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Socio-economic profiling of Ganga River basin in fostering environmental sustainability and cultural diversity in India

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ABSTRACT

The socio-economic propensity of a Ganga river has a seminal bearing upon the physical profile of the land and cultural heritage of India. The socio-economic potentials of Ganga Basin are enormous because of agro-climatic blessings of perennial character and the cropping season. It produces a substantial agricultural surplus, food security and water sustainability from northern to eastern India and Bangladesh. The variability and viability of over 600 million people's agricultural landholdings depend on the Ganga basin in India. As a bio-physical entity, The Ganga stands 34th rank among the major world rivers in terms of the bio-physical existence having a total area of only 1.01 million km^2. The compact and coherent Ganga Basin at some places sustain the highest population density in the world. The paper dwells on the socio-economic profiling of Ganga basin in fostering environmental sustainability and cultural diversity and spiritual reverence of Indian people.

Key words : *Ganga basin, Indian drainage, Socio-economic profiling, Environmental sustainability, Cultural diversity, Ganga river.*

Introduction

The Ganga Basin, with a length of 2,525 km, has a unique distinction amongst the world's major river systems. The longest river of India ranked as 34th in the world capturing a total geographical area of 1,087,300[2] km. The Ganga drainage basin geographically alone ranks alone 16th largest river basin in the world. It acclaims the demographic distinction of being the largest populated river basin of the world. The plain is an outstanding geomorphic feature, remarkable topography, agricultural productivity and high population density (Anderson *et al.*, 2019). The groundwater potentials are much higher along the deeper Himalayan Axis. The amplitude of relief in the Ganga Plain varies from 300 metres at Haridwar to nearly 25 metres above mean sea level in the deltaic region. The Ganga Plains have a great variety of surface features including incised river valleys, entrenched valleys, abandoned channels, palaeo-channels, alluvial ridges, wetlands and lakes (Nomani, 2012). The paper dwells on the socio-economic profiling of Ganga basin in fostering spiritual reverence (Pavan, 2005) and environmental Sustainability in the context of 'six degrees of connectivity' (Wohl, 2014). The faunal and floral diversity and cultural bonding of river Ganga (Nomani, 2019) addressed from 'river health assessment'

(RHA) (Boulton, 1999). The diversity and spiritual reverence towards Ganga examined in the context of 'six degrees of connectivity' and 'river health assessment' (RHA) (Baca, 2015).

Materials and Methods

The material and method of the study are contextualized in six degrees of spatial connectivity in river systems, especially its longitudinal connectivity between its upstream and downstream. The socio-economic parameters, demographic variability and geospatially pragmatically utilized in the present study (Meyer, 1997). The 'river health assessment' (RHA) sporadically employed in the assessment of ecological and diversity of Ganga river in India (Nandi *et al.*, 2016). The physical and anthropogenic character river basin management fosters sustainability models of Ganga river (Jain *et al.*, 2012). There is also no denying the fact it immensely contributes to the epistemology of coastal resource zone (Nomani, 2010), river system assessment (Buch, 2010) and water resource management in India.

Results

The socio-economic profiling of the Ganga basin helps in our understanding of the biophysical characteristics of the geomorphic system in shaping coherent spatial and temporal scales and landscape trajectories. Spread over a geographical area of approximately one million^2 and the catchment area of 3 lakh^2 it is rich by the major tributaries of the drainage system.

Geographical Personality of Ganga Basin: Ganga basin is an integrated network of three different kinds of tributaries. Firstly, there are major perennial Himalayan tributaries such as Yamuna, Ghaghara, Rapti, Gundak and Kosi. Secondly, Ganga also receives several tributaries from the Central Indian Highlands such as Chambal, Betwa and Son. These two types are the widely acknowledged tributary streams of the Ganga basin. However, there is a third type of tributary streams which are lesser-acknowledged but more numerous in this basin. Ganga significantly supported by these tributaries which originate in the alluvial plains. Such alluvial tributaries are much more in number in the Gangetic drainage system. The critical, long-distance alluvial branches are Gomati and the Sai, which runs south of Gomati, almost parallel to the former and flows up to Jaunpur district to join it (Kumar, 2017). The alluvial tributaries of the Gangetic drainage basin are groundwater-fed rivers. These rivers have their sources in the lowland alluvium rather than in the hills. The hydrographs of these alluvial streams show a peak flow during the monsoon season in July and August and a lean flow during the pre-monsoon drought period in May and June. Unlike the glacier-fed rivers, these alluvial rivers are the warm water rivers. Hence, their flora and fauna are different from the snow-fed rivers. Because of the low amplitude of relief in their basin and low gradient, most of these rivers are shallow and sluggish. They may have a lesser tendency of meandering along with their courses. As they are unable to build high levels, they are quite susceptible to inundation during the heavy rains when they are distinctly swift.

