



Remote Sensing Based Wetland Mapping and Analysis of Declining Trend of Water Bodies in Different Sectors of Gomti River Basin: A Satellite Remote Sensing Based Approach

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Abstract

The wetlands are now considered an important ecosystem and being subjected to continual monitoring, conservation and proper management. Remote Sensing techniques are much in use for mapping the wetlands these days as the conventional techniques are time consuming, labour intensive and lack the accuracy of spatial description. Besides, conventional mapping cannot be of use in cases when real time information is required. Gomti River is a ground water fed river; hence the water bodies play an important role in the recharge of the Gomti River. The changes in water bodies carried out by comparing the Survey of India toposheets (Surveyed 1972) and satellite data (LISS-III, 2013). Gomti river basin has been divided into three sectors on the basis of drainage and slope categories namely Northern, Central and Southern sectors. Comparison provide a typical results, it shows that there is a vast reduction in number of water bodies from 1972 to 2013. The analytical analyses of the water bodies changes as shown by graphical representation illustrates that the number of water bodies has been reduced in central region in considerable amount, in this sector water table has also gone down i.e. upto 25 mbgl but rainfall is average as compare to other sectors of the basin. The result shows that approximately 45% water bodies in this sector are extinct during this time span. Increasing urbanisation and heavy exploitation of the ground water are the main cause of this declining trend in surface water resources of this area.

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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. The Gomti River forms an elongated basin, trending in NW-SE direction. It is a gently sloping drainage basin with a total area of 30,520 sq. Km. After running 240 km from place of origin the Gomti enters Lucknow, through which it meanders for about 12 km. At the entrance point water is lifted from the river for the city's water supply.

2. 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)

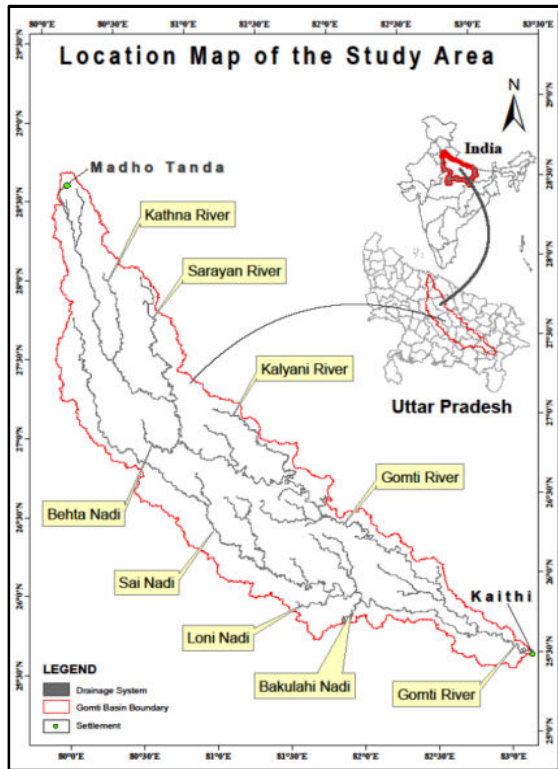


Figure 1: Location map of study area.

The Gomti River basin has been divided into three different sectors i.e. Northern, Central and Southern sector on 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.

3. Data used and Methodology

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

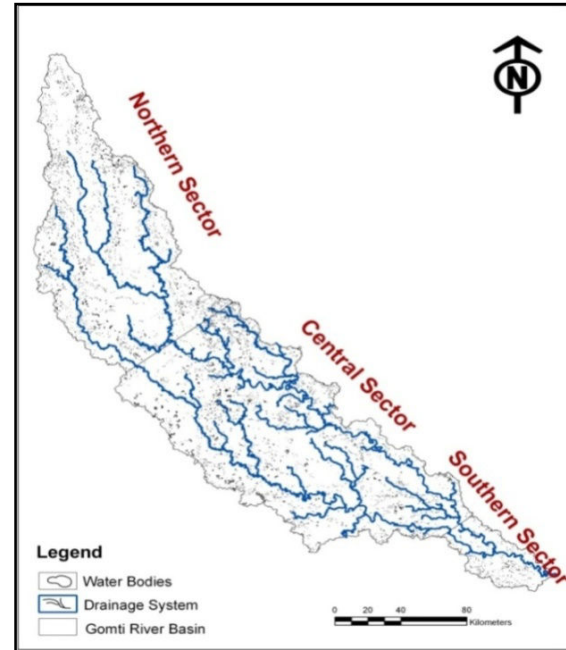


Figure 2: Showing different sectors of Gomti River Basin.

