

## Thwarting changing land use – a step towards Ganga rejuvenation

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The establishment of the Ministry for Water Resources, River Development and Ganga Rejuvenation by the Government of India has sprouted a new hope for River Ganga. The river is breathing on a ventilator supplemented with variable doses of pollutants. One may ponder whether the sanction of crores of rupees will accomplish what has not been since the last 27 years (Foundation of Ganga Action Plan (GAP), 1986). The GAP I and II failed to accomplish what has been documented in their dossiers. One of the issues the plan lacked was watershed development and land-use changes in the basin<sup>1</sup>.

The process of urbanization promoted with industrialization has flanked the riverfront. There are 17 cities along the river bank<sup>2</sup>. Today, 22% of the country's urban population lives in the riparian states along River Ganga<sup>2</sup>. As a result, the river is no longer only a source of water, but is a lotic dump yard, receiving and transporting urban waste. The flood

plains of the river at various places (especially in Varanasi) cannot be easily demarcated due to urbanization near the river bank. Varanasi, the city from where the GAP was initiated in 1986, presently acquiring the central stage after the 2014 elections, can serve as the best example of urbanization. The entire 7 km river stretch in the city is lined with the captivating 84 concrete Ghats. Further the state government plans three more new Ghats – Lohiya, Rajnarayan and Malviya – to be built ahead of Harishchandra Ghat on the banks of the Ganga<sup>3</sup>.

Recognizing the need to revamp the river health, it is necessary to focus on the land-use pattern along the banks and also the basin. Had we afforested the vacant bank of River Ganga or cultivated the fertile flood plains of the river instead of poorly intercepted nallahs and technology-less sewage plants, the change would have been noticeable since 1986. If the bricks or stones which lay the foundation of the Ghats are replaced

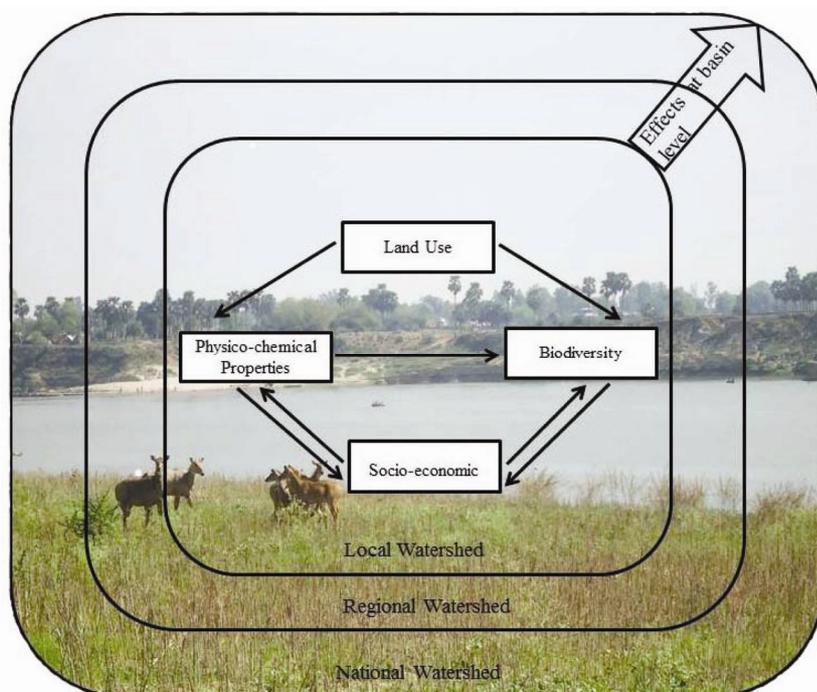
with green pasture covers, shrubs and cultivable plants, the river would have not been in the present pitiable state. Studies have been done in various countries to determine the relationship between the changing land use and riverine condition. There is a need to orient research in our country in this direction, especially for River Ganga. So far whatever is planned for improving the health of the river is at basin level (Ganga river basin management plan by seven Indian Institutes of Technology). What is easier to see – the entire basin as a single unit or dividing the basin into sub-basins and further into regional and local watersheds? Rather than being a centrally sponsored scheme, the solution lies in the management at local level.

As the anthrosphere traverses the lithosphere at a steady rate, freshwater systems are being stressed, demanding an interactive assessment at watershed scale. 'Watershed systems involve complex interactions among biotic (flora, fauna, humans), abiotic (soil, water, air) landscape elements, and socioeconomic components (markets, social characteristics)<sup>4</sup>.'

The eco-hydrological dynamics of watersheds is affected by urbanization and population<sup>5</sup>. With the growing population, watershed continues to be degraded persistently, and with expanding effects<sup>6</sup>. Urban watersheds have variable contaminants that impair ecosystem services<sup>7</sup>. Fragmented lands, due to urban development, not only affect infiltration and run-off, but also alter water quality and hydrologic flows in watersheds systems<sup>8</sup>.

In a study conducted by Poff *et al.*<sup>9</sup>, there were marked differences seen on hydrological responses from different land uses. The urban land cover caused more hydrologic responses than natural land cover or similar percentages of agriculture land cover. With urban land cover exceeding 15% in a watershed, the overall impacts were greater than a land cover with 25% total agriculture land.

Roy *et al.*<sup>10</sup> investigated 30 streams and found that increasing urbanization negatively correlated with water quality, habitat and macroinvertebrate diversity.



**Figure 1.** Conceptual model representing – a holistic approach for Ganga rejuvenation, from local watershed to multi-scale watershed, studying the interactive effect of land use pattern on abiotic and biotic components of river and their societal influence and vice-versa relationship (at the back drop is the river Ganga with its banks flanked with green cover in the upstream of Varanasi district).

Strong relationships between catchment land cover and stream biota were found with a negative correlation between the amount of urban land-use cover and taxon richness. Good-water quality was positively related to forested land cover<sup>10</sup>. Undisturbed land and large areas of natural landscapes are important for stabilizing hydrology<sup>1</sup>. The plight of River Ganga warrants a multi-scale ecological risk assessment (ERA) at local, regional and national watershed scales<sup>11</sup>. Developing a scientific understanding of the dynamics that exists between fragmented habitat within a watershed and hydrologic processes will allow future land management for more sustainable water resources<sup>4</sup>. As the river along its 2525 km course has diverse watersheds, policies need to be flexible and able to incorporate regional differences into the basin management plan.

The forthcoming policies and plans to rejuvenate the river must evaluate and make a comprehensive analysis on the effects of changing land use on riverine conditions. The comparison of watersheds that have major change in land use over a time period with those that have the least will allow for detailed assessment of the impacts of specific land-use patterns on river water quality<sup>4</sup>. Also, understanding the interaction between

watershed and river at local scale will indirectly lead researchers to analyse the societal influence on river dynamics.

We are left with the question whether Ganga will again be bullied between various political parties and ultimately die or will it be treated sustainably with scientific approach?

‘What has been built by our ancestors along riverfront cannot be demolished, but what has been planned by their successors can be sustainably restructured.’

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