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SPECIAL ISSUE ON NAMAMI GANGE

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EDITORIAL

Ganga: An eternal constant

In the Gangashtakam, the eight odes to the Ganga allegedly composed by the author of the Ramayana, Valmiki himself, the waters of the Ganga has been described as the final destiny for the desecrated and profane mortal body. The river is addressed here as a "resplendent necklace on the bosom of this earth" illuminating a path towards the heavens:

मातः शैलतुतासपत्नि वसुधाशृङ्गारहारावलि
स्वर्गारोहणवैजयन्ति भवतीं भागीरथि प्रार्थये।
त्वत्तीरे वसतः त्वदंबु पिबतस्त्वद्वीचिषु प्रेङ्ख–
स्त्वन्नाम स्मरतस्त्वदर्पितदृशः स्यान्मे शरीरव्ययः।।१।।

The first two lines of this ode offer prayers to Mother Ganga, the daughter of the mountains, who dwells in the heavens. The last two lines translate as – "I hope to live on your banks, to drink your water, to be lulled by your currents, to remember your name in prayer, and to gaze upon you until the day I die."

In presenting this special issue, we draw attention to the broad context of river rejuvenation in India in general and to the Namami Gange programme in particular as a response to the evolving development needs and environmental dynamics facing the country. This special issue on Namami Gange is a culmination of efforts from various stakeholders of the mission, dedicated professionals and employees, researchers and institutions who have toiled hard to put together papers that are exploratory, empirical or conceptual and analyses the possibilities and limits to Ganga rejuvenation as a factor in achieving the UN SDG agenda towards 2030.

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* An excerpt from 'Ganga: The Many Pasts of a River' by Dr. Sudipta Sen

The National Mission for Clean Ganga is thankful to IC Centre for Governance (ICCG) for dedicating a full issue on Namami Gange and reiterating the importance held for rivers in the civilizational history of India. In particular, we take this opportunity to thank Mr Prabhat Kumar, President of ICCG and Former Cabinet Secretary to Government of India for initiating this idea and throughout being a great support in bringing this issue to its successful conclusion. We appreciate the contributing authors and associated organizations for their efforts and pro-activeness in putting together the idea of Ganga in this book. Our invaluable acknowledgement extends to Mr Rajiv Kishore, Executive Director, NMCG whose determinations and coordination with the authors could finally germinate this issue and nurture it towards its progressive end, and to Ms Richa Rashmi, Young Professional (NITI Aayog) for supporting throughout the study and also penning some of the sections of this issue.

-Rajiv Ranjan Mishra

Rajiv Ranjan Mishra

Namami Gange — A Model for River Rejuvenation

Background

Ganga has been part of collective consciousness of India and can easily be considered the most revered river not only in India but also the world. It is not only the centre of faith of people, but also the source of their sustenance and critically important for economy, food security and livelihood. It is difficult to imagine India without Ganga.

The Ganga basin is the largest River basin in India in terms of catchment area constituting one-fourth of the country's land mass and supporting about half of its population. The river is 2525 km long, binds five states together along its main stem and eleven in her entire basin. The basin contains about 28% of India's water resources. It is rich in biodiversity and host of several sanctuaries, Ramasar sites and biosphere reserves. Ganga is the National River and Gangetic dolphin is the National Aquatic Animal of India.

The river also witnesses a paradox. On one hand, it is revered as divine mother and is always pure. On the other, there are challenges to clean it in view of several anthropogenic activities. During the course of its journey from the Himalayas to the Bay of Bengal, sewage from habitations and urban settlements along its banks, effluents from industries, solid wastes and polluting waste from several other non-point sources including agriculture gets discharged into the river resulting in its pollution. Large scale abstraction of water from river Ganga for different purposes, most substantial being for agricultural usage, lead to huge reduction in its flow in several stretches challenging its very existence as a great river. The

irrigation system – Ganga Canal System as developed by East India Company engineer Proby Cautley in 1854 – was then considered one of the largest irrigation networks in the world. It was primarily constructed to improve revenue through food production by helping irrigate much of the fertile area in the doab region between Ganga and Yamuna. They were also expected to control the massive floods in river and for taming the flow of the river. The system expanded over time and now Upper, Middle and Lower Ganga canal systems with barrages at Bhimgoda, Bijnaur and Narora respectively. The barrage at Kanpur is for diverting water only for drinking purpose. Over the decades the reduced flow in the river between Narora and Kanpur combined with discharge of untreated sewage and industrial effluents became a critical stretch and a serious threat to the river.

1. Historical Overview of Ganga related Schemes and evolution of Namami Gange:

Cleaning of Ganga and its rejuvenation has been the priority of different governments and several attempts have been made in past as well. Even though the responsibility for controlling pollution due to municipal sewage, solid waste or toxic industrial effluents may legally be the responsibility of local bodies/ state agencies or the industries, Government of India has been supplementing their efforts by providing financial and technical assistance to the states. The efforts to clean Ganga was first initiated in 1985 with launch of Ganga Action Plan (GAP I) covering 25 towns of Ganga Main Stem followed by Ganga Action Plan II (GAP II) in 1993 extending GAP I to some of the tributaries -Yamuna, Gomti, Damodar and Mahananda in 60 towns. National River Conservation Plan (NRCP) was launched in 1995 to include other major rivers of the country subsuming the GAP II including 8 rivers from Ganga Basin (Ganga, Yamuna, Gomti, Damodar, Mahananda, Betwa, Mandakini & Ramganga). National Ganga River Basin Authority (NGRBA) was created as a separate Authority for Ganga in 2009 to promote a holistic and integrated river basin approach. NGRBA was established with the Prime Minister of India as Chairperson. National Mission for Clean Ganga (NMCG) was established in 2011 as a registered society to act as the implementation arm of NGRBA.

Ganga River Basin Management Plan and Namami Gange: A consortium of seven Indian Institutes of Technology (IITs), entrusted with developing a holistic Ganga River Basin Management Plan (GRBMP) submitted the first version of plan in 2015 consolidating at one place a body of knowledge on different aspects of basin, identifying challenges and interventions required for its rejuvenation. The GRBMP envisioned a rejuvenated Ganga, restored of its wholesomeness defined in terms of "Nirmal dhara - unpolluted flow", "Aviral dhara- continuous flow" and "Swachh Kinara – clean banks", and recognition of the river as geological and ecological entity. These scientific studies combined with a critical analysis of past interventions helped in developing the contours of the newly announced Namami Gange program in 2014-15 as an integrated mission for conservation of Ganga and its tributaries. It was formally approved in June 2015 as a Central Sector Scheme with the aim of integrating previous and on-going initiatives in holistic manner following basin based approach. The diverse set of interventions can broadly be categorised as interventions for pollution abatement or Nirmalta, ecological restoration & improving flows for Aviralta and improving people-river connect through public outreach and other interventions.