Catchment to Command Area Ratio: Ganga Basin has a total geographical area of approximately one million^2 km. Figure 1 depicts the major tributaries of the drainage system. The catchment area of the Ganga river basin is over 3 lakh sq.km. The catchment area is nearly one-third of the entire drainage basin. The catchment area of the Himalayan tributaries exceeds that of its tributaries rising in the central Indian highlands. In the hilly catchment area, the first order tributaries are uninhabited with narrow valleys. There are no settlements, no stable economy and no human interference. Only natural forces of geomorphology such as the landslides remain operative. In the second-order tributaries down the first order confluence, there are narrow valleys and a few temples. There are no permanent settlements, no agriculture and no economy. The IIIrd order streams have deep and wide valleys. These thickly vegetated with thin soil formation and small rural settlements. The low lying and levelled command area in the plains is no less than 7 lakh sq.km. Here, it is crucial to note that no other major rivers in the world have two-thirds of the area under the command area category of the levelled land to fulfil the human right to the environment (Nomani, 2000).

Supplemental Status of Ganga Tributaries: Ganga drainage basin receives the bulk of its water supply from its tributaries. The tributary streams of Ganga contribute no less than three times the water in com-

parison to the water status of the main river. It remains a universal truth in almost all the major drainage basins that the tributaries contribute at least two to three times water as compared to the main river. On the whole, the tributaries of Ganga carry over 400 billion cubic meters of water annually. One can appreciate the fact that at Patna, the total Ganga flow exceeds 240 billion cubic metres per year. Further east, the overall Ganga flow exceeds 320.4 billion cubic metres annually. On the whole, the total surface flow of the entire Ganga Basin to its delta is over 525 billion cubic metres per year. The Planning Commission, Government of India, had estimated the increase in India's water demand from 710 billion m^3 in 2000 to nearly 1,180 billion m^3 in 2017which amounts to about 2.5 times increase in the water demand. We can estimate enormous pressure on the sustainability of both surface and groundwater resources (Bhatt *et al.*, 2016). About 12.6 billion litres per day (BLD) of domestic waste poured and 2.5 billion litres per day industrial waste generated in the entire basin. Although the daily industrial waste on the Ganga River is only one-fifth of the regular domestic wastewater by volume and intensity, the effect of the industrial effluent exceeds that of the household waste.

Discussion

The ecological fitness and catchment health happens to be indicators towards human intervention, channel diversion, water abstraction, biological and cultural diversity of Ganga river basin. The gap between science and the sanctity of Ganga needs to be bridged under the community-oriented RHA model to foster sustainability and cultural diversity of Ganga in India (Nomani, 2002).

Ganga Basin Sustainability: The Ganga basin is the major drainage basins of the world in terms of population and density. The Himalayan River has a total area of only 1.01 million km^2. A comparison made out among the 16 major drainage basins of the world. It is a highly favourable catchment to command area ratio, which makes the Ganga drainage basin a unique land of high socio-economic sustainability and environmental impact (Nomani, 2020). Ganga drainage basin is the largest populated area in the whole world, and it is also the most significant contiguous agricultural area in the world. The large Ganga basin has one of the highest agrarian densities in the world. The socio-economic sustainability and agricultural intensity of the Ganga basin is comparable only with the Yangtze basin of China. The average land-use concentration in the Ganga Basin is nearly 200 per cent. The net flooded area in the basin exceeds 37,000,000 hectares which comprise almost 59 per cent of the irrigated area of India. Ganga basin has the largest gross irrigated and gross cropped area in India. The irrigation in the basin from groundwater sources exceeds 140 billion cubic metres annually. Globally about 60 per cent irrigation is met by surface water of the rivers. As against this, in India, about 67 per cent irrigation is done by groundwater mining (Nomani *et al.*, 2020b). Hence, the groundwater sources of the Ganga Basin are also under tremendous pressure.

