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A Comprehensive Evaluation of Drinking Water Resources in Kanpur City, Uttar Pradesh.

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Abstract:
Water resources are considered the most essential urban amenities that provide the foundational assistance to urban development, industrial and economic growth, and a sustainable urban environment. Kanpur, formerly considered as the Manchester of North India, is regarded as the largest industrial and commercial hub of Uttar Pradesh. It was established due to its geographical advantages and availability of natural resources. Kanpur city acquires potable water from the Ganga River and the groundwater aquifers for its water demands and utilities. Kanpur city is among the most heavily populated cities in Uttar Pradesh, where about 27 lakh population lives.
Unprecedented demographic growth, accelerated urbanisation, and environmental deterioration through overuse of environmental assets have badly affected the property and accessibility of potable water in the Kanpur city region. This paper analyses the key drinking water resources of Kanpur city, consisting of river water, surface water, and groundwater, examines their present status, detects the major challenges like industry-based pollution, overuse of groundwater, and overexploitation of resources, and suggests a sustainable drinking water resource management strategy. This study shows that the holy Ganga River is still a principal source of water supply, while declining groundwater levels, over discharge of polluted water from industries, and sewage dumping threaten major security of water supply in the city region. The co-ordinated approach, through proper water facility management, groundwater recharge, urban sewage management, pollution control, public participation, and civic engagement, is a compulsory service for ensuring sustainable water resource availability in Kanpur city.

Keywords: Potable Water, Environmental Assets, Groundwater Aquifer, Groundwater Recharge, Public Participation, Co-Ordinated Approach, Pollution Control

1. Introduction

India is home to 17 percent population of the world and it has 4 percent of the total freshwater of the world. The river system of India plays a major in supplying the fresh water to the cities. This shows huge population depends on only 4 percent of the world's potable water, which makes major gap between the demand and supply of water in India. It is seem that urban areas have a higher demand for fresh water than rural areas.
Safe drinking water is assumed to be a critical natural resource, yet this biotic component of the environment is being depleted, contaminated, misused and mismanaged. Disturbance in the hydrological cycle causes water-related disasters such as floods, landslides, avalanches, and acid rain. Drinking Water is the basic natural asset which sustains all forms of living creatures on land and below water on Earth.

Freshwater is the most crucial natural component which is used not only for preserving the biological elements but also for industrial growth, employment generation, food security, agricultural growth, ecosystem, education, peace and human rights (Dixit, A, 2021).

Access to drinking water, sanitation and cleanliness are the essential human necessities for good health and well-being. The requirement for potable water is very high in densely populated cities because of accelerated urbanisation and urban population growth. High water consumption in various sectors such as energy, agriculture and industry is also a subject of concern for the world in future. The demand for drinkable clean water has exceeded to the population growth. Currently, the majority of developing countries are facing higher per head water consumption in metropolitan areas. City regions in South Asian developing countries are managing with high water stress because of quick urban expansion and population growth (Awasthi, 2026).

Kanpur is a prominent industrialised city in the mid-part of Uttar Pradesh, located in the fertile doab region of the Ganga and the Yamuna Rivers. It is renowned as the commercial capital of Uttar Pradesh and the core of textile, education, commerce, leather industries, and historic colonial structures. Kanpur city is historically developed due to ample source of fresh water and isotropic surface and about 80km nearness to the state's capital, Lucknow.

Urban centres in developing countries increasingly face water stress due to high population growth and industrial expansion. Kanpur, situated on the southern shore of the holy Ganga in Uttar Pradesh, is among the top India's major industrial cities and an important commercial centre. The city has historically developed around abundant water resources, particularly the Ganga River in the North and the Pandu River in the South.

Fresh Water distribution mechanism of Kanpur includes groundwater aquifers, surface water bodies, river canals, artificial lakes, water reservoirs, and ponds. Kanpur city's Water resource distribution comprises congested industrial activities, mainly chemical industries, tanning, textile industries and many small and micro industries, which have led to inverse impact on the environment and present significant environment challenges. This comprehensive study discusses about increasing demands of fresh water, joined with continuous population growth of the city and related challenges in Kanpur city.

2. Objectives

To investigate the drinking water resources of Kanpur city.

To examine the current status of drinking water resources in Kanpur city.

To detect the major challenges and suggest a sustainable water resources management strategy.

