

## Spatial Distribution and Temporal Change in Irrigated Area in Relation to the Hydrological Characteristics of the Gomti River Basin: A Case Study of Lucknow District.

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### Abstract

This paper examines the spatial distribution of irrigated areas and irrigation sources at block level and also observes the temporal variations in the irrigated areas and sources of Lucknow district from 2000 to 2023; study is especially focused on the relationship between irrigation dynamics and the hydrological behaviour specifically ground water table of the Gomti River. Using block-wise data, the study outlines a huge decline in the total irrigated area in the district, and across the blocks, accompanied by a shift from surface water irrigation sources such as canals and ponds toward tube wells (groundwater-based irrigation). The spatial analysis shows significant reduction in irrigated areas in all 8 blocks except Mal block. The outcome of the study reveals growing hydrological stress on ground water table in the Gomti River basin, driven by urbanization, declining river discharge, decreased ground water recharge and overexploitation of groundwater resources.

**Keywords:** Irrigation, Groundwater, Urbanization, Agriculture, Gomti river, Canal.

### Introduction

Irrigation is vital for agricultural productivity in the Indo-Gangetic plains, Lucknow district is the part of middle Ganga plain and drained by the Gomti river. Gomti River Basin is sub-basin of Ganga basin and plays a significant hydrological and socio-economic role in the district. The Lucknow District has historically relied on a combination of canal networks, ponds, wells and tubewells for irrigation. Over the past two decades, the district has undergone noticeable changes in irrigation patterns due to development, urbanization, infrastructural shifts, and groundwater depletion.

Irrigation is dependent on the availability of surface water and ground water level. Ground water level is closely interconnected with irrigation and also an important component of hydrological system. Continuous over exploitation for agricultural use can cause severe depletion in ground water, lowering water table, this may cause the increase in pumping cost. In areas under surface water irrigation such as canal may contribute in the ground water recharge by infiltration in the soil. Canal irrigation has positive impact on ground water but it has been seen that over the time canal irrigation has decreased and use of tube wells has risen.

This study analyses the spatial distribution and temporal changes in irrigation sources across the blocks of Lucknow District between 2000 and 2023, specially in context of the Gomti river basin.

**Study Area:** Lucknow is the district of state of Uttar Pradesh, having a rich heritage and cultural wealth in its history but most high tech and modern city of current era in Uttar Pradesh. Lucknow covers an area of 2565 sq. km. and has its geographical extension between the latitude 26° 30" N to 27° 10" N and longitude 80° 30" E to 81° 13" E. Gomti river traverses from the middle of the district. The Lucknow city is developed along both the banks of Gomti river. The agriculture, industry and culture have flourished around the Gomti river. District fall under the subtropical climate and faces three seasons clearly, winter, summer and monsoon. The

administrative division of district is in 8 blocks, namely Bakshi ka Talab, Mal, Chinhath, Kakori, Malihabad, Sarojani nagar, Mohanlalganj, and Gosaiganj. Initially the city has been the centre of administration along with agriculture, being an important occupation of people of the region. The district has grown as an urban centre and a long-term analysis of land use and land cover pattern shows that the agricultural land use is on continuous decline. There are three canals namely; Gomti feeder canal, Gomti right bank canal, Gomti left bank canal, which supply water to Lucknow district and other associated areas. These canals get their water supply from Gomti Barrage constructed on Gomti river in Lucknow. Gomti river enters Lucknow district from the north in Bakshi ka talab, forming boundary between Mal block and Bakshi ka Talab, Kakori and Chinhath and flow from the middle of Chinhath block and exit Lucknow through the Gosaiganj block.

