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Human Impact on rivers: A case of Yamuna River in Delhi-NCR

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ABSTRACT

The present research work has highlighted the human impact on the river systems. There is no area environment in which human have not interfered or modified by agriculture, construction, and mining and in the name of development. Delhi-NCR is one of the most densely populated areas of the world where River Yamuna flows for around 125 km in length. The natural character of River Yamuna has diminished in the study area as a result of ever-increasing urbanization, industrialization and agricultural activity. There is a complete lack of riparian vegetation around the river bank which is very important for river health. The construction of three barrages just within 25 km in Delhi has adversely impacted the natural river functioning. The river channel width has also decreased and meanders have straightened in the study area. There is an urgent need to formulate a sustainable river management plan which will benefit both river and population in the study area.

INTRODUCTION

In the modern world the rate of geomorphic change has now been outstripped by human activities associated with urbanization, industrialization, construction and development [1]. The impact human activities can be seen in river water quality and caused hydrological process change in many river basins globally, resulting in a series of water resource problems [2]. Human impacts or modifications to biophysical attributes of river systems can be direct or indirect. While most direct modifications are intended, indirect modifications are inadvertent. Direct modifications to the channel bed or banks have typically taken the form of resource development activities (water supply, power generation, gravel extraction) or structural engineering works (dams, barrages) designed to alleviate the effects of flooding. Clearance of vegetation cover and sand mining on the banks are direct impact of human activities. Indirect human impacts refer to adjustments brought about as secondary responses to changes outside the channel that modify the discharge and/or sediment load. These impacts relate primarily changes in land cover that modify the nature, balance and interaction of water and sediment fluxes. Enormous efforts have been undertaken to make dry lands wetter (network of canals) and wet lands drier, ensuring that water is available for human purpose [3].

The human impact can be seen in river water quality as wastewater discharge has increased tremendously in recent times. Increase in population has resulted in increase in wastewater discharge. Industries related to chemical usage, paint industry or battery industries discharge their wastewater to rivers without treatment or partial treatment. Rapid urbanization along the rivers plays an important role in the increase in point source (fall of drains and sewer pipes in rivers) and non-point sources of pollution [4]. The amount of heavy metal in river water has increased very rapidly as reported by many researchers [5][6].

Table 1: Forms of human disturbances to river courses (source: Brierley & Fryirs 2006)

Direct channel changes	**Indirect catchment changes**
River regulation • Water storage by reservoirs and water diversion schemes (e.g. for irrigation etc.) Channel modifications • River engineering. Channelization programs include flood control works, bed/bank stabilization structures, and channel realignment • Sand/gravel extraction and dredging programs • Clearance of riparian vegetation and removal of woody debris	Land-use changes • Changes to ground cover, including forest clearance, afforestation and changes in agricultural practices (e.g. conversion of grazing land to arable land and emplacement of agricultural drains and irrigation channels) • Urbanization and building/infrastructure construction, including storm water systems • Mining activity

STUDY AREA

Yamuna River originates from the Yamunotri glacier in the Himalayas and is the major tributary of river Ganges. It flows a total length of 1,376 km through the Indian states of Uttarakhand, Himachal Pradesh, Uttar Pradesh, Madhya Pradesh, Delhi, Rajasthan and Haryana. The river draining through Himalayan valleys for several kilometers in Himachal and is entered into the Shiwaliks and Indo-Gangetic Plain. It meets with the river Ganga at Prayag in Allahabad, Uttar Pradesh and forms the vast Ganga-Yamuna fertile flood plain. The river enters in plain area near DakPathar from which it flows slightly south-west and southward direction for nearly 200 km to enter the National Capital Territory of Delhi (Delhi-NCR) forming the boundary between Uttar Pradesh and Haryana. The maximum and minimum elevations of the study area are 181.6 m above mean sea level amsl. In NCT- Delhi, the river flow is diverted through into Western Yamuna Canal and Eastern Yamuna Canal from Hathnikund Barrage for the purpose of irrigation. The important tributaries of the River Yamuna are Rishi Ganga, Hanuman Ganga, Tons, Hindon, Chambal and Sind. The river is characterized by 96.1 x 10^9 m^3 of annual discharge and 107 x 10^6 tons of total loads per year at Allahabad (Bawa et al. 2014).

Topographically, the study area includes barren low hills of the Aravalli range and its outcrop in the west, flat topped prominent precipitous hills of the Aravalli range enclosing fertile valley and high table land in the south west and the rolling plains dominated by the rain fed torrents in the south. Hindon River, a tributary of the river Yamuna joins the main river channel after Okhla barrage.

