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Mapping Wetlands Using Satellite Remote Sensing and Analyzing the Declining Trend of Water Bodies in the Gomti River Basin

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Abstract

The wetland environment is currently being carefully monitored, conserved, and managed because of its significance. Due to the inefficiency, manual labor, and imprecision of traditional wetland mapping methods, remote sensing techniques have become more popular for this purpose. Furthermore, traditional mapping is useless when up-to-the-minute data is essential. Since the Gomti River receives its water supply from the ground, the water bodies play a crucial part in the river's recharge. Changes in water bodies were determined by comparing toposheets from the 1972 Survey of India with data from 2013's Landsat satellite. Based on drainage and slope classifications, the Gomti river basin was separated into three sectors: northern, central, and southern. The findings are typical: the number of bodies of water has drastically decreased between 1972 and 2013. Compared to other parts of the basin, the central region receives about average rainfall, but the water table has dropped by as much as 25 mbgl, as shown by the graphic representation of the analytical analyses of the changes in the water bodies. The findings reveal that throughout this time period, nearly 45 percent of the region's water bodies disappeared. This trend of dwindling surface water supplies is mostly attributable to the region's rapid urbanization and intensive usage of ground water.

Keywords: *Wetland, GIS, Satellite data, Gomti River, aquatic ecosystems & Remote Sensing.*

1. Introduction

The Gomti River is a tributary of the Ganges River and it is a ground water fed river. It originates from Gomat Taal (which formally known as Fulhaar jheel) near Madho Tanda, Pilibhit, (Uttar Pradesh), India. The place of origin is located near Himalayan foothill in the Piedmont Zone of the Ganga Plain. It extends 900 km (560 miles) through Uttar Pradesh and meets the Ganges River near

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Kaithi in Varanasi. An extended basin, running about NW-SE, is formed by the Gomti River. It has a total size of 30,520 square kilometers and has a mild slope. The Gomti travels 240 kilometers until it reaches Lucknow, where it meanders for around 12 kilometers. At the intake, the city's water is pumped up from the river.

Study Area

The Gomti River Basin is situated between 80˚00´E to 83˚10´E longitudes and 24˚40´N to 28˚40´N latitudes. (Figure 1)

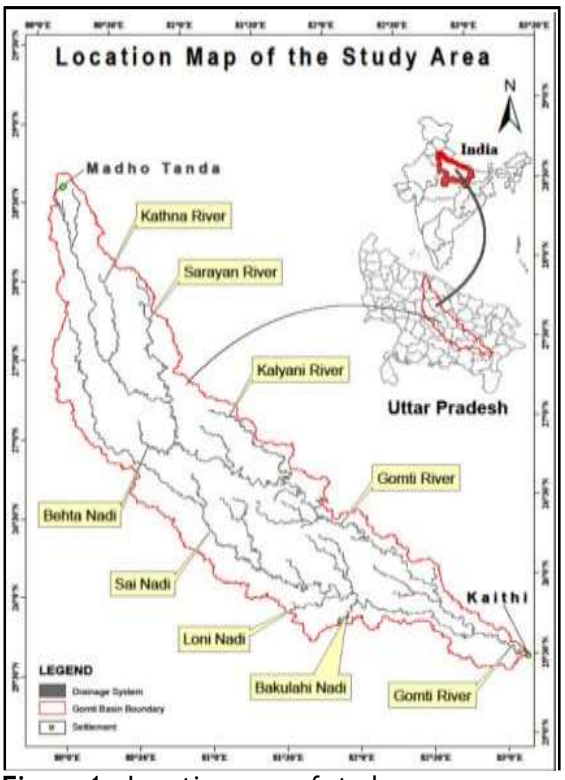

Figure 1: Location map of study area.

The Gomti River basin has been divided into three differentsectors i.e. Northern, Central and Southern sectoron the basis of drainage characteristics and relief parameters (Figure 1 & 2).The orientation of the river-channels in the northern sector has a NNW-SSE regional trend. The orientation of river-channels in the central sector has a NW-SE regional trend. However, in southern sector E-W trends also dominate.

2. Data used and Methodology

The change in wetlandanalysis was carried out bySurvey of India (SOI)toposheetof 1: 50,000 scale (surveyed in 1972-73) and satellite data (LISS III, 2013 and LISS IV, 2010data). The SOI toposheet and digital satellite data were rectified and geo-referenced using digital image processing software (ERDAS IMAGINE ver. 8.7).