Pollution abatement measures comprehensively tackle all sources of pollution such as municipal sewage, industrial effluents, municipal solid waste, non-point sources of pollution such as agricultural runoff, open defecation, un-burnt dead bodies etc. Interventions for ecological restoration and Aviralta include scientific afforestation, catchment area treatment, biodiversity conservation, determination and implementation of environmental flow, demand side management to reduce abstraction of water with sustainable agriculture, wetland and spring rejuvenation, improving ground water through aquifer recharge, flood plain protection, etc. It was also realised that people need to be a part of this gigantic task, and the association they have with the river have to be augmented through nudge and behaviour change campaigns. To meet this objective, interventions for improving amenities and sanitation at river banks, community outreach, development of Ganga Vichar Manch, Ganga

Praharis, Ganga Mitras, Ganga Task force with ex-servicemen, special campaigns, Ganga Utsav, Ganga Run, rafting expeditions and several other activities have been taken up. Youth and students are special drivers of these campaigns and help in creating good awareness response. The use of socially and culturally identifiable name for the scheme of Namami Gange, among others, has also helped to build the affinity of the people for the scheme.

The Namami Gange program was given a dedicated budget of INR 20,000 crores for a period of 5 years (2014-19). The certainty of funds and scaled-up budget enabled the mission to survey and conduct condition assessment of all the cities, towns, villages and industries along Ganga and develop a scientific roadmap for appropriate multi-sectoral interventions. In order to impart momentum and broaden the scope of the program for Ganga Rejuvenation, it was realised to develop an empowered institutional framework. NMCG was notified as an Authority under the Environment Protection Act on 07 October 2016 giving it the regulatory mandate, strengthening its administrative structure and authorizing it to undertake effective allocation of financial and administrative powers. The Authority order dissolved NGRBA and constituted a 5-Tier structure with National Ganga Council (NGC) at the top, under the chairmanship of Hon'ble Prime Minister of India, notifying it to be 'overall responsible for the superintendence, direction, development and control of river Ganga and the entire Ganga basin.' NGC being at apex level, the other four levels of institutions include an Empowered Task Force headed by the Minister for Jal Shakti for regular inter - ministerial coordination; National Mission for Clean Ganga as key implementation authority; State Ganga Committee headed by Chief Secretary; and District Ganga Committee chaired by District Magistrates. NGC is responsible for the 'protection, prevention, control and abatement of environmental pollution in River Ganga', and for 'its rejuvenation to its natural and pristine condition', and 'to ensure continuous adequate flow of water in the River Ganga,' and connected matters.

Figure1: Namami Gange Components

2. Namami Gange Program – Progress and Status

The holistic approach and innovative features in policy making, project management, financial planning, sustainability of investment, scientific research, knowledge management, institutional development, basin management and planning helped Namami Gange program to evolve as a pioneering river rejuvenation program of the country. A total of 310 projects have been sanctioned at a total cost of INR 28,910 crores under Namami Gange program, as on 20/01/2020, for diverse sets of activities. Out of these, 114 projects have been completed and rest are at different stages of execution. During the first two years (FY 2014 – FY 2016), an expenditure of INR 746.33 crores was incurred with focus on analysis, policy and project preparation. In the subsequent years (FY 2016 - FY2019), the program has gained momentum with several projects making good progress leading to better financial performance with expenditure rising to INR 5314.36 crores. A total expenditure of INR 8060.69 crores has been incurred till now since 2014 compared to government

of India expenditure since 1985 up to 2014 being only to the tune of about INR 4000 crores. Assured and scaled up budget ensured that for the first time , the mission is able to bridge the gap of the past and plan for capacity development to meet the demands for next 15years.

I. Restoring the 'Nirmalta'

The approach towards sewage management – the single biggest cause of pollution – has been to first comprehensively map the cities and towns along Ganga, analyse the existing gaps in sewage treatment capacity through condition assessment of existing Sewage Treatment Plants (STPs) and then plan for need based rehabilitation or up-gradation of the existing STPs and capacity creation for deficit infrastructure with the design period of 15 years (population in the year 2035). With assured financial support and empowered institutional framework at national and state level, for the first time, the pace of capacity creation has started to outpace the population growth and consequent sewage load. Starting from 28 sewerage projects in 2014, it has exceeded 152 projects with an almost ten times more capacity. Out of 152 sewerage projects, 113 projects have been sanctioned on Ganga main stem for creating treatment capacity of 2,159 MLD and 39 projects on tributaries for creating a treatment capacity of 2,172 MLD. More than 100 years old, infamous Sisamau Drain at Kanpur discharging 140 MLD untreated sewage into Ganga and on the agenda since GAP I has been successfully tapped.

Taking a leaf from past shortcomings, as was observed in the condition assessment of existing STPs, fifteen years Operations and Maintenance (O&M) has been made integral part of the project for ensuring sustained and desired outcome. To ensure long term satisfactory performance of STPs, a paradigm shift took place in 2016, with policy decision approved by Cabinet to take sewage infrastructure projects under Hybrid Annuity based Public Private Partnership (PPP) Mode for the first time in India. Hybrid Annuity Model (HAM) addresses the issues such as sub optimal design, weaker O&M support and lack of ownership. HAM also ensures distinct accountability for continuous acceptable performance in the

long term. It is a shift from paying for construction to payment for performance. Under HAM, 40% of the capital cost is paid during construction period and balance 60% is paid as quarterly annuity, over a period of 15 years, linked with STP performance. In addition, cost towards O&M is spent in a phased manner quarterly during project duration. This has been taken further by introducing the concept of 'One City, One Operator' for major cities to improve governance and accountability in wastewater management with citywide approach. Under this, one operator takes over the O&M of existing assets, rehabilitates any of them as per need and constructs the required new assets. NITI Aayog has also appreciated and recommended this approach for adoption in other schemes. Some of the states are also adopting it in their own waste water management and river rejuvenation programs. Our experience is being shared at different platforms. As we have proceeded, there have been learning and fine tuning of processes which would further improve. In addition to STPs, the program also facilitates decentralised approach, in-situ treatment options, faecal sludge & septage treatment plants, etc. As a policy, NMCG has been promoting reuse of treated wastewater through specific projects as well as developing guidelines and state policies with an aim to monetize treated wastewater. We are also trying to bring a special focus on river cities and need for urban planning to have a fundamentally different thinking for river cities. The integration of river, city and people is being done by developing a policy framework and guidance template of Urban River Management Plan in association with National Institute of Urban Affairs. This aspect was also highlighted by Hon'ble Prime Minister during National Ganga Council meeting in December, 2019 wherein he asked what can cities do for rivers. He further stated that there is need for fresh thinking with facilitative and developmental mind-set.

