

Rejuvenation and Conservation of Ganga with Ecosystem Approach: Science and Community Participation to Enrich Native Biodiversity

Dr. Vinod Tare and Dr. Vishal Kapoor in conversation with Akash Sondhi



Dr. Vinod Tare (vinod@iitk.ac.in) is a Professor of Environmental Engineering and Management at the Indian Institute of Technology Kanpur and also held Sir M Visvesvaraya Chair Professor. He is a Civil Engineer, obtained his Master's and Doctoral degrees in Environmental Engineering from IIT Kanpur, and subsequently did post-doctoral research at the Illinois Institute of Technology, Chicago. He began his professional career with a short tenure at the Engineers India Ltd. He has guided numerous masters' and doctoral dissertations, and published many reports and papers. Dr Tare has developed nature-friendly toilet systems with potential for deployment in Indian Railways, communities, house boats, large congregation, etc. Dr Tare led the consortia of seven IITs that prepared Ganga River Basin Management Plan (GRBMP) and is the founding head of the Centre for Ganga River Basin Management and Studies (cGanga) supported by the Ministry of Jal Shakti, Government of India.



Dr. Vishal Kapoor (vishal.262570@gmail.com) is currently working as Senior Project Scientist at Indian Institute of Technology, Kanpur, India in Centre for Ganga River Basin Management and Studies and deals with the issues related to floral and faunal biodiversity of the rivers. He was awarded PhD in 2012 in Botany by CSJM, University Kanpur. He completed his M.Tech. from Indian Institute of Technology, Kharagpur, India in Applied Botany (Agricultural Biotechnology) in 2007. He has more than 15 International publications in peer-reviewed international/national journals. He has worked as team member of the biodiversity group for e-flow assessment of the upper Ganga and Ramganga River (WWF-India).

Reckoned as a major riverine system of the world, river Ganga has been the source of physical and spiritual sustenance of Indian civilization; with numerous previous common or magnificent capitals, situated on her banks. It is adored as the goddess Ganga in Hinduism. Beyond water, the fertile basin of the Ganga River provides food and nutritional security by supporting agriculture and industry. The free-flowing river sustained rich biodiversity within as well as in her basin.

We are joined by Prof. (Dr.) Vinod Tare, Founding Head, cGanga and Dr. Vishal Kapoor, Senior Scientist as they share the first-person perspective on the stewardship efforts, the challenges, the role of stakeholders and need for a continuing effort on the rejuvenation of Ganga – The National River of India.

AS: Why Ganga?

VT: Ganga represents culture of rivers in India as well as in the region. Ganga is viewed as synonym to the rivers, Biophysically, emerging from the Gangotri Glacier, approximately 4100 meters above the sea level, as “*tri path gamini*” (three routes) named as Bhagirathi, Alaknanda and Mandakini, the river flows through the Himalayas until the confluence of Alaknanda and Bhagirathi at Devprayag, where it acquires the name Ganga.

The Ganga River basin - the largest river basin in India - houses and quenches the thirst and needs of about 40% of India's population. The river, after traversing a distance of 2525 kms from its source, meets the Bay of Bengal at Ganga Sagar in West Bengal. During the course of her journey from the hills to the sea, developmental and human activities discharge municipal sewage from large urban centres, trade effluents from industries and polluting waste from several other non-point sources into the river, resulting in degradation of water quality and impacts on native biodiversity.

From historical times characteristics of the Ganga waters are known to be remarkable for their life-giving properties. Medieval documents and scriptures indicate on how the river should be treated by humans. The environmental significance should be obvious to the modern mind, and they convey a sense of deep respect for river Ganga. Thus, essential wisdom, plus the common man's faith in the river's eternal qualities form the basis of a convergence of ideas of what Ganga is. The significance of Ganga transcends beyond a perennial stream. Ganga, along with her many tributaries and distributaries, has been the source of physical and spiritual sustenance of Indian civilisation for millennia. And all through the ages, Indians held the bountiful River Ganga as a Divine Body and the flow of River Ganga as the flow of Divinity.