3. Study Area

Kanpur is categorised as among the largest metropolises and industrial hubs situated on the right shore of the holy River Ganga. The city's latitudinal and longitudinal extents are 26° 41' North and 80° 23' East, placed on an alluvial plain deposited by the River Ganga. It is situated at an average height of about 126 meters above MSL (mean sea level). The climate of Kanpur is characterised as subtropical monsoonal type, with distinct hot and cold season, monsoon from June to September, with moderate rainfall. Kanpur city experiences average annual rainfall around 850-900 mm, the majority of which happens from the southwest monsoon and cyclonic activities. The geographical and geological aspects of the city provide suitable conditions for flourishing industries, urban growth and urban expansion.

4. Surface Water Bodies

4.1 The Ganga River

The River Ganga passes directly through Kanpur city, which is a major source of fresh water and provides the water supply to industrial and residential areas, and environmental support to the entire city. The water treatment plant (WTP) is installed near the Ganga Barrage. It purifies river water from the Ganga and supplies it to the city through municipal corporation facilities. Historically, The River Ganga has acted a significant source of water in the development of this city through upholding agriculture, transportation, industry, and urban development. Various studies show that the River Ganga receives more pollution due to untreated sewage nalas, industrial and manufacturing discharge. These activities have changed the water composition of the Ganga, degraded the quality of water, and created ecological imbalance in the river. Most of famous historical and religious Ghats are built on the banks of the Ganga in Kanpur, like Sarsayya ghat, Atal ghat, and sati chaura ghat.

4.2 Pandu River

Pandu River flows through five central districts of Uttar Pradesh, including Farrukhabad, Hardoi, Kannauj, Kanpur, and Fatehpur. It is 242 km long and a tributary of the River Ganga, which it adjoins at Gurir village, Fatehpur. This river passes through the south of Kanpur city and provides rainwater drainage and groundwater aquifer recharge. It plays a major role in the hydrological cycle and in the management of rainwater discharge. Pandu River disconnects Kanpur Nagar district from Kanpur Dehat in the west and Fatehpur in the south, respectively.

4.3 Lakes and ponds

Historically, Lakes, ponds, water reservoirs, tanks, canals and marshland were developed as crucial elements of Kanpur city's water resource management system. All these water bodies collectively regulate and maintain flood mitigation, runoff, groundwater recharge and biodiversity conservation. Nevertheless, urbanisation and population growth have captured areas under such water resources and created more severe challenges in their restoration.

Some of these are mentioned below:

Moti Jheel: It is an artificial lake and a famous recreational area built during the colonial period as a water reservoir of Kanpur. This lake is surrounded by an amusement park and children's play areas. This entire site is known as the lungs of Kanpur city.

Wilson Lake: It is a natural British-period water body located within eminent Chandra Shekhar Azad University (CSAU) campus. It has performed as a natural ecosystem for migrant birds species during winter for a long time.

Sher Shah Suri Talab: This is an ancient lake constructed along the Grand Trunk Road by the ruler of the Sur Empire, Sher Shah Suri in his regime. It was developed as a major source of water for travellers, military convoys, and their animals visiting along this strategically important Grand Trunk Road.

4.4 Canal system and Ganga barrage (Luv Kush Barrage)

The Ganga Barrage was constructed in 2000 to manage the river water flow across Kanpur. It provides river water for municipal uses, industrial uses and agricultural irrigation through canals. Officially, this barrage is also known as Luv Kush Barrage and works as a significant bypass for connecting NH 91. This is a 621-meter-long bridge that maintains river water flow and ensures fresh water supply to urban and agricultural areas through local water treatment plants. Nowadays, it is considered a famous tourist spot in Kanpur Nagar, where the boat club has been set up to entertain nature lovers. The River canal system,

starting from the Ganga Barrage, ensures continuous water supply to surrounding rural areas and supports water security management