In the present study the stretch of the River Yamuna covering Delhi- NCR start from north of Baghpat district of Uttar Pradesh to Chhainssa in Faridabad district of Haryana. The study area lies between longitude 77°00′ to 77°30′ E and 29°00′ N to 28°15′ N latitude covering a total length of around 125 km (Figure 1).

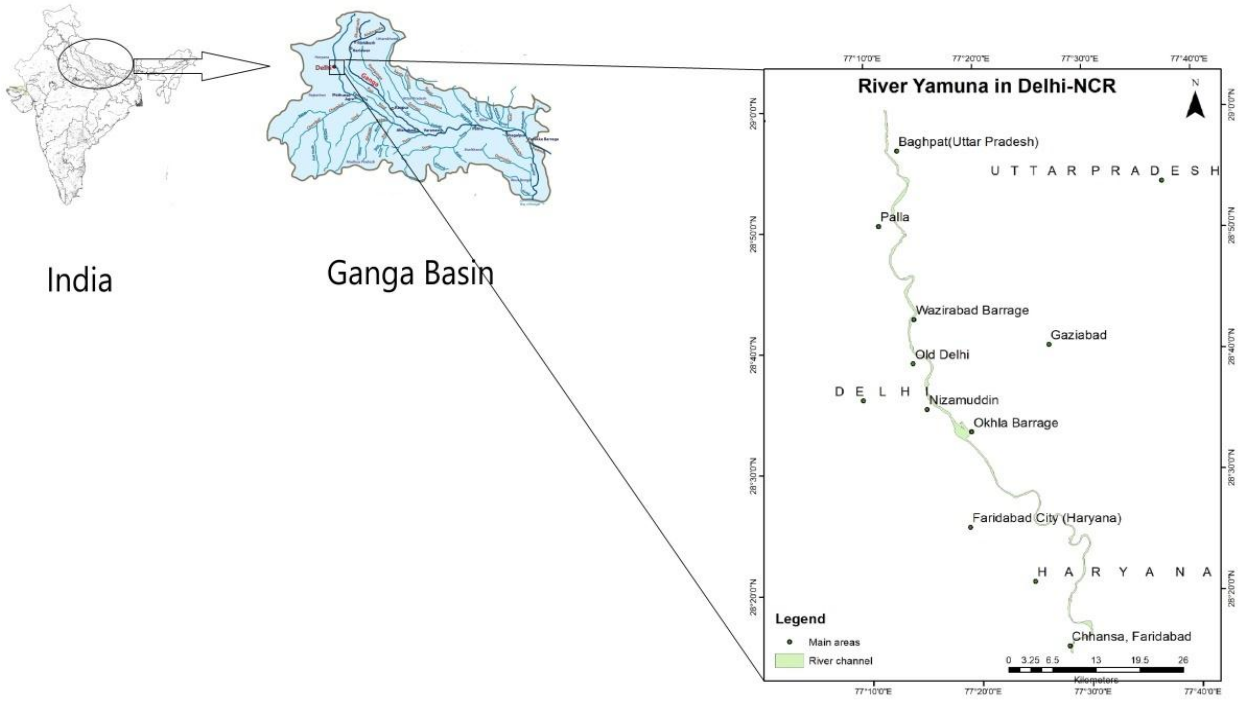

Figure 1: Map showing location of the study area

MATERIALS AND METHODS

The present research work was carried out using mostly secondary data available like satellite data and GIS environment. Channel change has been carried out using satellite images while impact of land use land caver change has been done using supervised classification in ESRI ArcGIS software. The channel profiles were extracted and digitized from Landsat satellite images of 1987 and 2017 years. Visual interpretation of satellite images were also conducted to assess the change in land use and land cover of the study area to assess the population pressure on the river for water supply demand.

RESULTS AND DISCUSSION

The ever-increasing urban population of Delhi-NCR has resulted in the increase in demand of fresh drinking water. To fulfill the drinking water demand of Delhi-NCR, the barrages were constructed on the river at Wazirabad, ITO and Okhla areas. This construction of barrages has caused hydrological changes in Yamuna River system like negligible flow in the river downstream of Wazirabad in the dry season and excessive flow in the monsoon season which causes flood-like situation in the study area (Figure 2).