Ganga finds historical and medieval references in the form of scriptures. A salient scripture on Ganga quoted below means: “the qualities of Ganga water are: coolness, sweetness, transparency, high tonic property, wholesomeness, potability, ability to remove evils, ability to resuscitate from swoon caused by dehydration, digestive property and ability to retain wisdom”:

अस्या जलस्य गुणाः शीतत्वम्, स्वादुत्वम्, स्वच्छत्वम्,
अत्यन्तरुच्यत्वम्, पथत्वम्, पावनत्वम्, पापहारित्वम्,
तृष्णामोहध्वंसत्वम्, दीपनत्वम्, प्रज्ञाधारित्वञ्च, इति राजनिर्घण्टः

AS: Tell us about cGanga

VT: Ganga River was declared as the National River of India on November 4, 2008, At the initiative of the Government of India a 7-IITs Consortium had prepared the Ganga River Basin Management Plan (GRBMP) and submitted it to the government in the year 2015.

National Mission for Clean Ganga (NMCG), Ministry of Water Resources, River Development and Ganga Rejuvenation (MoWR, RD & GR), was a setup under the ambit of National Ganga Council in October 2016 under the River Ganga Authority order 2016. The Centre for Ganga River Basin Management and Studies (cGanga) was established as a think tank under the aegis of NMCG led by the Indian Institute of Technology, Kanpur (IITK) in 2016 with representation from most leading science and technological institutes of the country. One of the stated objectives of cGanga is to make India a world leader in river and water science. It aspires to play a pivotal role in the implementation and dynamic evolution of Ganga River Basin Management Plan (GRBMP) prepared by the Consortium of 7 IITs. In addition to this it is also responsible for introducing new technologies, innovations and solutions into India through a number of nodal institutions and organisations for data collection, the creation and

dissemination of knowledge and information for the sustainable development of Ganga River Basin.

AS: What is cGanga's role and vision for conserving and rejuvenating Ganga?

VT: We started with an aspiration for a holistic approach toward Ganga Restoration and conservation. In order to preserve and invigorate national river Ganga, her essential character first needs to be grasped in a holistic manner. After extensive review of literature, research, in-house discussions and consultations with stakeholders, the “wholesomeness of national river Ganga”, viewed from a dynamic perspective, was determined in GRBMP to be the sanctity of the river system imbibed in the following four points:

I. “Aviral Dhara” (Uninterrupted Flow): the flow of water, sediments and other natural constituents of river Ganga are continuous and adequate over the entire length of the river throughout the year. Hence in-stream barriers, water diversions and barriers to surface runoff must be regulated.

II. “Nirmal Dhara” (Unpolluted Flow): the flow in the Ganga river network is bereft of manmade pollution. Hence the river waters in present times should not be sullied by polluting human activities.

III. Geologic Entity: the Ganga river system is the earth's creations of ancient times, which may not be reparable if damaged. The geological integrity of the entire basin must therefore be protected.

IV. Ecological Entity: the Ganga river system is a delicately structured balance between various living species and the physical environment, achieved by nature over thousands of years and vulnerable to irreversible changes. Overexploitation and unhealthy interferences with the biophysical resources of the river system must therefore be abandoned outright.

AS: What is unique about cGanga's approach in Ganga Restoration and Conservation?

VK: When we conserve a river – it goes beyond saving the river, it has to be a basin wide action. A river is much more than the single channel or multiple channels of the river. It includes wetlands, lakes, and below the Earth waterbodies. Ganga is even more complex - it is Sahastra Dhara i.e. thousands of streams which flow under and over the surface.

One of the most important missions of GRBMP was that of Ecological Restoration. This is because it was realized during the preparation of GRBMP that the ecological health of River Ganga would be the best indicator of her wholesomeness rather than piecemeal assessment of hydrological, water quality or geomorphological characterization of the river. As a vibrant ecosystem of ancient origin, the river's biodiversity would be the most complete indicator of her overall status. It is for this reason that it was ardently hoped that GRBMP would be implemented speedily to revive the vibrant River Ganga teeming with life.