The mission for Ganga rejuvenation has got further diversified and mainstreamed into the basin management with Hon'ble Prime Minister suggesting during the meeting that the Namami Gange mission should lead and transform into a sustainable and viable economic development model **"Arth Ganga"** to integrate people in

the basin with Ganga rejuvenation. Proposed interventions along the Ganga basin include, agriculture (with special emphasis on organic farming), development of Ganga Nurseries and Aushadhi Van, promoting sustainable fishery, promotion of floriculture, planning and promotion of sustainable tourism and wetland conservation & development of bio diversity parks, promotion of local arts and craft, rejuvenation & fabrication of watermills etc. Involvement of different stakeholders, institution and community organization is of prime importance.

The strategies for Industrial Pollution Management include creating inventory of grossly polluting industries (GPIs), assessment of pollution load, annual inspection by third party expert institutions of repute in addition to check by state and central regulators leading to improved compliance standards, setting up common effluent treatment plants (CETP) for tanneries, textiles etc., improving process technology to reduce water consumption, and recycle/reuse to minimise fresh extraction. Industry specific charters have been implemented leading to no black liquor discharge in paper & pulp industry, zero liquid discharge in molasses based distilleries, increased salt free tanning etc.

Under Namami Gange, the solid waste management on ghats and in the vicinity of river has been given priority and urban local bodies, through Ministry of Housing & Urban Affairs, have been asked to keep at least one km of the drain, from the point of meeting the river, completely free from solid waste by fixing screens in discharge zones along-with regular cleaning of the same. Periodical third party inspections are carried out by agencies such as Quality Council of India (QCI). In the long term, improving processing capacity of solid waste in river towns is required along with removal of legacy dumps and ensuring protection of flood plains from dumping of urban and rural wastes. The current solid waste processing capacity in five main stem states is only 27.7 % of the waste generated. Ban on single use plastics have to be strictly enforced. Ghat cleaning projects have been taken up under Namami Gange for places with heavy footfalls of pilgrims and visitors for improved sanitation and proper disposal of solid waste. Trash Skimmers have been deployed in such places to

arrest floating material and to tackle river surface pollution.

For rural sanitation, 1674 Gram Panchayats (of the 4465 Ganga Grams) situated along Ganga have been made open defecation free by construction of around 11 lakh independent household toilets. Attention is now on solid & liquid waste management, tree plantation, agro forestry and organic farming in these Ganga Grams. To meet the primary water quality criteria for bathing, as notified by MoEF&CC, Real Time Water Quality Monitoring Stations have been set up to supplement the manual stations. The observed water quality data as received from these stations have shown that the Dissolved Oxygen (DO), an indicator of river health, has been found to be within acceptable limits of notified criteria and satisfactory to support the ecosystem of river across all seasons and also for entire stretch of river Ganga. Further, the water quality assessment of the river has been showing improving trends from 2014 to 2019. The DO levels have improved at 21 locations; Biochemical Oxygen Demand (BOD) levels and Faecal Coliforms (FC) have improved at 39 and 19 locations, respectively.

II. Ecological Interventions and Aviralta

As per the mandate, NMCG on 09 October 2018 has notified the minimum ecological flow (e-flow) in the River Ganga required to be maintained at different points in different stretches at all times, starting from the head streams of river Ganga up to Haridwar in Uttarakhand and from Haridwar to Unnao. A mechanism for monitoring of e-flow regime has also been put in place with the help of Central Water Commission (CWC). A similar exercise has also been initiated for some of the other important tributaries viz., Yamuna and Ramganga. National Institute of Hydrology is carrying out a study for assessment of environmental flows in river Yamuna for the stretch starting from Hathnikund barrage to Okhla barrage. WWF-India, working on an integrated approach for rejuvenation of Ramganga with multi-stakeholder approach aims at restoring the health of Ramganga. Their paper shares their experience. A conference was conducted recently with GIZ assistance, where in global experts participated, appreciated growing understanding of

e-flow in India through this mission and shared their expertise in this evolving area in India.

As wetland conservation is an integral component of 'Namami Gange', NMCG has been closely working with the experts, stakeholders and line departments such as, State Wetland Conservation Authorities, Wetland Division of MoEF&CC and Wetland International India, to take the cause of wetland conservation in Ganga basin forward. Recently, a project proposal from U.P. Wetland Authority has been sanctioned for developing detailed briefs and an integrated management plan to conserve 226 wetlands situated in 27 Ganga districts in U.P. up to ten kms on either side of the river. This is a first of its kind effort to conserve wetlands at such large scale and link with basin management. Similarly, 51 wetlands have been identified in Uttarakhand for development of management plan. A model tool kit is under development for integrated management and rejuvenation of urban wetlands, in partnership with School of Planning & Architecture, Delhi with a case study of Bhagalpur. This is also being coordinated with the Urban Development Departments of Ganga States. A paper explores efforts of conservation of wetlands in urban setting.

Flood plains are such areas of river, which get periodically flooded at different points of time. These are integral part of overall river ecology and perform very important role in hydrological cycle, improving ground water recharge, providing base flow to the river during lean season and also protecting damage to life and properties during floods. Protection of flood plains is important for ensuring health of the river. NMCG 'Authority' notification mandates the bank of River Ganga and its flood plain to be construction-free zone so as to reduce pollution sources, pressures and to maintain its natural ground water recharge functions. A special committee was constituted by NMCG to demarcate Ganga flood plain from Haridwar to Unnao and to identify no-development zone and regulatory zones therein. The report of the Committee has been forwarded to State Government for implementation of the recommended measures.

NMCG has also initiated forestry interventions in Ganga basin as per the detailed project report (DPR) prepared by Forest Research

Institute, Dehradun for improving the health and rejuvenation capacity of river Ganga. The plantation cost under this project for a period of four years (2016-2020) is INR 269.76 crores. Maximum abstraction of water from river takes place for usage in agriculture. Medicinal plantation along the river has been taken on pilot basis with the Ministry of AYUSH. NMCG has also taken up a project for Medicinal plantation to Uttar Pradesh Forest department at INR 37 crores, in seven districts linking with livelihood and income generation for farmers.

Sustainable Agriculture is very important for Ganga rejuvenation in ensuring Nirmalta as well as Aviralta. Implementation of e-flow regime has to be supplemented by demand side management of water so that flow could be restored in river. Developing sustainable agriscapes in basin and improving water use efficiency are key interventions in partnership with the Ministry of Agriculture along with promoting organic and natural farming in Ganga Grams. Linking livelihood & development with conservation for sectors such as agriculture, horticulture, animal husbandry, forestry is needed and several initiatives are planned in collaboration with different ministries, agencies at different levels. Some of these possibilities have been explored in two of the papers. National Ganga Council has also underscored this in its December, 2019 meeting and mooted the concept of Artha Ganga to play a key role in future.