Figure 2: Showing different sectors of Gomti River Basin.

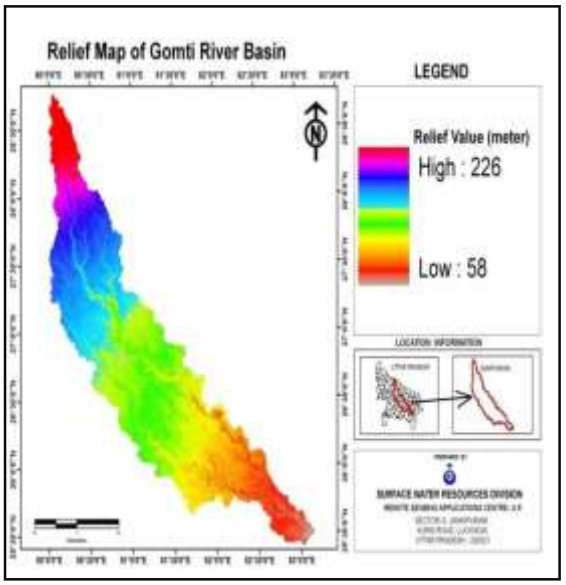

Figure 3: Showing different sectors of Gomti River Basin

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Digitization work has been carried out for entire analysis of basin on GIS platform (Arc GIS ver. 9.3).The methodology comprises following steps.

- Data preparation and geo-referencing
- Digital processing of satellite data for wetland delineation.
- Utilisation of support data & ground truth information
- Preparation of wetland Inventory and generation of relevant statistics.
- Finalisation of wetland maps.

3. Wetland Mapping

Wetlands have many distinguishing features most notable of them are the presence of standing water, unique wetland soils and vegetation adopted to or tolerant of saturated soil. Wetland classification system is based on Ramsar Convention definition of wetlands, which provides a wide structure for define wetlands. And it is agreeable to remote sensor data, has been used for inventory of wetlands.Main criteria followed in this system are:

- Wetland hydrology, i.e. manifestation of water on the satellite imagery.
- Wetland vegetation - mainly hydrophytes and other aquatic vegetation in a part or whole of the water body as observed on satellite data.
- It takes into account all wetlands whether inland or coastal, natural or man-made.
- It provides information on the extent of vegetation present in the wetlands, both in pre-monsoon and post-monsoon seasons, wherever discernible on satellite imagery.

On the above characteristics the wetlands are classified into three ways given below:-

A. Hydrogeomorphic classification of Wetlands
B. Ministry of Environment and Forest (MoEF) classification
C. A classification of wetland and deep waterHabitats of the United States.

4. Change Detection in Water bodies

Geomorphologically, two major units are present in the Gomti River Basin: The regional upland interfluvious surface and the Gomti River valley. The major wetland types are Lake/pond, Ox-bow lakes, paleochannels, cut-off meanders, meander scars, channel bars and Tank/pond. Aquatic vegetation is mainly observed in Lake/pond and also in the some tributary of Gomati Rriver. The present condition of waterbodies in the different sectorof Gomti River is given below-

5.1. Northern Sector

The number of water bodies in northern sector is less in comparison to central sector. Graphical representation shows that there is decrease in number of waterbodies from year 1972 to 2013 (Figure 4).

Northern Sector	SOI topo-sheet (1972)	LISS-III Satellite Data (2013)	LISS-IV Satellite Data (2010)
Number of Water bodies	10400	4180	4165

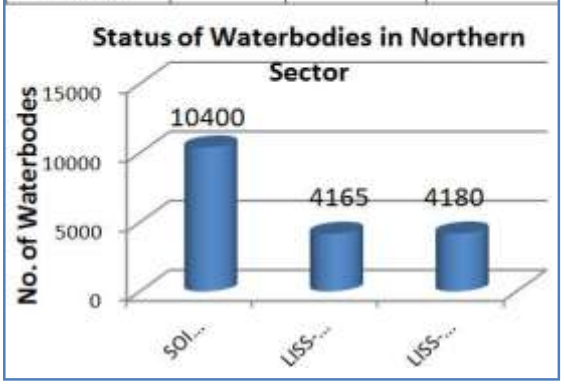

Figure 4: Graphical representation of waterbodies in Northern Sector.