And it is for the same reason that the separate compilation for each focal species is planned, which not only covers the biology of the organisms i.e., fish, turtle, gharial, dolphin, etc., but also its historical and current status in terms of abundance and distribution, major threats, conservation measures, formulated guidelines, current and future policies by state and central authorities and challenges for scientific understanding. The periodic assessment of the focal species in river Ganga is necessary to decipher overall improvements or decline in the river habitat conditions within the Ganga River Basin.

AS: What are the existing and continuing threats to Ganga River Basin and ecosystem?

VK: Numerous and ever-changing human activities have rendered a new dimension to the basin dynamics. Primarily anthropogenic causes: increasing population, urban growth, industrial, agricultural and our interventions to meet various demands has impacted Ganga

and its ecosystem and its biodiversity.

While Ganga is a single stream from its origin in the Himalayas to its final discharge in the Arabian Sea, we must realize that the river varies every 8 - 10 km. The major threats vary area wise. While Hydropower and Irrigation Project had a role in the Upper stretches, excess water abstraction linked with agriculture and agricultural pollution in the plains, anthropogenic and industrial demands and associated pollution in proximity to urban and industrial centres has resulted in severely impaired river system. Salinity changes in the lower stretches has also resulted in a changed ecosystem.

River Ganga's water quality is abysmal at present, posing a grave threat to health and life, but urban and industrial development also caused habitat destruction in the Ganga basin. Dredging, sand mining and embankments of the rivers caused habitat degradation, resulted in decline of certain species. Salinity in the lower deltaic Indian region of the estuary changed drastically due to interventions in both India and Bangladesh. There are also natural factors such as channel migration and siltation which create a short-term threat but are self-balancing.

AS: What has been the approach of Ganga River Basin Management Plan? What areas are being addressed by cGanga?

VT: Scientific evaluation of the status of the Ganga River network, its causal connection to natural and anthropogenic activities in river system and the basin, and the planning of appropriate technological interventions to reverse or arrest the river's degradation lie at the core of Ganga River Basin Management Plan (GRMBP).

But, based on past learning, we realized that it will not be sufficient for a successful and sustainable restoration with introspection and need assessment we co-created an approach: "Apply modern science and technology in conjunction with traditional knowledge"

**पारंपरिक ज्ञान के साथ आधुनिक विज्ञान और प्रौद्योगिकी
जन ज्ञान + ज्ञान धारा**

There is some merit in following this approach. It is also noteworthy that, in order to protect the quality of Ganga waters from human misuse, the following edict in Sanskrit, compiled from teachings outlined at various places in Bramhand Puranam, prohibited fourteen types of human actions: (1) defecation, (2) gargling, (3) shampooing (4) throwing of used religious offerings, (5) rubbing of filth, (6) flowing bodies (human or animal), (7) frolicking; (8) acceptance of donations; (9) obscenity; (10) considering other shrines to be superior, (11) praising other shrines, (12) discarding garments; (13) hurting anyone, and (14) making noise:

गंगा पुण्यजलां प्राप्य चतुर्दश विवर्जयेत्।
शौचमाचमनं केशं निर्माल्यं मलघर्षणम्।
गात्रसंवाहनं क्रीडां प्रतिग्रहमथोरतिम्।
अन्यतीर्थरतिचैवः अन्यतीर्थं प्रशंसनम्।
वस्त्रत्यागमथाघातं सन्तारं च विशेषतः ।।

Under GRBMP 1.0 we covered lot of things, and these efforts were mostly on higher order streams. But with the realization that we cannot build an inverted pyramid, i.e. we cannot clean Ganga which is a higher order stream before cleaning the lower order streams, efforts of GRBMP 2.0 are focused on lower order streams and waterbodies including ponds, lakes and wetlands.

AS: How do you interpret the Ecosystem with respect to Ganga – which is an aquatic ecosystem?