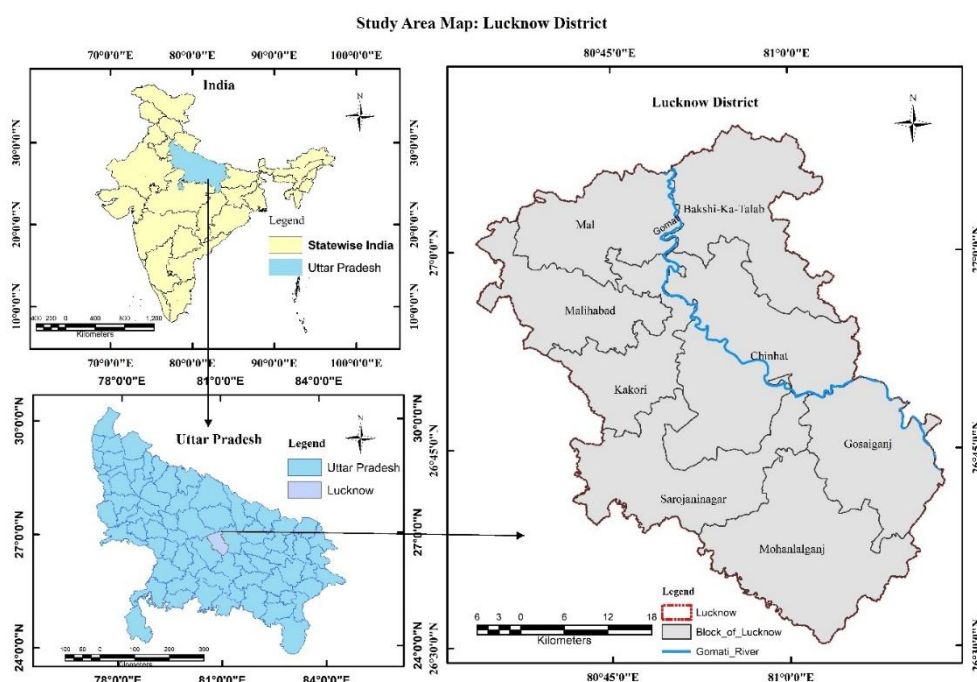


Figure 1

Source: Prepared by ArcGIS Using SOI Data

## Objective-

1. To observe the spatial distribution of major irrigation sources along the Gomti river in the Lucknow district from 2000-2023.
2. To compare temporal changes in the means of irrigation sources from 2000-2023.
3. To identify the high irrigation stressed and groundwater dependent areas.

## Data Sources and Methodology: -

**Data Sources-** This study is based on the secondary data base of government and other authentic publications. The data of block-wise irrigated area of 1999-2000 and 2022-23 collected from the District Statistical Handbook, Lucknow. The ground water level data of 2023 at various ground water stations collected from the government website which is published by the Central Ground Water Board.

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**Methodology:** The data of block- wise irrigated areas and irrigation sources is compiled and tabulated in Microsoft Excel. Calculation of differences in changes in areas and number of sources, percentage of change, preparation of bar diagram and pie chart based on the available data has performed in Microsoft Excel.

| Block              | Canal | Tube well  |         | Well | Ponds | Others | Total  |
|--------------------|-------|------------|---------|------|-------|--------|--------|
|                    |       | Government | Private |      |       |        |        |
| 1. Malihabad       | 2055  | 698        | 10110   | 0    | 28    | 22     | 12913  |
| 2. Mal             | 1409  | 2075       | 8301    | 79   | 27    | 28     | 11919  |
| 3. Bakshi-Ka-Talab | 4095  | 2151       | 14732   | 31   | 20    | 180    | 21209  |
| 4. Kakori          | 3446  | 463        | 8794    | 0    | 10    | 72     | 12785  |
| 5. Chinhat         | 510   | 1072       | 5823    | 4    | 13    | 0      | 7422   |
| 6. Sarojaninagar   | 3096  | 725        | 15721   | 61   | 6     | 221    | 19830  |
| 7. Gosaiganj       | 7920  | 438        | 7597    | 0    | 22    | 0      | 15977  |
| 8. Mohanlalganj    | 6987  | 340        | 10783   | 0    | 10    | 0      | 18120  |
| Total Rural        | 29518 | 7962       | 81861   | 175  | 136   | 523    | 120175 |
| Total Urban        | 302   | 0          | 1336    | 0    | 0     | 31     | 1669   |
| Total District     | 29820 | 7962       | 83197   | 175  | 136   | 554    | 121844 |