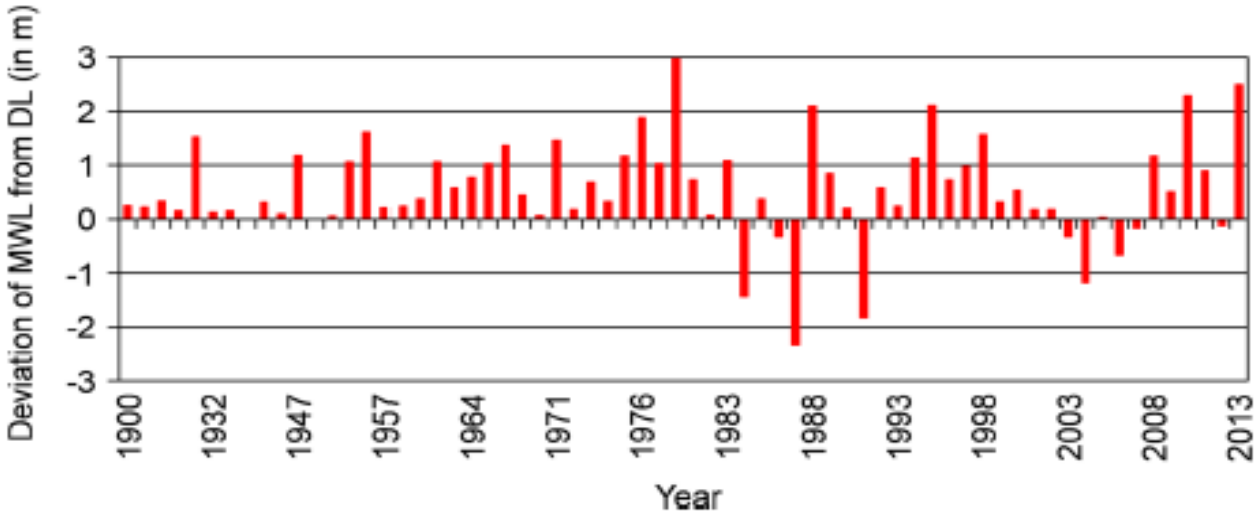

Figure 2: Deviation of maximum water level from danger level (1900-2013) [7].

The embankment around the river bank to prevent lateral movement of the river has decreased the width of the channel which causes heavy flood after an intensive rainfall event along with the increased runoff from the impervious urban concrete areas of the study area. Figure 3 clearly shows how the concrete forest (impervious surface of urban area) has increased from 1987 to 2017.

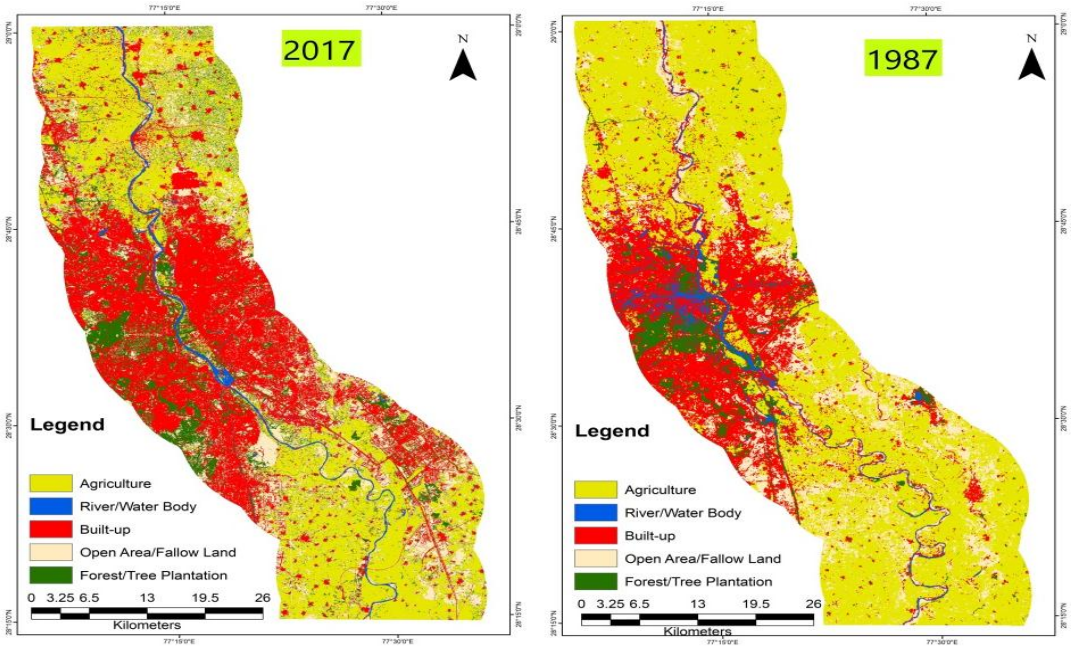

Figure 3: Map showing land cover and Land use of the study area in 1987 and 2017 years

The emergence of NCR areas to decongest the core urban area of Delhi capital gives rise to many million cities like Faridabad, Noida (Figure 4) and Gurgaon.