VT: The Ganga River basin comprises valuable physical resources (such as soil and water) and biotic resources (plants, animals and micro-organisms) in a dynamic balance achieved over millennia. The river network, the numerous surface waterbodies and the groundwater in the basin are closely interconnected by hydrological linkages (such as surface runoff, groundwater flow, river flooding, and local evapotranspiration-precipitation cycles) as well as ecological connections (from complex food webs to activities of biological agents).

The basin, with such hydrological-ecological linkages, is a closely interactive natural resource system. It provides macro, meso, and micro level material and energy transfer along with intricate biophysical communication between the river and her basin. An interactive resource dynamic governs the health of both the basin and the river system.

Ecosystem is the integrated whole; we must understand it in a holistic manner both from a macro perspective and also the intricate balance which lies within. If we side-line one factor - the overall ecosystem is impacted.

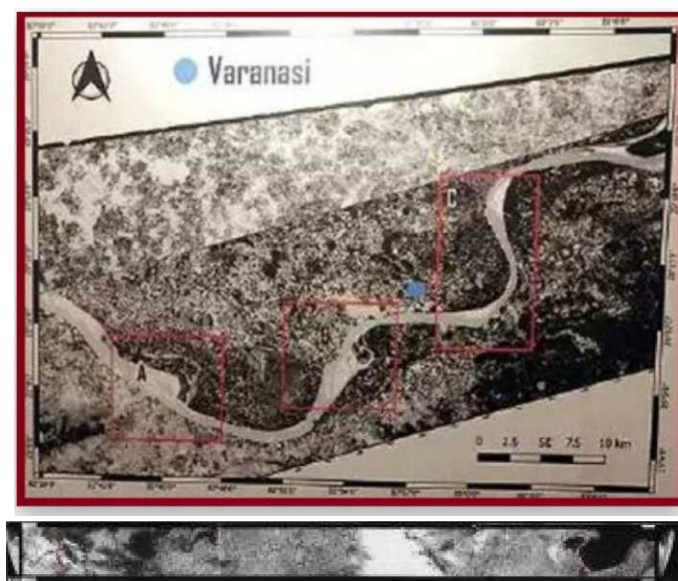
AS: Which areas cGanga is addressing now?

VT: We started with a lack of cogent data and absence of unified studies. We started by researching and collating scientific studies, historical records, focused surveys – talking to elderly who are 100-year-old and so on.

Under these constraints, we made a sincere effort to capture trend for relevant parameters within different stretches of river Ganga, for example in the upper stretches it was temperature and land use land cover information that were consolidated to develop an understanding of natural and anthropogenic factor impacting Ganga.

We started using recently available satellite data, digitized and compare that from the old data. One unique effort which our team did was to collect historical images from USGS server - past Information was fetched which was available in parts through tiles. With the help of Geo Referencing, we made an attempt to find out what changes are observed. This brought in some important understanding and gave us the opportunity to set our directions.

Images collected from 1965 by Corona*, which was a US Spy satellite, were compared with recent Sentinel Satellite Images.



Typical Photo from Corona Satellite

Box : CORONA spy satellite data: the 1960s in high resolution!

CORONA is the code name for the first optical spy satellite mission of the United States (1960-1972). The goal of the mission was to produce high-resolution analog photos of most of the Earth's surface, especially of political hot spots and military locations (Wikipedia). Due to the regular recordings, large areas could be continuously monitored and evaluated for the Department of Defence. Until 1995, more than 800,000 photos remained secret and were then made publicly available by the US Geological Survey

AS: How is biodiversity used as an indicator of River restoration and conservation?

VK: Does Ganga only belong to us? There is an ecosystem within and beyond Ganga. The flood plains, lakes, ponds, wetlands. There are flora and fauna which depend on the river ecosystems. The construction of dams and barrages, selective fishing, prey unavailability has an unbalanced forcing. If there is decline in a native species - it will ultimately impact higher order groups and unbalance the entire ecosystem. As a result, we are trying to map certain factors primarily anthropogenic and its impact on the behaviour and ecology of the species such as its home range, feeding, breeding, and spawning behaviour.