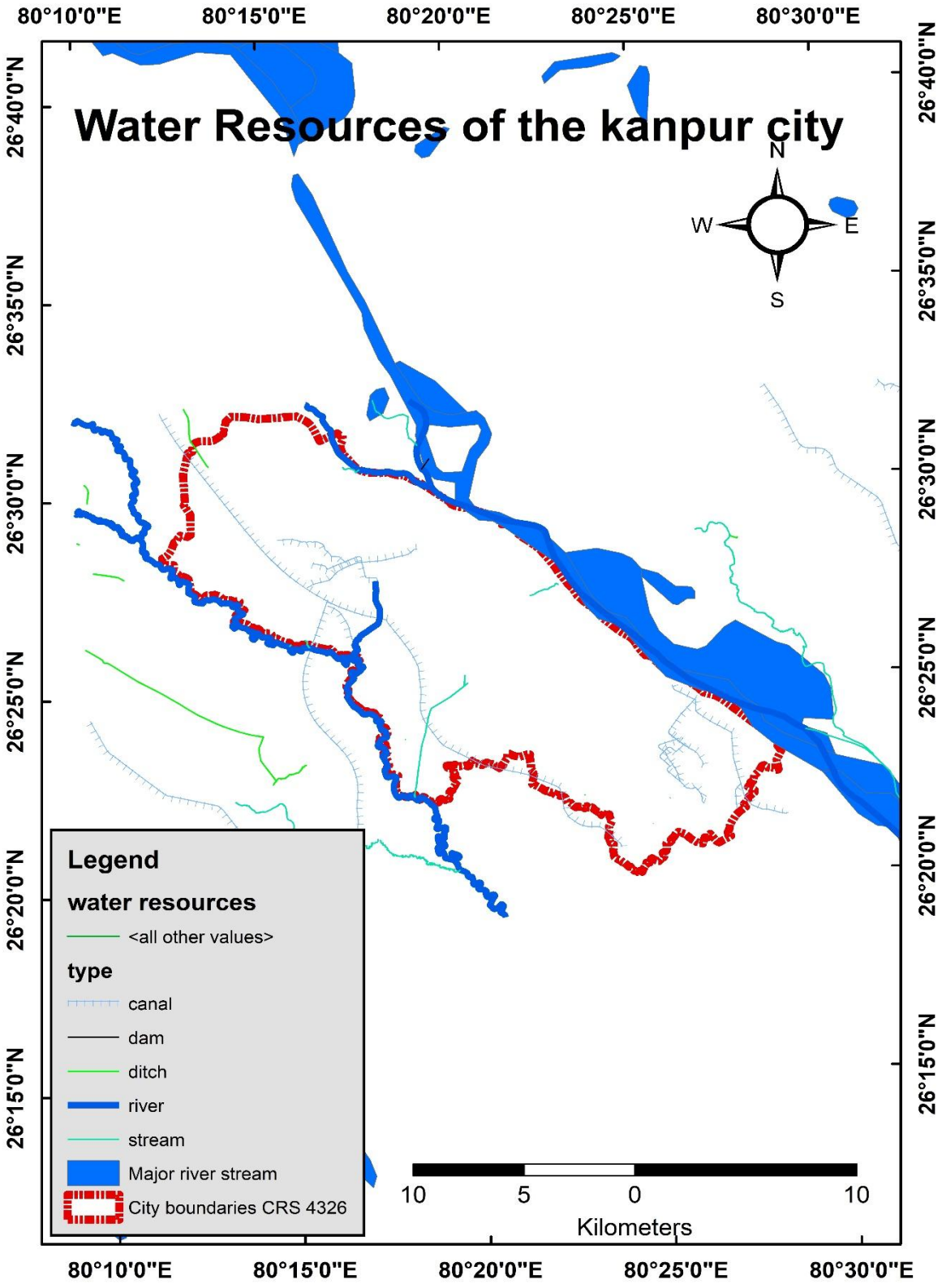

Figure no. 1

5. Groundwater Bodies

The groundwater system is restored mainly from rainfall discharge, river seepage, check dams, canal seepage, ponds and lakes infiltration. In Kanpur urban areas, Groundwater is not only used as potable water, but also for commercial property and industrial units. Bore wells, tube wells and hand pumps are utilised as significant tools of groundwater extraction for agricultural, gardening, industrial, domestic and commercial purposes.

5.1 Hydrological Processes

Groundwater resources are the vast subterranean reserve of water stored in alluvial deposits, including rock, sand, silt, clay, and saturated soil. These structures construct an enormous water reserve called an aquifer. In the context of Kanpur city, this entire region, spread over the Ganga -Yamuna doab, is capable of collecting large quantities of water. This fertile soil land is the most densely populated regions in India due to its water availability and favourable conditions for agriculture. The Groundwater system in Kanpur Nagar, Uttar Pradesh, is maintained and managed by the Central Ground Water Board (CGWB) and Uttar Pradesh State Ground Water Department (UPSGWD).

5.2 Groundwater Utilisation

Groundwater is included as the most essential natural commodity of the world, and a major source of drinking water. It constitutes an auxiliary source of water supply in municipal water plants, but it is not enough for the entire water supply of Kanpur City. The core region of the city uses bore wells as a supplementary source of water supply, and the peripheral region of the city, which is mostly agricultural land, largely depends on bore wells and tube wells. It is observed that as per increasing dependency on groundwater in cities has resulted in declining groundwater aquifers.