*Source: District Statistical handbook*

**Table:1 Block-wise Actual Irrigated Area in hectares 1999-2000**

In the year of 1999-2000 the total irrigated area was 121844 hectares by various means, and urban area contributed about 1669 ha. The largest irrigated area was under the means of private tubewell which was 83197 hectares and second largest of 29820 ha was done by means of canals. Gosaiganj, Mohanlalganj had about 7920 ha, 6987 ha area under the canal irrigation, Chinhat and Mal had lowest area under canal irrigation.

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Bakshi ka Talab area was the block which had largest irrigated area of 21209 ha and second largest area was under Sarojani Nagar had 19830 ha.

| Block              | Canal | Tube well  |         | Well | Pond,<br>Lake,<br>Pool | Others | Total  |
|--------------------|-------|------------|---------|------|------------------------|--------|--------|
|                    |       | Government | Private |      |                        |        |        |
| 1. Malihabad       | 1555  | 362        | 10018   | 0    | 0                      | 0      | 11935  |
| 2. Mal             | 1569  | 498        | 11236   | 0    | 0                      | 0      | 13303  |
| 3. Bakshi-Ka-Talab | 2234  | 899        | 15474   | 0    | 3                      | 0      | 18610  |
| 4. Kakori          | 3146  | 481        | 8384    | 0    | 0                      | 0      | 12011  |
| 5. Chintahat       | 331   | 265        | 2248    | 0    | 0                      | 0      | 2844   |
| 6. Sarojaninagar   | 1596  | 792        | 10548   | 0    | 0                      | 0      | 12936  |
| 7. Gosaiganj       | 2869  | 204        | 9245    | 0    | 1                      | 0      | 12319  |
| 8. Mohanlalganj    | 6306  | 366        | 10386   | 0    | 0                      | 0      | 17058  |
| Total Rural        | 19606 | 3867       | 77539   | 0    | 4                      | 0      | 101016 |
| Total Urban        | 96    | 105        | 1808    | 0    | 0                      | 0      | 2009   |
| Total District     | 19702 | 3972       | 79347   | 0    | 4                      | 0      | 103025 |

Source: District Statistical handbook

**Table:2 Block-wise Actual Irrigated Area in hectares 2022-23**

In 2022-23 Total irrigated area in district is 103025 ha and urban irrigated area is 2009 ha, total canal irrigated area is 19702 ha. Total area under government tubewell and private tubewell is 3972 ha and 79347 ha respectively. Maximum area under irrigation by all means is 18610 ha in Bakshi ka Talab followed by Mohanlalganj (17058 ha). Lowest irrigated area is 2844 ha in Chintahat.

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| Block              | Canal  | Tube well  |         | Well | Ponds | Others | Total  |
|--------------------|--------|------------|---------|------|-------|--------|--------|
|                    |        | Government | Private |      |       |        |        |
| 1. Malihabad       | -500   | -336       | -92     | 0    | -28   | -22    | -978   |
| 2. Mal             | 160    | -1577      | 2935    | -79  | -27   | -28    | 1384   |
| 3. Bakshi-Ka-Talab | -1861  | -1252      | 742     | -31  | -17   | -180   | -2599  |
| 4. Kakori          | -300   | 18         | -410    | 0    | -10   | -72    | -774   |
| 5. Chinhat         | -179   | -807       | -3575   | -4   | -13   | 0      | -4578  |
| 6. Sarojaninagar   | -1500  | 67         | -5173   | -61  | -6    | -221   | -6894  |
| 7. Gosaiganj       | -5051  | -234       | 1648    | 0    | -21   | 0      | -3658  |
| 8. Mohanlalganj    | -681   | 26         | -397    | 0    | -10   | 0      | -1062  |
| Total Rural        | -9912  | -4095      | -4322   | -175 | -132  | -523   | -19159 |
| Total Urban        | -206   | 105        | 472     | 0    | 0     | -31    | 340    |
| Total District     | -10118 | -3990      | -3850   | -175 | -132  | -554   | -18819 |