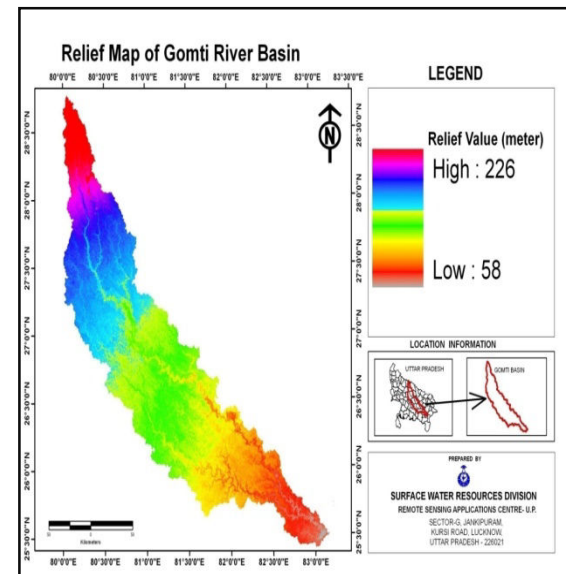


Figure 3: Showing different sectors of Gomti River Basin

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.

4. Wetland Mapping

Wetlands have many distinguishing features most notable of them are the presence of standing water, unique wetland soils and vegetation adapted 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:-

- Hydrogeomorphic classification of Wetlands
- Ministry of Environment and Forest (MoEF) classification

- A classification of wetland and deep water Habitats of the United States.

5. Change Detection in Water bodies

Geomorphologically, two major units are present in the Gomti River Basin: The regional upland interfluvial 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 River. The present condition of waterbodies in the different sector of 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).

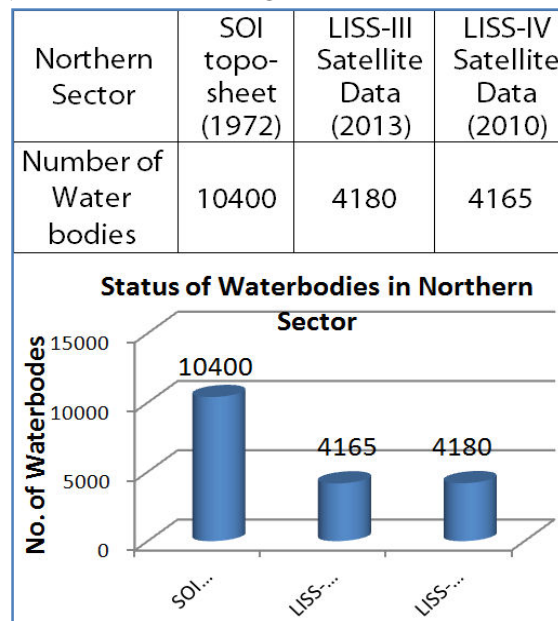


Figure 4: Graphical representation of waterbodies in Northern Sector.

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 topsheet surveyed in 1972 and Satellite

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

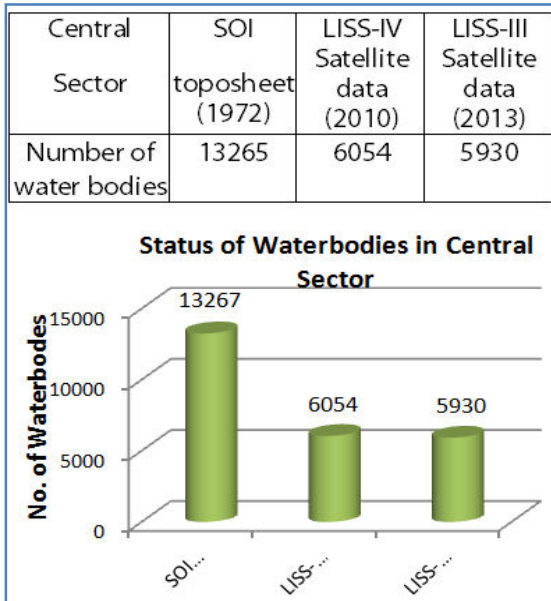


Figure 5: Graphical representation of water bodies in Central Sector.