A connected aspect of NMCG's long-term vision for Ganga rejuvenation is to protect and restore the biodiversity of and along the river. To address threats to the aquatic biodiversity of Ganga, Wildlife Institute of India (WII), Dehradun was awarded a project at a cost of INR 24.84 crores for three years (2016-2019), for developing a science–based aquatic species restoration plan along with participatory approaches of community involvement. A more comprehensive project under phase II, spanning 2019-2024, has been awarded to WII at a cost of INR 113.99 crores for scaling up the research over the entire Ganga basin in next five years. The conservation of fish & fisheries of Ganga is being implemented along with Central Fisheries Research Institute (CIFRI), Barrakpore under which, project ranching of indigenous fish species along with

capacity building and livelihood improvement of fishermen has been under taken. A commendable initiative within the project is a Hilsa fish ranching station established at Farakka, West Bengal by CIFRI for the restoration of Hilsa Fishery around Farakka Barrage through the understanding gained from studying the upstream migration of Hilsa fish in Ganga.

GRBMP recognizes the importance of interplay between groundwater and surface water. NMCG has taken up a project in collaboration with CGWB and National Geophysical Research Institute (NGRI) for aquifer mapping with focus on paleo-channels in parts of Ganga-Yamuna doab in Kaushambi-Kanpur stretch. This project will be insightful in developing a plan for managing aquifer recharge, which may help in increasing the flow of river Ganga during lean season. Similarly, springs happen to be an important source of water in hilly streams during lean flow periods. They sustain, partly or fully, the drinking water requirements of rural settlements. Recognising the important role played by springs in maintaining the health of River Ganga, Survey of India, Dehradun and IIT, Roorkee are working closely with NMCG on a project for mapping the springs in Tehri Garhwal district of Uttarakhand. This inventory will further be used to initiate a rejuvenation programme with Central Ground Water Board (CGWB), State authorities and other technical institutes viz. Garhwal University, NIH-Roorkee and others.

III. Establishing river-people connect through Jan Bhagidari

People visit Ganga for several purposes and river banks are integral to life along Ganga. These visits should be pleasant with better amenities and sanitation for strengthening the connect. One of the approaches in this respect has been development of River Fronts and construction of traditional Ghats & Crematoria as important public spaces. Patna River Front Development (RFD) project has been completed in which 16 ghats out of 20 and 6.6 km of promenade have been developed with required amenities and sanitation facilities. In Haridwar, one RFD at Chandi Ghat has

been completed. Development of Ghats & Crematoria works in select cities has been taken up with about 45 projects sanctioned for construction of 177 ghats and 48 crematoria. Work on 123 Ghats and 36 Crematoria has been completed. Work on rest of the sanctioned Ghats and Crematoria are under progress and most of these are likely to be completed by March 2020.

A series of events, workshops, seminars, conferences and numerous IEC activities were organized to make a strong pitch for public outreach and community participation in the programme. Various awareness activities through rallies, campaigns, exhibitions, shramdaan (voluntary labour contribution), cleanliness drives, competitions, plantation drives, and development and distribution of resource materials were organized. For wider publicity, mass mediums such as television, radio, print media advertisements, advertorials, featured articles and op-ed piece were published. Recently concluded Ganga Aamantran Abhiyan- 34 days rafting expedition over the length of Ganga, from Devprayag to Ganga Sagar, by a multidisciplinary team from NMCG and its partners was largest social outreach campaign through adventure sports. This was greatly appreciated by people and succeeded in sending message for Ganga conservation to wider network of citizens. Mountaineer Bachendri Pal led similar expedition up to Patna in 2019, which also was very successful. NMCG ensured presence at Social Media platforms like Facebook, Twitter, You Tube and Instagram through regular feeds.

Community connect is being promoted through developing several trained cadres such as Ganga Praharis, Ganga Mitras. A paper dwells into details of Ganga Prahari initiative and another one comes up with a river trust model to engage communities while giving overview of several national and international community participation models. The connect of people with river is further explored in another paper in the context of Kumbh.

Further, to seek public contribution and crowd source funding, a Clean Ganga Fund (CGF) has been established as a trust headed by Union Finance Minister since January 2015. CGF receives contributions from Resident Indians, NRIs/PIOs, PSUs, Trusts, Indian private sector corporates and overseas corporate bodies. To

encourage domestic donors, CGF contributions are made eligible for 100% income tax exemption under Section 80 G (1) (i) of the Income Tax Act, 1961 and also fall within the purview of CSR activity as defined in Schedule VII to the Companies Act, 2013 to make it an attractive proposition for institutional donors. The total amount in the Clean Ganga Fund corpus stands at INR 390.93 crores with several projects and activities sanctioned worth INR 203.91 crores. Attempts are in progress to expand the donor base.

IV. Policy, Research, Technology, Knowledge Management:

Another important sector that NMCG emphasises to create a ripple is in research and academia. Through its various initiatives, the mission has been scientifically driven to explore innovations and critically assess its own shortcomings so that comprehensive solutions can be developed in a time-bound manner to better performance. Attempt has been to promote evidence based policy making. Examples are consortium of IITs basin management plan recommendations and setting up of cGanga-a centre for Ganga management and studies at IIT, Kanpur. NMCG has sanctioned projects to reputed institutions such as Survey of India, NEERI, IITs, INTACH, NIUA, SPA etc. for projects such as G.I.S. and spatial mapping of Ganga Basin; assessment of special quality of Ganga water; study of communities traditionally dependent upon Ganga for livelihood; microbial mapping in Ganga basin; cultural mapping of natural, built and intangible heritage of Ganga; template for urban river management plan; heli-survey for paleo channels and spring rejuvenation through a scientific mapping and identification of sources through isotope technology, study of long term climate change impacts etc. Attempt is also on to develop courses/online modules to give a holistic picture of river rejuvenation followed by more specific modules.

The mission is trying to develop a robust Ganga Knowledge centre with several innovations. It may lead to better understanding of rivers and river rejuvenation. The present attempt to develop this collection of studies on different aspects of river, challenges and initiatives is also a step in that direction. There is vast scope of

in depth analysis of different aspects and new areas developed with Ganga would be helpful for other rivers and associated eco system including useful lessons in public policy and management for tackling a highly complex managerial challenge of rejuvenation of Ganga with basin approach.