*Source: District Statistical handbook*

**Table: 3 Difference in irrigated areas in hectare in between the year of 2000 and 2023**

The analysis of the Table 3 this is apparent that total irrigated area is decreased by 18819 ha by all means of irrigation, largest decrease in total irrigated area by various means is noticed in Sarojaninagar block of 6894 ha, Chinhat (4578 ha), Gosaiganj (3658 ha), and canal irrigated area is decreased by 10118 ha. Largest area under canal irrigation of 5051 ha is decreased in Gosaiganj and followed by Bakshi ka Talab (1861ha), Sarojaninagar (1500 ha), Mohanlalganj (681) blocks. Total area under tube well irrigation also decreased by 3990 ha (government tube wells) and 3850 ha (private tube wells), and well irrigation is decreased by 175 ha, Ponds irrigation is 132 ha, and others is 554 ha. Total decrease in rural irrigated area is 19159 ha.

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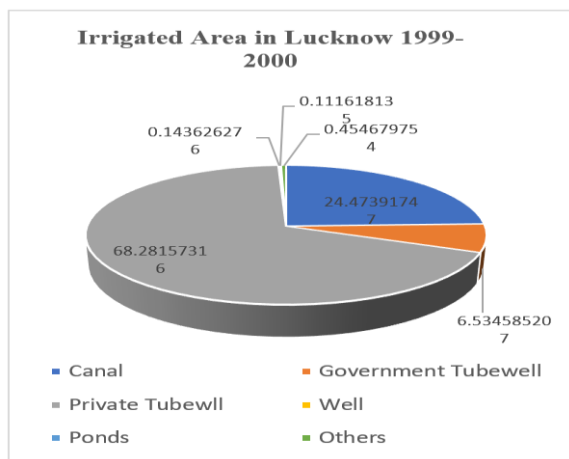


Figure:2

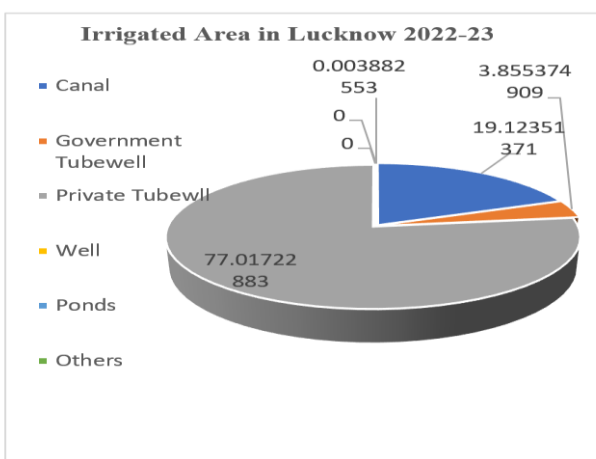


Figure:3

| Block              | Length of canals (km) | State Tube Wells (No.) | Well s (No.) | Pumping Sets on Ground Water (No.) | Shallow Tube Well  |                  |        |        | Medium Tube Wells (No.) | Deep Tube Wells (No.) |
|--------------------|-----------------------|------------------------|--------------|------------------------------------|--------------------|------------------|--------|--------|-------------------------|-----------------------|
|                    |                       |                        |              |                                    | Electric Operate d | Diesel Operate d | Oth er | Tot al |                         |                       |
| 1. Malihabad       | 78                    | 22                     | 170          | 10                                 | 0                  | 0                | 0      | 0      | 0                       | 0                     |
| 2. Mal             | 103                   | 77                     | 139          | 8                                  | 0                  | 0                | 0      | 0      | 0                       | 0                     |
| 3. Bakshi-Ka-Talab | 166                   | 92                     | 169          | 49                                 | 0                  | 0                | 0      | 0      | 0                       | 0                     |
| 4. Kakori          | 90                    | 34                     | 88           | 4                                  | 0                  | 0                | 0      | 0      | 0                       | 0                     |
| 5. Chinhath        | 24                    | 53                     | 125          | 2                                  | 0                  | 0                | 0      | 0      | 0                       | 0                     |
| 6. Sarojaninagar   | 170                   | 21                     | 174          | 6                                  | 0                  | 0                | 0      | 0      | 0                       | 0                     |
| 7. Gosaiganj       | 144                   | 19                     | 268          | 8                                  | 0                  | 0                | 0      | 0      | 0                       | 0                     |
| 8. Mohanlalganj    | 187                   | 23                     | 279          | 5                                  | 0                  | 0                | 0      | 0      | 0                       | 0                     |
| Total Rural        | 962                   | 341                    | 1412         | 92                                 | 0                  | 0                | 0      | 0      | 0                       | 0                     |
| Total Urban        | 0                     | 0                      | 0            | 0                                  | 0                  | 0                | 0      | 0      | 0                       | 0                     |
| Total District     | 962                   | 341                    | 1412         | 92                                 | 0                  | 0                | 0      | 0      | 0                       | 0                     |