We are focusing on flagship species, umbrella species, keystone species, and indicator species. For e.g. Hilsa, a characteristic fish of lower estuarine stretch of river Ganga, is a highly valuable fish for its flesh and flavour. It travels great distances and migrates up to 1,200 km inland through rivers for spawning. Hilsa significantly contributes to the fisheries of the transition zone (Bhagirathi-Hooghly River). Its catch varies between 3.9-16% of the total catch of the estuary. One of the major sources of fishermen's household family income is Hilsa fishery contributing 38.84% per annum. Before the construction of Farakka dam, it used to travel upstream of Varanasi and sometimes up to Allahabad. Nowadays, due to Farakka barrage, it is restricted up to Farakka where they have started breeding. Hilsa which used to be a good fishery at Allahabad as 10.3% (1961-1968), has dropped to a meager 0.16% (2001-2010). Hilsa fishery above the Farakka barrage has dropped from 116.1 kg/km² pre-construction to less than 1 kg/km² post construction.

We are also targeting Ganga Dolphins; now the national aquatic animal. The earliest reference of Dolphin was reported in a report by Anderson 1879. These are now present in the middle-lower stretches, but earlier they were found until up to the transition zone between the Himalaya Mountains and the Indo-Gangetic Plains. The research efforts of our team based on information culled from scattered documents now throws light on unique biodiversity of the system. Spatial and temporal changes in ichthyofaunal diversity in terms of catch and composition has also been documented.

Ganga has a mega diverse ecosystem that is home to a wide variety of relic species from the tiny and microscopic to macroscopic forms — from planktonic to benthic and free floating to submerged macrophytes. It is a hierarchical system of more than 2,000 biological forms, out of which more than 1,600 are the forms at 1st, 2nd and 3rd trophic levels. We invite readers to further explore its major forms in the “COMPENDIUM OF BIODIVERSITY IN GANGA RIVER SYSTEM – 2019”. It is a unique and systematic compilation of major biological forms including phytoplankton, zooplankton, periphyton, zoobenthos, ichthyo-fauna and higher vertebrates in river Ganga and her major tributaries.

We have realized the importance of an Integrated River Monitoring Program engaging local stakeholders, this is proposed to be initiated in the current financial year on a pilot basis. We have developed a comprehensive monitoring programme in consultation with NMCG and all our Member Institutes and partners organisations. The programmes envisage monitoring of many aspects including water quality with different parameters monitored at varying frequencies from once in two days to once in three months at very high spatial resolution, micro-invertebrates seasonally, gauge and discharge measurements on lower order streams by engaging various types of stakeholders including schools and colleges, river side communities, etc.



AS: The expanse of Ganga is large. How are you managing and coordinating the efforts on such a large-scale river monitoring?

VT: We have moved one step further in this direction. Earlier there was no role of riverside communities or it was totally ignored in such kind of monitoring programmes. We are now actively engaging with the riverside community with the efforts to understand the health of river. Bio-monitoring is rather a more intuitive way to assess whether a river is healthy or in a dire state. We are training the local community for bio-monitoring. The community is reporting back with samples for macro invertebrates. We are moving one step at a time in this direction.

With this effort we are empowering the riverside communities including schools and colleges. We are sensitizing the community to report certain peculiar events related to the existing biological forms. This type of monitoring helps to reduce the cost of monitoring; and it allows the community to take ownership. A team is in the making at different monitoring locations. Here community participation and crowd sourcing are being availed effectively.

We are engaging and involving the community both from a short term and a long-term perspective. On a short-term basis, through the local fisherman awareness Program, we are sensitizing the locals on several aspects related to traditional fishing pattern. There is a need for close monitoring in the field. Lab studies are often limited towards a sound decision making, we are aspiring for a long-term bio-monitoring program for keystone species. For knowledge exchange cGanga is bringing out a quarterly Newsletter “Pragyambu” with in-depth information, knowledge & studies about the river basin management. This will be an endeavour of cGanga team to combine modern science with traditional wisdom for river basin management.

