the concerned authorities to prevent misuse of water.

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