Source: District Statistical handbook

Table:4 Block- wise distribution of Sources of irrigation 1999-2000

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In 1999-2000 total length of canals in Lucknow was 962 km and all the 8 blocks had more or less area under canal irrigation, maximum area was existed under canal irrigation, highest length of canal was in Mohanlalganj followed by Sarojani nagar, Bakshi ka Talab, Gosaiganj and Mal over more than 100 km. There were 341 state tubewells, 1412 Wells and 92 Pumping sets on ground water were existed. Bakshi ka Talab had about maximum concentration of all the available sources of irrigation. Mohanlalganj and Gosaiganj had great density of well of 279 and 268 respectively. Chinhat lacked in the canal irrigation but had a good number of wells.

**Table: 5 Block- wise distribution of Sources of Irrigation 2022-23**

| Block              | Length of canals(km) | State Tube Wells (No.) | Wells( No.) | Pumping Sets on Ground Water (No.) | Shallow Tube Well |                 |       |       | Medium Tube Wells (No.) | Deep Tube Wells (No.) |
|--------------------|----------------------|------------------------|-------------|------------------------------------|-------------------|-----------------|-------|-------|-------------------------|-----------------------|
|                    |                      |                        |             |                                    | Electric Operated | Diesel Operated | Other | Total |                         |                       |
| 1. Malihabad       | 78                   | 27                     | 10          | 10                                 | 373               | 2771            | 165   | 3309  | 148                     | 35                    |
| 2. Mal             | 103                  | 76                     | 2           | 0                                  | 496               | 3368            | 183   | 4047  | 65                      | 63                    |
| 3. Bakshi-Ka-Talab | 166                  | 98                     | 19          | 16                                 | 277               | 5375            | 265   | 5917  | 182                     | 82                    |
| 4. Kakori          | 90                   | 31                     | 0           | 0                                  | 115               | 2976            | 121   | 3212  | 101                     | 14                    |
| 5. Chinhat         | 24                   | 36                     | 0           | 1                                  | 242               | 2429            | 148   | 2819  | 65                      | 45                    |
| 6. Sarojaninagar   | 170                  | 26                     | 0           | 2                                  | 132               | 5168            | 179   | 5479  | 86                      | 27                    |
| 7. Gosaiganj       | 144                  | 20                     | 8           | 0                                  | 130               | 5605            | 189   | 5924  | 78                      | 15                    |
| 8. Mohanlalganj    | 187                  | 25                     | 13          | 0                                  | 214               | 7927            | 195   | 8336  | 146                     | 18                    |
| Total Rural        | 962                  | 339                    | 52          | 29                                 | 1979              | 35619           | 1445  | 39043 | 871                     | 299                   |
| Total Urban        | 0                    | 0                      | 0           | 0                                  | 0                 | 48              | 0     | 48    | 0                       | 0                     |
| Total District     | 962                  | 339                    | 52          | 29                                 | 1979              | 35667           | 1445  | 39091 | 871                     | 299                   |

Source: District Statistical handbook

In the year of 2022-23 the canal length 962 km has not changed from previous decades and maximum length is in Mohanlalganj block. State tubewells are 339 which have reduced and wells remained only few in numbers, this is an enormous decrease from 1412 in the year of 2000 to 52 in the year of 2023, only Bakshi ka Talab and Mohanlalganj have wells in double digits 19 and 13 respectively.