We encourage interested users to access: <http://cganga.org/gangapedia/>

AS: What are the challenges that your team foresee in implementation? How are you trying to help your stakeholders and actors?

VT: River Ganga as such accepts whatever is released into her stream or disposed on her land. Whatever one releases, or adds in the system, it will accept and try to accommodate. So, it is a choice, whether one wants your River to be capable of performing most of its processes and deliver many functions “Samarth Ganga”. Either way an ecosystem will try to exist. For e.g., if you ever visit or see the Kalindi Kunj water you will see life and biodiversity which are more attuned with a polluted ecosystem.

It is important to realize that river restoration and conservation and development have to be two side of a coin. This is the key concept of “Arth Ganga”, a call given by our Hon'ble Prime Minister in the First Ganga Council Meeting held in Kanpur in December 2019. We deliberated this extensively in the Fifth Edition of India Water Impact Summit, an annual

Flagship event of cGanga and NMCG, held in December 2020.

We invite our reader to visit<https://iwis.cganga.org/>

It is important to bring key stakeholders together i.e. Urban, agricultural, industrial and forestry. We are observing positive signs, the stakeholders are starting to understand the efforts in this direction, this is the first step towards their ownership.

AS: As cGanga pursues Valuing water and Transforming Ganga, how do you take this from Sloganeering to Action?

VT: I would like to acknowledge here a special purpose vehicle Arth Ganga, thanks to our Prime Minister Shri Narendra Modi for providing us a unique instrument / vehicle named Arth Ganga.

Amidst River Conservation, we observed two powerful views and voices, these are 1) Development and 2) Environment. It is important to recognize the two contradictory views coming out of these, two voices, one demands economic development for society and the other stands for conservation and safeguarding the ecology. How can we balance the two? Arth Ganga Approach tries to balance the two strong voices of Development and Conservation i.e. the sustaining of rivers and also the economic growth. Can we look as River Conservation and Development as a unified mean? To know more about Arth Ganga, We invite our reader to visit<https://iwis.cganga.org/>

AS: What is the end goal / target of cGanga?

VT: We started with and continue with the vision - Valuing water and Transforming Ganga. We are working on implementing the concept of “Samarth Ganga” at the district level. For Analysis and Planning we are respecting the natural boundaries i.e. the basin of each and small (lower order rivers), while for implementing purposes we are deciphering this information within administrative boundaries i.e. districts within a state. We are working with various departments and units of central, state and local governments to bring in sink many plans and programmes such as Swachh Bharat Mission, Jal Jeevan Mission, Namami Gange Programme, Make in India, Start-up India, Vocal for local, etc.

While setting and working towards a defined goal is important, it may not be wise to set an end goal towards such an effort, which is a continuous process. This is similar to how we clean our houses every day or maintain personal hygiene. River restoration and conservation must necessarily be a process of continuous understanding and revising, taking account of the various actors and stakeholders who may have conflicting interests or no interest at all in the venture.

Ganga has been and will remain much more than a body of water. It is also an understatement to say that ecosystem-based definition would suffice for Ganga because of its spiritual and social significance.

It is a journey, which will continue. Someone brought it to the present state, others will have to continue after us.

To the Indian mind, River Ganga is not only the holiest of rivers and purifier of mortal beings, but also a living Goddess—“MOTHER GANGA”. Her exalted status in Indian consciousness is encapsulated in the evocative words of Lord Sri Krishna in the Bhagavad Gita as:

पवनः पवतामस्मि रामः शस्त्रभृतामहम्।
झषाणां मकरश्चस्मि स्रोतसामस्मि जाह्नवी॥

Among things that purify, I AM THE WIND; of the wielders of weapons, I AM RAMA; of the water creatures, I AM THE CROCODILE; and of rivers, I AM GANGA.