Ganga is in the heart of millions who are drawn to it since time immemorial. Its story is the story of Indian civilisation and culture. Several empires flourished on its bank. Not only that, even empires far and wide also drew inspirations and referred to this great river in many ways. In essence, Ganga represents all rivers and several rivers, streams are also called after Ganga. It is regarded by all religions and paths. "The Ganga offers a different window into the culture and civilisation of the greater Indian subcontinent. The rich and boisterous mythology surrounding the river does not reveal such a straightforward relationship to the dominant social and political order. If anything, the practice of mass pilgrimage to sacred sites along the river has defied the everyday strictures of status and caste." Ganga has always been and will remain a great unifying force. Its rejuvenation needs all to join and its rejuvenation is needed by all.

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* 'Ganga: The Many Pasts of a River'; Sudipta Ghosh.

SECTION I
NATURAL RESOURCE MANAGEMENT

Birgit Vogel and Rajiv Ranjan Mishra

Ganga Basin Management and Implementation of River Basin Management Cycle

Abstract

Rejuvenation of Ganga has always been a challenge and priority for the country. Evolving over time, an understanding has developed to adopt an integrated approach with basin as unit of planning. A comprehensive Ganga River Basin Management Plan developed by consortium of IITs has identified several sectors to work on simultaneously with a vision of restoring the wholesomeness of river Ganga. Government has also started Namami Gange- an integrated mission for conservation of Ganga and its tributaries with basin approach. Enabling environment and institutional framework has also been facilitated with notifying NMCG as an authority. The task now is to use this and GRBMP to actually put basin planning in practice. European union has a rich experience of River Basin Management (RBM) and operationalizing through River Basin Planning and Management Cycle. Program of Measures (PoM) sets forth concrete actions to improve the status of the basin. There is opportunity to learn from the EC experiences and practices such as using various tools to clearly understand the basin characteristics and basin functions. The DPSIR methodology (driver, pressures, state, impact and response model of intervention and other specific tools and practices would be useful for Ganga Basin Management program to study and suitably adapt to the basin conditions. India-EU water partnership has possibility to facilitate this exchange and this potential would be explored within the Namami Gange framework and help in putting into operation the Ganga River Basin planning cycles. This would also be a model for other river basins in India.

1. Ganga Basin and Ganga River Basin Management Plan (GRBMP)

Ganga Basin is the largest and most important basin of India from several perspectives and Ganga Rejuvenation has been a challenge as well as priority for long. This basin, spread over four nations (India, Nepal, China and Bangladesh) covers an area of about 1,080,000 Sq. km. Out of this about 80% is in India and focus of discussion here is on basin within India. This basin covers more than 26% of India's geographical area, supports almost 45% of India's population having a large water availability. GRBMP defines river Ganga as comprising of six major head streams originating in the Himalayas from feeding glaciers to respective confluences (comprising the Upper Ganga Segment), the subsequent main stem of river downstream from Rishikesh to Varanasi (Middle Ganga Segment) and the final stretch from Varanasi to Ganga Sagar (Lower Ganga Segment).

Over a period of time, a realization has come that to succeed in the long run, it is advisable to develop a comprehensive approach with basin as a unit of planning. A consortium of 7 IITs were entrusted with the task of developing a Ganga River Basin Management Plan (GRBMP) and the first version of GRBMP got ready in 2015. This consolidated at one place a great deal of knowledge on different aspects of basin, challenges and interventions required for its rejuvenation. These concepts and a review of previous programs helped in developing the contours of the newly announced Namami Gange program in 2014-15 as an integrated mission for conservation of Ganga and its tributaries. The GRBMP envisioned rejuvenation of Ganga in terms of restoring the wholesomeness of river which is focused on "Nirmalta - unpolluted flow", "Aviralta – maintain minimum environmental flow", and to recognize river as Geological and Ecological Entity.

The GRBMP has elaborated the basin characteristics in great detail and has also identified the challenges and possible interventions with scientific basis with several thematic and mission reports. Unlike conventional basin management in India that considers mainly water resource management, GRBMP attempts to deal with the comprehensive natural resource management in Ganga basin. It

identifies eight important areas needing restorative actions to be carried out in mission mode-Aviral Dhara (Continuous flow); Nirmal Dhara (Unpolluted flow); Ecological Restoration; Sustainable Agriculture; Geological Safeguarding; Basin Protection against safeguards; River Hazard Management and Environment Management-Building and Sensitization. There are several thematic reports corresponding to these areas as well as other background material such as analysis of previous programs on Ganga, institutional and legislative framework etc.

India has good deal of expertise in different areas such as hydrology, river morphology, ecology etc. but water resource management practices has not developed on the lines of River Basin Management (RBM) and hence the RBM as a field of research as well as practice can develop by learning from international experiences. European Union has developed a comprehensive framework after years of study and practice and have RBM in place for several rivers. India- EU Water Partnership has priority areas such as Ganga Rejuvenation and River Basin Management among others. Hence it is useful to build upon this to develop conceptual understanding, learn about the approach of RBM planning cycles, measures to monitor and operationalize the basin management plans.

2. River Basin Management – an Introduction

Water is a fundamental building block of life. As a natural resource it is an essential component of human survival that also contributes significantly to sustain the economy and hence is naturally in demand by multiple stakeholders. Its inherent spatial and temporal variability supplemented by anthropogenic interventions and the impacts of climate change have induced a high degree of complexity making it more susceptible to even minor marginal changes. As a result, the increasing gap between demand and supply has brought a paradigm shift from the development to the management of water resources.

With rising populations, improving living standards, growing economies and the impacts of climate change, many of the world's river and groundwater systems as well as associated ecosystems

are under threat or even facing collapse. This is evidenced by the undeniable thirst leading to excessive abstraction and degradation of water quality leading to ecosystems collapse.

To overcome these challenges, the management of water resources including rivers has to be looked at through a more holistic lens where water as not 'just' a resource to be exploited, but one that sustains economies and ecosystems into the future. The integrated management of both surface and groundwater and how they interact with society and the economy is a starting point towards water security.

As of today, many countries including the European Union base their management of surface waters and groundwater on the approach and process of integrated River Basin Management (RBM). Overall, integrated RBM is widely accepted as good practice and forms a structured framework for sustainable development.

However, in order for RBM to succeed several preconditions need to be addressed:

- An enabling (legal) environment;
- Institutional and organizational governance structures,
- Establishment of management tools and,
- Effective engagement of basin sharing States and related stakeholders.

One tool to structure, assist and guide this process is the River Basin Planning and Management (RBPM) Cycle. As a tool, the RBM Cycle could also support the management of the Indian river basins and enable the Indian water authorities to take well-informed decisions.

3. The River Basin Planning and Management Cycle

The River Basin Planning and Management Cycle as described in Figure 1, builds upon the European Union's Water Framework Directive. The European Union is a global leader when it comes to the management of river basins and the implementation of River Basin Management Plans. In the past two decades, RBM Plans have been approved and implemented for 198 river basin districts. This

has resulted in significant lessons learned regarding good practice and failure, which now support improved implementation.