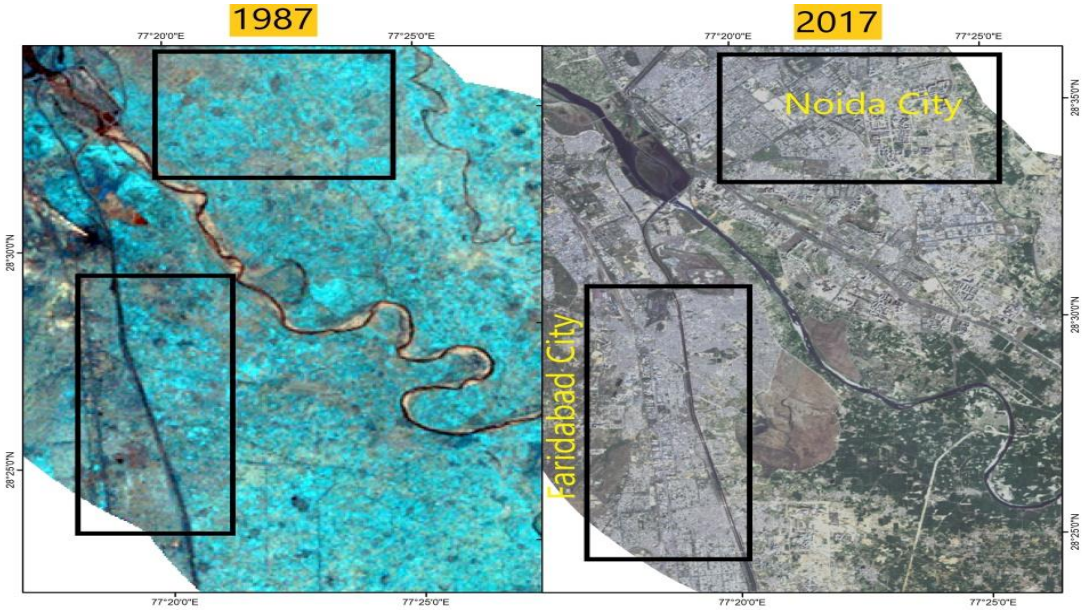

Figure 4: Satellite images for 1987 and 2017 showing growth of urbanization in Delhi-NCR

These cities contribute significantly to pollution in the river water. Trapping of the river water in barrages reduces the flow downstream which in turn reduces biological (fish and other organisms) health along with reduced BOD demand due to falling of many drains which carry high organic contaminants. These contaminants use up all BOD in the river leaving nothing for fishes. The width and sinuosity of the river channel has decreased due to the construction of barrages and water withdrawals and diversions like Agra canal from the Okhla Barrage.

Figure 5 shows the channel change from 1987 to 2017 in which we can clearly ascertain that in the year 1987 the river was having more meanders as compared to recent river channel of 2017 year which comparatively straighter in length. It can be attributed to the reduction in water flow in the channel.