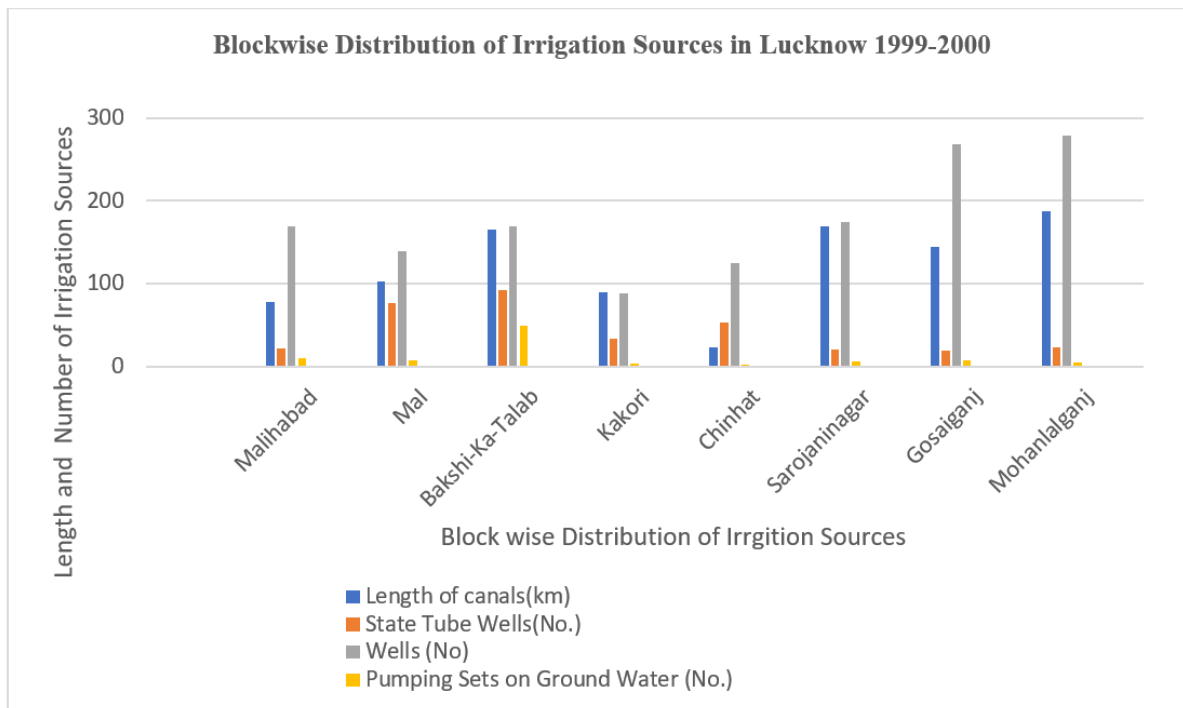


Figure:4

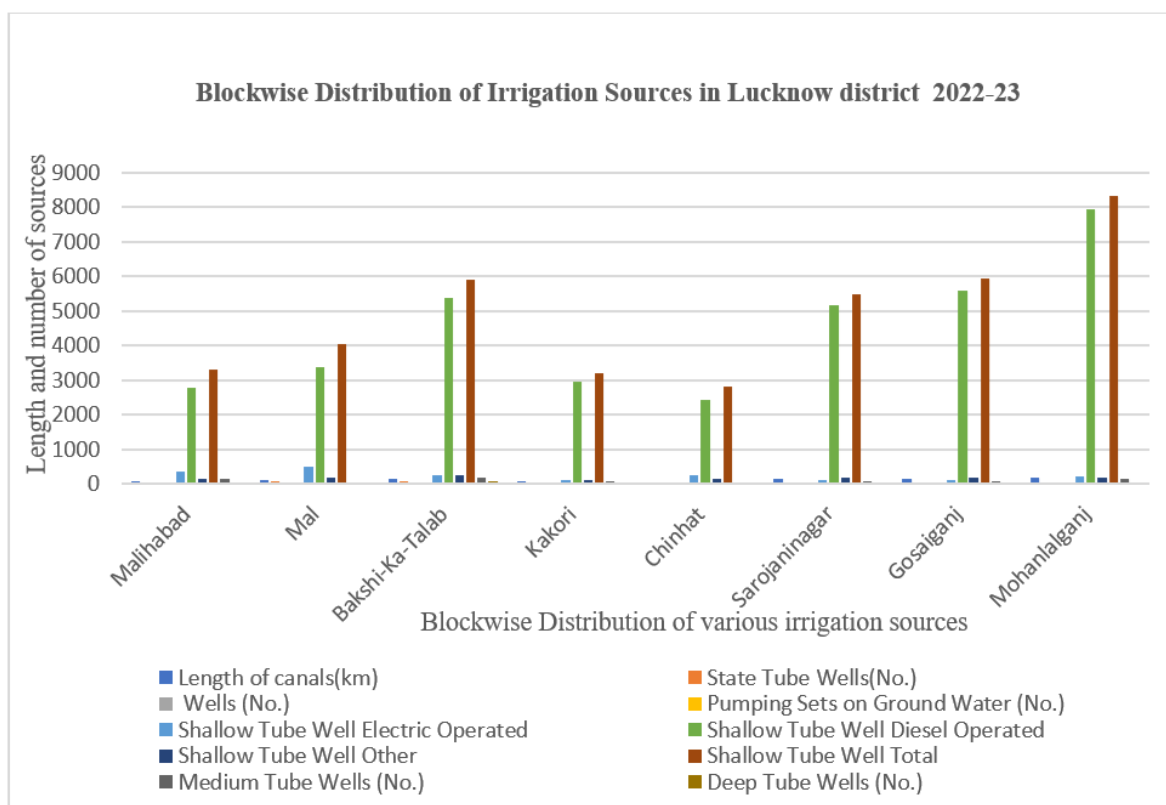


Figure:5

**Table :6 Ground water level status of Lucknow district in 2023 yearly range***Source – Central ground water board*

| Ground water Station | Observed Range of Water Level (mbgl) |
|----------------------|--------------------------------------|
| Lu New Campus_1      | -25.64 - 1                           |
| Mohanlalganj_2       | -6.9 - -1.22                         |
| Rehman Khera_1       | -36.11 - -12.23                      |
| Tejkishan Khera_1    | -4.56 - 2.47                         |
| Vikasnagar_1         | -46.28 - -41.09                      |

Ground water level in Lucknow district is in critical status, this is apparent from the above table, that except the two ground water station of Mohanlalganj and Tejkishan Khera all other three ground water monitoring stations have recorded severe decline. The Gomti river is dependent on the ground water, the availability of ground water ensures the level of surface water also. Recently this has been observed that the severe exploitation of ground water for irrigation purposes has degraded the level of ground water table in Gomti river basin in Lucknow.

## **Result and Discussion-**

### **(a) Status of Canal Irrigation**

The data showing that the total length of canal has remained unchanged since 2000, which means there is no development or modernization in the canal irrigation network between two decades. Gomti River is continuously supplying the water to the canal system, but over the time reduced river discharge, siltation, and poor maintenance have negatively affected canal efficiency. Resultantly there is a sharp decline in the contribution of canal irrigation to total irrigated area, which can be observed by comparing the data.

### **(b) Decline of Traditional Wells and Pumping sets:**

The analytical study of traditional open wells indicates that the irrigation from open wells is non- prevalent in current time as the number of open wells has declined from 1,412 to only 52, which reduced by 96 %, this is a huge downfall which reflects open wells are being unviable due to falling groundwater levels, urbanization and land conversion around all the blocks specially in Chinhat, Kakori, Sarojaninagar. The number of pumping sets decreased from only 92 in 1999–2000 to over 29 in 2022–23.