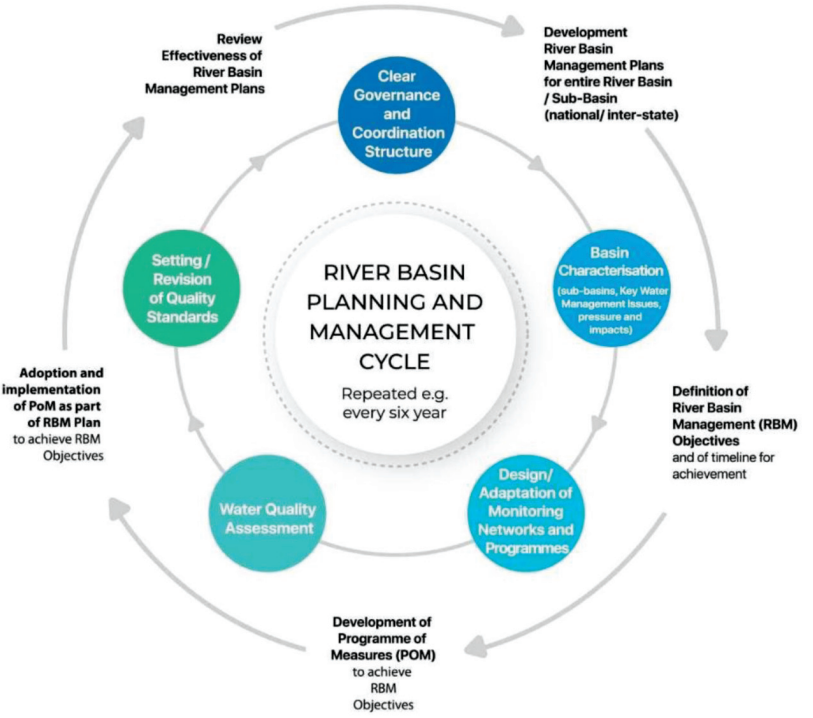

Figure 1. The River Basin Planning and Management Planning Cycle

The RBM Cycle is a framework to guide the planning and management process of entire river basins beyond administrative borders addressing their full hydrological catchment area. The final result of RBM Cycles are River Basin Management Plans (RBM Plans) that have been developed by responsible water authorities and relevant stakeholders. RBM Plans reflect key water management issues, the river basin's qualitative and quantitative status as well as proposing a Programme of Measures (PoM). The PoM is the heart of any RBM Plan as it sets forth concrete actions that improve the status of the basin's water bodies towards objectives that have been jointly agreed.

The RBM Cycle is comprised of two concentric processes:

(1) the outer process cycle addresses the planning and decision making,

(2) the inner cycle focuses on the technical operations, the development and implementation of an RBM Plan.

It should be noted at this point that river basin planning, management and action implementation is an integrated process and requires that engagement at three levels: the macro level (national), where high level decision making occurs looking at strategic orientation, national mandates and integration into national objectives; the meso level (State), where decisions are made at basin level regarding the objectives of basin planning, Programme of Measures (PoM) are developed and implemented; the micro level (district/municipal/community), where implementation of actions included in the PoM occur. The RBM Cycle accommodates the different levels through the inner and outer rings, however there is not a clear distinction which levels should be engaged in what component; this needs to be determined based on the activity.

The Outer Cycle focuses on activities that require decision making at the strategic, legal and planning levels, in addition to key points in technical basin characterization and data collection. It is comprised of five components: 1) Development of a River Basin Management Plan 2) Development of River Basin Management Objectives 3) Development of a Programme of Measures (PoM) as the heart of the RBM Plan 4) Adoption and Implementation of the PoM as Part of RBM Plan and, 5) Review of Effectiveness of RBM Plan and evaluation of the PoM in preparation of the development of the next multiyear cycle.

The Inner Cycle focuses on technical activities. It is comprised also of five components: 1) the Governance and Coordination Structures, 2) Establish Basin Characteristics and Socioeconomic interaction, 3) Design/Adaptation of Monitoring Networks and Programmes, 4) Water Quality Assessments, 5) Setting/revision of Quality Standards. The main activities in the Inner Cycle link to the objectives of the WFD, may differ from those ultimately set

for the Indian river basins and can be adapted. The focus of this summary document is the planning and decision making towards RBM Plans.

It should be noted that in addition to the components of the "planning and decision making" process, two components of the operations and implementation processes require higher level planning and decision-making. These are 1) the Governance and Coordination Structures and 2) Establish Basin Characteristics and Socioeconomic interaction.

RBM is not a discrete process, but one that is iterative and continuous. The Iterative process is a simple concept and often results in creative impactful solutions to complex problems. However, to implement iterative process in the context of river basins is not easy as water has differing values to stakeholders such as: economic, environmental, cultural, spiritual, and more. In addition, as it is an iterative process and involves many stakeholders, the development of RBM Plans is time intensive, requires resources and implementation across years and decades based on mid and long term planning. Commitment by the national government, basin sharing states and stakeholders must be maintained throughout if the process and a resulting effect management system is to be realized. Still, it should be highlighted that interim results allow actions throughout multiyear Cycles.

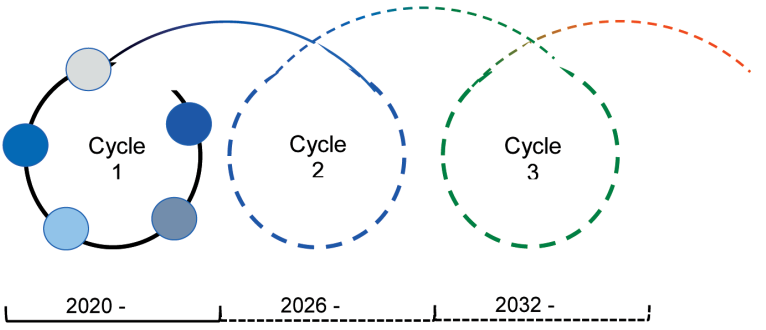

Figure 2. River Basin Management Cycle Timeline

In the context of the above, the RBM process is based on set multiyear planning and implementation cycles that are to be repeated

in a certain frequency (i.e. 6 years; Figure 2). Each Cycle is based on a revision process and can adjust to new conditions of the basin and addresses new challenges facing the basin. The following sections further describe the components in the decision-making processes that are key to the RBM Cycle.

3.1 Clear Governance and coordination structures

Once the RBM Cycle is a decided course of action, a framework in which to plan, implement and monitor management outcomes needs to be designed and established. Establishing effective governance, institutional and coordination structures is an extremely critical step in the journey of RBM. It provides the basis of the enabling environment required for effective management. If governance structures are established without consideration of the legal, institutional and social contexts, including the engagement of stakeholders, the resulting governance structures can delay and/or undermine the realization of effective river basin planning and the desired sustainable outcomes.