5.2 Central Sector

The number of water bodies in central sector is much more in comparison to other two sectors. On comparing **(Figure 5)** with SOI toposheet surveyed in 1972 and Satellite

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data (LISS-IV, 2010 & LISS-III, 2013) the result shows that approximately 45% water bodies in this sector are extinct.

Central Sector	SOI toposheet (1972)	LISS-IV Satellite data (2010)	LISS-III Satellite data (2013)
Number of water bodies	13265	6054	5930

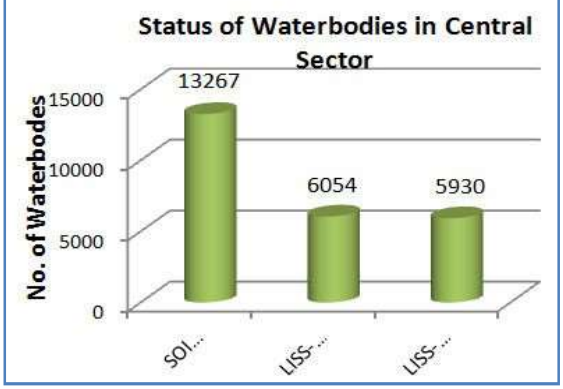

Figure 5: Graphical representation of water bodies in Central Sector.

5.1.C.Southern Sector

The number of water bodies in southern sector is much less in comparison to other two sectors. Graphical representation shows that there is no drastic change in waterbodies. **(Figure 6)**

Southern Sector	SOI toposheet (1972)	LISS-IV Satellite Data (2010)	LISS-III Satellite Data (2013)
Number of Water bodies	941	912	820

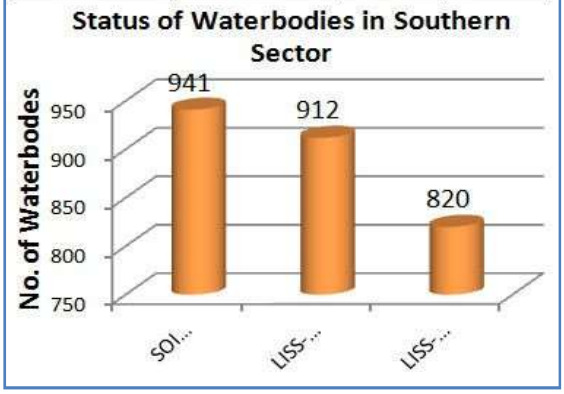

Figure 6: Graphical representation of waterbodies in Southern Sector.

5. Causes of extinction of wetlands

The majority of wetlands have gone dry due to anthropogenic activity and natural process. The major cause of wetland changes are given below:-

6.1. Anthropogenic activities:-

Most of wetlands of the Gomti river basin have been occupied by agricultural land, due to this the surface area of wetland gets reduced and cause drying of waterbodies (Figure 7).

Figure 7: Waterbody occupied by agricultural land.

Banks of the wetland encroached upon by human being for residential purpose is also a considerable cause for extinction of wetland (Figure 8).

Figure 8: Water body occupied by settlement.