6. Drinking Water Facility Management Programme

6.1 Namami Ganga Programme (2014): National Mission for Clean Ganga (NMGC)

It is a central government-funded programme to execute the following goals as mentioned below:

- Improve River water quality
- River surface water cleaning
- Development of river fronts (Ghats)
- Monitoring industrial discharge
- Building up of water purification plants
- Creating sewerage treatment plants
- Conservation of nature, preservation of biodiversity and ecosystem.
- Spreading awareness towards clean Ganga

This multi-level programme aims to ameliorate river water quality and enhance the diversity of life and productivity of forests along the Ganga water area. Namami Ganga programme achieved its key goal in Kanpur by building sewerage treatment plants, intercepting drainage, controlling industrial discharge and creating several modern Ghats. The infamous sewage discharge unit, 128-year-old Sisamau Nala, has been treated and its wastewater course has been deflected from the Ganga to the treatment plant via underground drainage systems. These initiatives help rejuvenate the River Ganga and protect the diversity of aquatic life in river waters.

6.2 Rainwater Harvesting method for groundwater recharge

A groundwater recharge system is a part of hydrological functions where water is stored through rainwater

harvesting, shallow recharge pits, recharge well systems, infiltration structures and wetland seepage, and flows it into the ground to increase groundwater replenishment. This hydrological process works naturally through precipitation and artificially through man-made structures such as managed aquifer recharge systems. This process helps to raise the level of groundwater and ensure water accessibility in the Kanpur. There are many rules implemented by local government bodies in Kanpur to maintain groundwater replenishment. The Kanpur Development Authority (KDA) passed a rule that it is mandatory to set up a rooftop rainwater harvesting to all commercial and residential buildings in Kanpur.

6.3 Pollution Control Measures

Initiatives taken for controlling the pollution:

Over the past few decades, three sewerage treatment plants (STPs) have been built to resolve water-related pollution and make water reusable. These treatment plants are specially located in Jajmau, which is infamous for its leather-based industrial water pollution. One treatment plant is built in Unnao district. These four sewerage treatment plants together have a potential sewage treatment capacity of 190 MLD, which covers only 25% of the total sewage water produced by Kanpur city (Kanpur municipal areas).A new Sewage treatment plant: a 43 MLD facility has been activated since 2020.

Commissioning years	Name/address (STP)	Installed potentiality (MLD)	Utilised Capacity (MLD)	Responsible Authorities	Urban/Rural
2016-17	42 MLD, Sajari Kanpur	42	21	U.P. Jal Nigam	R
2015-16	210 MLD, Bingawan Kanpur	210	135	U.P. Jal Nigam	R
1989-90	5 MLD, Jajmau Kanpur	5	5	U.P. Jal Nigam	U
2020	43 MLD Jajmau, Kanpur	43	37	U.P. Jal Nigam	R
1998-99	130 MLD Jajmau, Kanpur	130	120	U.P. Jal Nigam	R

Source: Jal Jeevan Mission (Ministry of Jal Shakti)

The set-up of an industrial pollution controlling and monitoring system, sewerage treatment plants (STPs), common effluent treatment plants (CETPs), and strict environmental rules can collectively decrease the polluted water discharge going into the water bodies.

6. Conclusion

Kanpur city's water supply system is estimated to have a supply for portable water about 600 MLD, but 385 MLD is being provided due to limited infrastructure in the city. The population of Kanpur city has grown by more than trice over the past 50 years; however, Kanpur urban expansion has increased by about 4 square km. This shows that the pressure on drinking water resources has significantly elevated along with the increase in population density of Kanpur city.

Drinking water infrastructure is the most crucial urban asset and the essential facility to expand the industrial and urban economy of Kanpur. The principal source of drinking water, River Ganga and other

sources such as groundwater aquifers, artificial reservoirs, canals, lakes, ponds and wetlands fulfil water demands of the city together. It is seen that urban expansion, population growth, industrial water discharge, groundwater degradation, and other related issues together pressurise the sustainability of river water.
Water security in future is ensured through successful execution of effective groundwater recharge management programs and water pollution control measures, rooftop rainwater harvesting systems, sewerage treatment plants, and unified potable water management strategies in Kanpur city. Responsible utilisation of potable water and careful conservation of the hydrosphere are crucial for ensuring water availability, better environmental conditions, Quality of life and sustainable urban development.

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