### **(c) Tube Well Expansion and Depth Intensification:**

In 1999–2000, only 341 state tube wells existed but in 2022-23 it is reduced to 339. In 1999-2000 there were no shallow, medium, and deep tubewells but by 2022–23 there are multiple categories such as shallow, medium and deep tubewells' can be seen on the basis of mode of operation and depth of extraction. The number of shallow diesel (35667), electrically operated (1979), medium tube wells (871) and deep tube wells (299) has increased dramatically.

### **Hydrological Implications on Gomti river:**

Seasonal flow reduction in Gomti river due to erratic monsoon pattern, and sedimentation have decreased canal discharge, lowered the surface irrigation potential. Currently, over- dependence on government and private tube wells has caused declining groundwater levels, especially in the blocks having higher percentage

of urbanization. Encroachment of wells and ponds have deteriorated the natural recharge systems, reducing baseflow to the Gomti river and their tributaries in Lucknow district. Rapid urbanization has transformed fertile agricultural land in other land use categories, and intensified the hydrological stress.

### Conclusion:

The northern and central blocks (Bakshi-Ka-Talab, Malihabad, Mal) display the moderate irrigation sustainability, which is benefited from upper canal networks and also get water from Gomti floodplain. The southern and eastern blocks (Sarojaninagar, Gosaiganj, Chhat) display severe decrease, due to urban encroachment, reduced infiltration and paved surface expansion. The shift from surface water irrigation sources to groundwater sources shows a hydrological transition driven by decreasing Gomti flow and over extraction. The overall study of spatial distribution of irrigation sources and irrigated areas under various irrigation sources clarifies that the total irrigated area in the district has decreased continuously and declining trend has been observed across the blocks but the traditional irrigation sources of surface water are on decline in Lucknow district due to various reasons. Now dependency on ground water has become significant and number of privately owned tubewells has increased which are extracting water from different depths. This extraction is burdening the ground water level in Gomti river basin which is on continuous decrease from past decades. Recent trends which emerged in agriculture are diesel-based mechanization and Electrification, reduced reliability of canal water, availability of private tube wells and pump sets, neglect of traditional recharge systems such as ponds and percolation wells. The decline of these wells also represents the loss of small-scale, sustainable water structures that once supported rural hydrology and river recharge.

### Reference:

1. Central Ground Water Board (CGWB). (2023). *Ground water yearbook: Uttar Pradesh (2022-2023)*. Ministry of Water Resources, Government of India.
2. Gupta, S. K., & Singh, A. (2018). Spatial and temporal variation of groundwater levels in Gomti river basin, India. *Journal of Hydrology: Regional Studies*, 19, 120-136.
3. Jain, S. K., Singh, V. P., & Jain, M. K. (2007). *Hydrology and water resources of India*. Springer.
4. Kumar, A., Malik, A., & Singh, K. P. (2011). Health risk assessment of the people exposed to trace metals via multiple pathways in the Gomti river basin, India. *Ecotoxicology and Environmental Safety*, 74(6), 1478-1488.
5. Lohani, A. K., Goel, N. K., & Bhatia, K. K. S. (2008). Groundwater level prediction using artificial neural networks and adaptive neuro-fuzzy inference systems in the Indo-Gangetic plains. *Journal of Hydrology*, 358(1-2), 142-151.
6. Singh, A., & Goyal, H. (2017). Changing land use land cover and its impact on the hydrology of Gomti river basin, India. *Journal of Earth System Science*, 126(1), 1-15.
7. Upper Ganga Basin Organization, Central Water Commission. (2024). *Gomti river basin*. Government of India. Retrieved from <https://cwc.gov.in/ugbo/gangabasin/gomti>
8. District Statistical Handbook, Lucknow
9. <https://indiawris.gov.in/wris/#/groundWater>
10. <https://updes.up.nic.in/>