Biological & Cultural Diversity: The biological and cultural diversity of Gangetic Plains bounded by the 'Boundary Faults' of Tertiary foothill zone in the north and spurs of the Deccan plateau in the south. The groundwater potentials of the Ganga Basin estimated by the depth of alluvium in the basin. The geographical personality of Ganga Basin rated high in terms of alluvium depth of Sand, Silt and Clay as much as 1,300 to 1,400 metre deep. The Gangetic plains slope from north-west to the south-east with an average gradient of 95 mm per km. The angle in the deltaic region is as low as 20 mm per km. Due to underlying structural controls, from Allahabad to Rajmahal, the right bank of the river is steep and 8-15 m high (Singh, 1999). West of Allahabad, the Yamuna which runs along the Delhi ridge, strikes the plateau rim near Agra. Hence, Geddes terms Ganga and Yamuna as 'Rim Rivers'. It is crucial to note from the Flood Security Perspective and the groundwater availability that all the major cities of Ganga basin such as Kanpur, Allahabad, Varanasi, Patna and Bhagalpur grew on the right bank of Ganga (Nomani *et al.*, 2020c). Similarly, Delhi and Agra also developed on the right bank of the Yamuna river. The drainage pattern is also dendritic, and most of the tributaries meet at an acute angle. Braiding, meandering and course shifting of the river are a standard feature, and sandy shoals are often liable to monsoon floods. A characteristic part of the Gangetic plains is the increasing amount and intensity of rainfall towards the east and the deltaic region. High rainfall in the catchment areas and relatively steeper gradient of the tributaries renders them highly vulnerable to floods. The Hima-

layan tributaries of Ganga River like the Gomati, Ghaghara, Rapti, Gandak and Kosi are highly susceptible to frequent floods.

Potentials and Problems of River Health: The potentials and problems of river health of Ganga Basin attributed to the anthropocentric factors. It is the most densely populated of all the rivers in the world. Due to high pollution levels in all its tributaries the level of contamination of water runs very high (Nomani, 2004). The average population density in the basin exceeds 600 persons per sq.km. The highest population density is in the Gangetic state of Bihar, where it exceeds over 1,100 persons per sq.km. As Bihar is amongst the least urbanized states of India with average urbanization of nearly 15 per cent, the rural and agricultural density in Bihar is the highest in the world. The thickness of the farming population in Bihar is near twice the agricultural frequency of Yangtze River in China. These high densities, on the one hand, might depict very high sustainability of our Ganga basin. However, emotions aside, the same high frequencies indicate a tremendous land-use pressure on the Ganga basin. For example, in Bihar, the exceptionally high agricultural densities also indicate very small operational landholdings. As a result of it, the agricultural farms in Bihar are not only the most modest in India but also the most insignificant in the whole world. The situation almost resembles in the state of West Bengal and eastern parts of Uttar Pradesh. The smaller landholdings, coupled with acute poverty, adversely affect the propensity of mechanized and modern agriculture in the east of Ganga Basin. The socio-economic sustainability of the predominantly agricultural Ganga basin may not hold a good promise unless drastic measures of population control and social transformation are adopted (Nomani *et al.*, 2019).

Conclusion

The vigour and vitality of ecologically and culturally sensitive Ganga River need an inclusive space for collaboration and public participation. It should usher ecocentric and trans anthropocentric approach to conserve the Ganga river. The vast Ganga Basin, within the Indian territory, extends across 11 states of Himachal Pradesh, Uttarakhand, Uttar Pradesh, Haryana, Delhi, Rajasthan, Madhya Pradesh, Chattisgarh, Bihar, Jharkhand and West Bengal. A population and land-use perusal of the Ganga Basin reveals that Indian agriculture still largely remains a labour intensive and water-intensive practice. Agriculture mostly practised by flood irrigation method. Because water use efficiency is lowest under traditional flood irrigation systems, we need to enhance the water use efficiency. Ganga Basin produces a substantial agricultural surplus. Even then, the lingering food insecurity is mostly the result of politico-administrative inefficiency and marketing exploitation. We need to harness as much socio-economic relevance of Ganga as we harbour its spiritual reverence. The behavioural approach in water conservation should implant through the social revolution in consumption behaviour. We have not yet groomed into capital intensive agriculture by increasing the sprinkle and drip irrigation methods of higher water use efficiency. India's large farmers should compulsively adopt the capital intensive and water conservative drip and sprinkle irrigation.

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