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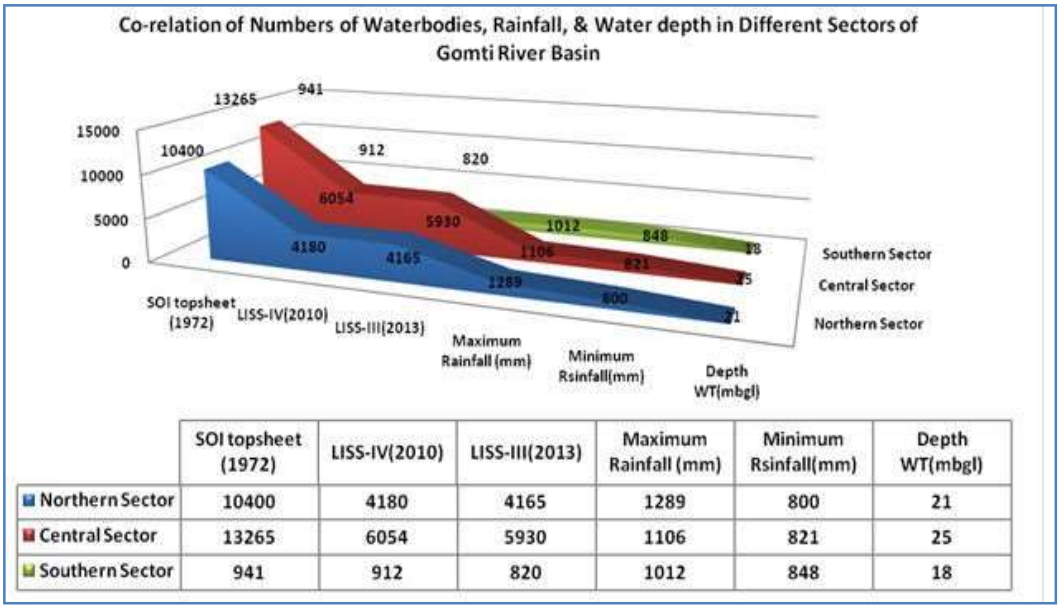
Excessive use of fertilizers like Urea, Phosphates, Potash, etc. by farmers leads to eutrophication in the wetlands. Eutrophication may cause excess growth of vegetation algae, hyacinth (Jal Kumbhi) which is also responsible for wetland regression (Figure 9).

Figure 9: Water body occupied by Vegetation.

6.2. Natural activities

Human activities such as burning of fossil fuel, land use and land cover changes have caused recent change in the world climate system, and continued emission of greenhouse gases is projected to result in further climate change (IPCC , 2001), which is potentially larger future pressure on wetlands. The projected changes in climate including increasing mean global temperature, changes in precipitation, sea level rise and increase frequency and intensity of some extreme climatic events, will impact wetland and their independent species. Siltation refers accumulation of fine particulate terrestrial clastic material, with particle size dominated by silt or clay. The primary source of sediments in wetland is wind and water erosion from agricultural fields (Gleason 1996). The sedimentation in wetland cause siltation which checks percolation of water and consequently extinction of wetland take place. The impact of suspended sediment and sedimentation on aquatic life has been investigated. Sedimentation impact includes increase turbidity that reduces the depth of the photic zone and increases sediment fall out which may cover primary producer and invertebrates. Excessive sediment input thus potentially alerts aquatic food webs as well as basic wetland functionsrelated to water quality improvement, nutrient, cycling and biogenic processes.



	SOI topsheet (1972)	LISS-IV(2010)	LISS-III(2013)	Maximum Rainfall (mm)	Minimum Rsinfall(mm)	Depth WT(mbgl)
Northern Sector	10400	4180	4165	1289	800	21
Central Sector	13265	6054	5930	1106	821	25
Southern Sector	941	912	820	1012	848	18

Figure 10: Comparison of Waterbodies, Rainfall, & Water depth in Different Sector of Gomti River Basin.

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6. Conclusion

On comparing the statistical data of the three sectors (Figure 10) mentioned above, it is found that: The area of the central part is maximum; it has maximum number of water bodies. Analysis show that there is drastic reduction in number of wet water bodies (approx 41%) also the increase in dry water bodies (approx 50 %) is also highlighted in the graphs mentioned below. It may be inferred from the above data there is excessive exploitation of ground water (due to increasing population in this sector of the Gomti basin) and it experiences moderate rainfall (approx 1100 mm) (Figure 10).

7. Wetland conservation and Recharging of the Ground water

Wetland conservation refers to the restoration, creation, and enhancement and in certain circumstances the preservations of wetlands for the purpose of compensating for multiple wetland losses in advances of development. Some general principle of ecotechnology that could be applied for creation and restoration of wetlands (Mitch and Cronk, 1992) which are outlined below:-

a) A system must be designed in such a way that it may require minimum maintenance. The system of plants, animals, microbes, substrate and water flows should be developed for self-maintenance and self- design.
b) A system must be designed in such a way that utilizes natural energies such as the potential energy of stream as natural subsidies to the system. Flooding rivers and tidal circulation transport great quantities of water and nutrients in relatively short periods, subsidizing wetlands open to these flows.
c) Wetlands do not become functional overnight. Several years may pass before plant establishment, nutrient, retention and wildlife enhancement can become optimal. Strategies that try to short- circuit ecological succession or over mange it are doomed to failure.

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