It should be acknowledged that the governance and organizational structures for a specific basin are unique and cannot be cut and paste from other basins as it is dependent on factors such as legal mandate, stakeholders, basin characteristics, issues facing a basin. However, good practices lessons learned from other river basins across the globe can help guide the final governance and coordination structure to be established for the basin.

An integral part of this framework is States sharing a river basin, the related stakeholders and how they are engaged in the process. As has been evidenced from the past, even though finances were available and activities were implemented the results were not sustainable as the governance and organizational structures were not sufficiently transparent and did not employ one of the basic principles of RBM, the Principle of Subsidiarity. The principle of subsidiarity holds that decision-making authority is best placed (a) where responsibility for outcomes will occur; and (b) in the closest appropriate proximity to where the actions will be taken that will produce the outcomes.

3.2 Definition of River Basin Management Objectives

Due to the multiple demands on a basin and it resources at the onset of the planning process it is important for the basin sharing states to establish their joint objective for river basin management. In the case of the EU the Water Framework Directive the EU Member States determined the objective to be the achievement of good water status for all waters in a river basin. All assessments and measures relate to this objective and, hence its setting is of crucial importance.

The objective of good water status may or may not be the same for India, but a clear and informed process of what the objectives are for India's River Basin Management needs to be clearly articulated and guide the RBM planning processes.

3.3 Basin Characterization

"Management of a system requires knowledge of the interrelationships between all of the components within the system and of everybody that works in it." (W. Edwards Deming)

This is especially true in the complex systems of catchments, watersheds, and river basins where land and water are ecologically linked in a natural system as precipitation is intercepted and directed into the system. However, "a watershed also includes all the humans, plants and animals who live in it, and all the things we have added to it such as buildings and roads. Everything we do affects our watershed – from washing clothes and growing food to power, commercial farming, and building roads or dams. The reverse is also true: our watershed affects everything we do, by determining what kinds of plants we can grow, the number and kinds of animals that live there, and how many people and livestock can be sustainably supported by the land. (Internationalrivers.org)".

Therefore, a clear understanding of characteristics that define a river basin and the behavior of the river in space and time provides the basis for an informed scientific approach resulting in potential tradeoff considerations during RBM. River basins are characterized by natural features but also by modifications that are caused by human pressures that may impact the achievement of the set basin objective.

In this context, characterization includes the identification of Key Water Management Issues, the identification of related impacts and their validation. All of this provides the basis to develop a Programme of Measures (PoM) to overcome issues and impacts within a river basin (i.e. degraded water quality, limited availability or mitigation of hazards/risks).

One very practical tool the European Union has adopted to assist in building and understanding of basin functions is the DPSIR assessment methodology (driver, pressures, state, impact and response model of intervention). It is a causal framework for describing the interactions between society and the environment that helps the identification of human pressures and impacts through technical expert judgement. This expert judgement step is essential as it gives a first and comprehensive overview of possible impacts in a river basin before investing in water quality/quantity monitoring and in measures that might not be (cost) effective in achieving the basin objective (Figure 3, EU EEA).

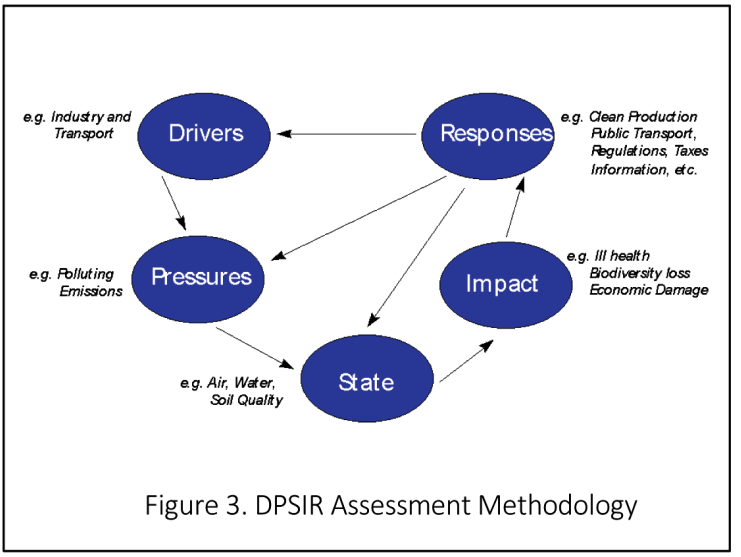

Figure 3. DPSIR Assessment Methodology

It should be noted that a recurring theme in water resource management is that there is not enough data to manage the system, but the lack of data or its quality should not hamper any RBM process, but strengthen it in identifying where data gaps exist and

actions taken fill in those gaps. Dr. Deming also noted "It is wrong to suppose that if you can't measure it, you can't manage it – a costly myth". The cost of inaction or postponement of action is more detrimental in the long run.

3.4 Development of Programme of Measures (POM)

This Cycle component works to develop a PoM and builds upon the processes and outcomes of the proceeding components. More specifically on the objectives set for RBM and the Basin Characterization components. This is not a straightforward process as it needs to link both decision-making and technical processes while also linking to the governance framework and the situation on the ground.

The current status of the river basin, Key Water Management Issues and existing pressures/impacts (degraded water quality, over abstraction…) were determined during the Basin Characterization component - this forms the foundation for a targeted process to develop the PoM. Measures are set to achieve the defined river basin objectives by a certain time and a set target.

To support the actions of the PoM and to show implementation success, basin scenarios are developed regarding future conditions based on agreed parameters (e.g. set measures, population increase, impacts of climate change, improved water quality, land degradation, increased water use efficiency etc.) These scenarios can both result in negative or positive impacts regarding the river basin objectives and additionally inform what actions need to be taken to mitigate the pressure points and achieve agreed upon targets.

The PoM needs to not only address technical activities, but also the actions that ensure the sustainability of these activities and that the stakeholders have the ability to engage in the RBM process.

3.5 Adoption and implementation of PoM as Part of RBM Plan

This component has two parts, first adoption and then implementation. The former ensures that the PoM is valid and agreed upon by each basin sharing state, as they are responsible for

its implementation and outcomes to positively impact the overall RBM objective. This is a stakeholder engagement and verification process that results in a decision at meso (state) level to agree to the contents of the plan and its implementation.

Once the PoM is adopted the implementation of measures starts. Each State implements the measures, whereas the national or RBO level steers and oversees the progress. How the measures are delivered is the role of the State to determine. These measures can be implemented by a single state, or bi-lateral and multi-party partnerships.

3.6 Review of Effectiveness of RBM Plan

The role of this component is to determine if the PoM has achieved its targets and impacted positively the overall basin objective set. In addition, it looks at the PoM measures and evaluates their effectiveness as well as the implementation success.