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)

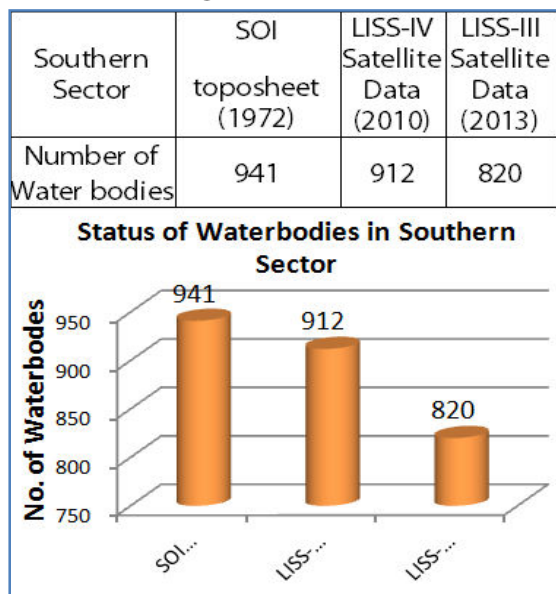


Figure 6: Graphical representation of waterbodies in Southern Sector.

6. 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.

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 functions related to water quality improvement, nutrient, cycling and biogenic processes.

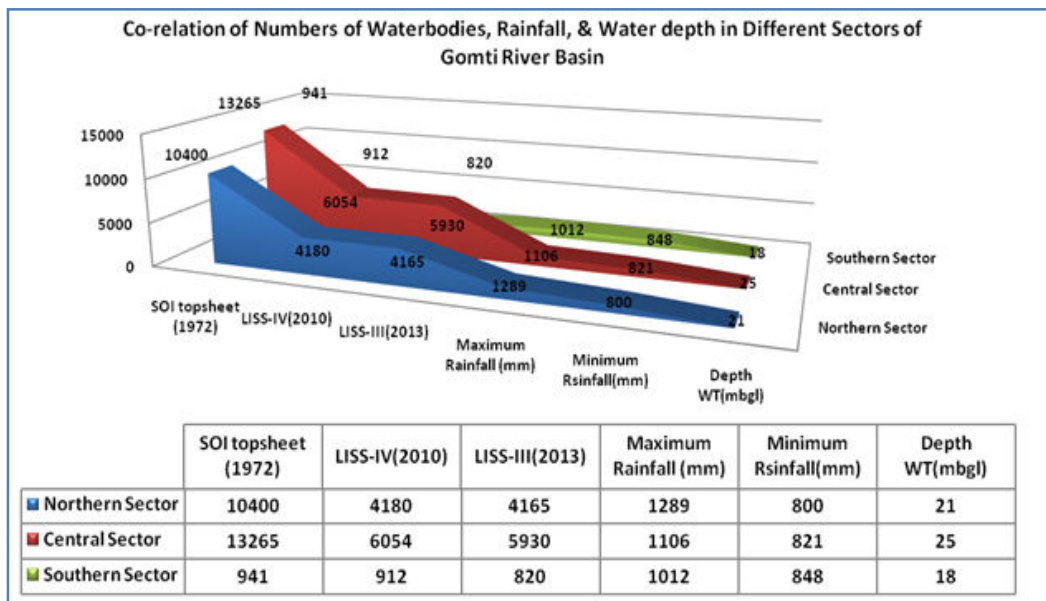


Figure 10: Comparison of Waterbodies, Rainfall, & Water depth in Different Sector of Gomti River Basin.

7. 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).

8. 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 mangle it are doomed to failure.

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