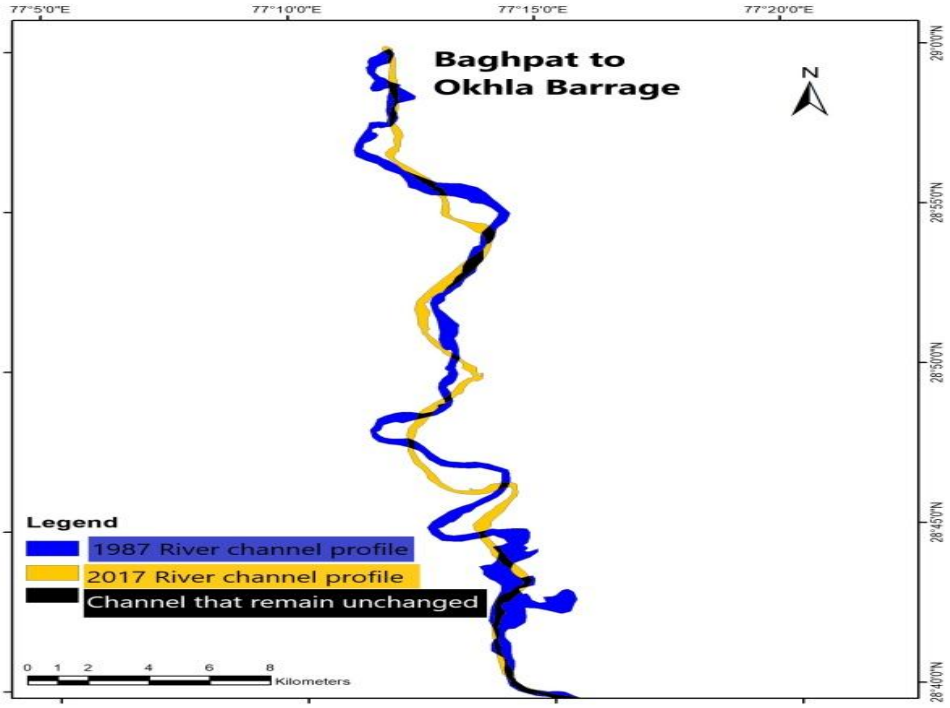

Figure 5 a: River Channel in 1987 and 2017FromBaghpat to Upstream of Wazirabad Barrage

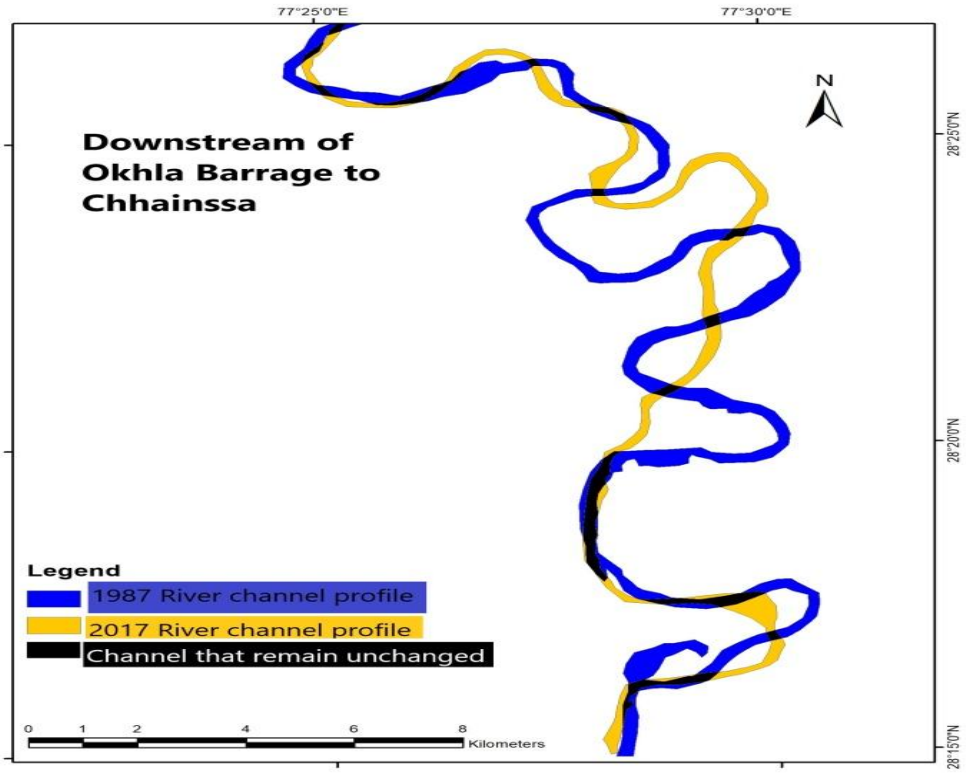

Figure 5b.River Channel in 1987 and 2017From downstream of Okhla Barrage to Chhainssa

CONCLUSIONS

After all the analysis we can sum up by raising the issue of the Yamuna river disturbed ecosystem. There is an urgent need to protect this sacred river. It is utmost important to formulate sustainable river management plan. Because if it is not taken seriously now it might get out of control for the managers to tackle the problem. We have to take all aspect of river health like hydrology, morphology, and biology in our plan to save the river. We should never forget that rivers are the cradle for civilizations and if we exploit it carelessly it might bring hazard for us.

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