With the review, the National government and States can determine if the RBM Plan was over/under ambitious, if the financing was adequate and if it was effective towards achieving the basin objectives of improving the status of the basin. With the above information determinations can be made if the PoM's ambition needs to be modified, if the monitoring framework is correct for measuring the PoM's outputs and impacts and if the overall objective is still applicable. Armed with this information, the development of the next RBM Cycle, with its associated PoM, can be started.

4. Possible Way Forward in River Basin Management for NMCG

The National Mission for Clean Ganga has undertaken many steps in water resources management during the last few years. The Namami Gange Programme holds comprehensive measures to improve the situation in the Ganga River Basin to (i) ensure effective abatement of pollution and rejuvenation of the river Ganga and (ii) to maintain minimum ecological flows in the river Ganga with the aim of ensuring water quality and environmentally sustainable development. An enabling legal environment, Institutional and

organizational governance structure, management tools and effective engagement with states and other stakeholders are preconditions for RBM to succeed. Environment Protection Act, Water Act and other legal provisions help create enabling environment for basin wide interventions. Institutional arrangement and mandate has also been given in October, 2016 for a basin-wide multi-sectoral approach by the government through a notification under Environment (Protection) Act, 1986. This has notified NMCG as an authority giving long term perspective, regulatory as well as developmental role. The notification also creates a five tier structure from National level to State and District level. Engagement with states is regular through different channels. GRBMP is a good foundation. It needs to be taken forward from here and in this RBM Planning Cycle approach would need to be followed up. Ganga River Basin Management Plan prepared by consortium of IITs does not hold a Programme of Measures that has been adopted by the Government of India and its States.

It can be said without any doubt that significant and valuable achievements, including infrastructure projects and information management, has resulted from the above actions to improve the water status in the Ganga Basin and towards realizing comprehensive RBM.

Building on these achievements, the introduction and implementation of the above described River Basin Planning and Management Cycle would further support a fully structured and integrated RBM approach as applied in many other inter-state basins in the world. In this context, the introduction and agreement through all Ganga Basin States on the implementation of the RBM Cycle in the Ganga River Basin is crucial.

The implementation of the RBM Cycle would set the scene and guide the process towards the:

- development of joint River Basin Management Objectives across the entire basin;
- development of a revised Ganga River Basin Management Plan through NMCG based on the previous IIT Ganga RBM Plan and holding a Programme of Measures (PoM) as the heart of the RBM Plan;

- adoption and implementation of the PoM;
- review the Ganga RBM Plan and repeat the RBM Cycle on a regular level towards sustainable planning and management.

Due to its structured process, the implementation of the RBM Cycle can also guide and shape the establishment of institutional and organizational governance structures that support the effective involvement of all Ganga River Basin States. Good practices from other large, inter-state river basins can feed into a process with targeted examples that demonstrate the role of River Basin Organisations as coordinating and facilitating bodies for all States sharing a basin. This would help in improving effectiveness of planning and implementation of GRBMP and would also have a potential to set example for other basins in India as well.

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Richa Rashmi

Namami Gange: Acing Sustainable Development Goals

Abstract:

The Sustainable Development Goals (SDG), as adopted by nations worldwide in 2015, presents a trajectory of global development that focuses on improving quality of life through natural resource management. The integrated nature of SDGs implicates an environmentally led social development and economic prosperity model. Water flows through and connects all the SDGs. SDG 6 specifically calls for clean water and sanitation for all by 2030, which stresses on sustainable management of fresh water systems for ensuring availability of potable water. Rivers, in this context, are the largest fresh surface water system in the world. India is naturally endowed with rivers in which, Ganga is the largest river basin. With the objective of restoring the wholesomeness of River Ganga, the Government of India launched an ambitious programme of Namami Gange as a gradual, holistic and continuous effort towards improving basin management and governance. It entails sustained efforts for integration of institutional responsibilities, policy directions, stakeholder participation, scientific and traditional knowledge, technological possibilities, and funding prospects to abate pollution in the river and sustainably manage its natural ecosystem. The paper presents the synthesis of the strategies used in the Namami Gange programme to achieve the underlying targets of SDGs through basin approach of river rejuvenation and preservation.

Introduction

The Sustainable Development Goals (SDGs) were formulated as an indivisible set of goals and targets, with the environmental

dimensions integrated into socioeconomic development plans. According to UN Environment, the "environmental dimensions" could refer to a total of 86 out of 169 targets that directly or indirectly seek to reduce environmental damage or emphasize the critical role of natural resources and ecosystem services in ensuring human well-being and prosperity. India continues to target and maintain its economic growth by introducing and implementing various policies and measures relating to sustainable development, climate change, resource efficiency, and air pollution.

Namami Gange is an umbrella initiative integrating previous and on-going efforts with the aim of pollution abatement, conservation and rejuvenation of the River Ganga and its tributaries. For effective implementation and proper synchronization with the State and Local Bodies, National Mission for Clean Ganga (NMCG), the implementing agency for Namami Gange programme, was empowered as an Authority under the Environment (Protection) Act, 1986 for fast track implementation and to formulate policies for long-term sustainability of the Ganga rejuvenation efforts. The work done under the programme has been duly recognised by Economic Survey 2018-19 as a key initiative poised to achieve the Sustainable Development Goals.

Mapping SDGs with Initiatives under Namami Gange Programme:

The initiatives undertaken in the Namami Gange programme have comprehensively addressed the key environmental parameters. The following section links the specific projects with the SDG targets that are addressed through their implementation:

SDG 2: Zero Hunger

Working to improve food and agriculture can have a substantial impact on combating climate change, bolster economic growth, and contribute to peace and stability in societies around the world. Climate change is putting greater pressure on the resources and increasing risks associated with natural disasters. Target 2.4 poises to ensure sustainable food production systems and implement resilient agricultural practices for improved land and soil quality.

In order to mitigate the negative impact of the conventional farming in the Ganga plains, a joint project with Ministry of Agriculture and Farmers Welfares has been in progress to promote organic farming, which seeks to use swathes of green belts along the river for decontaminating the cultivable lands. The organic farming involves the careful handling of the environment and resources in such a way that the soil stays healthy - rich in organic matter, nutrients and microbial activity as well as provides a potential solution to the challenges being faced like depletion in soil fertility, water pollution as well as health hazards.

SDG 3: Good Health and Well-being

SDG 3 aims to ensure healthy lives and promote well-being for all. Target 3.9 aims to reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination. Putting in place trunk infrastructure lines for collection of wastewater in certain cities and STPs in largely every city with higher degree of criticality in the Ganga basin has not only improved water pollution abatement but has also progressively and increasingly reduced the likely impact of water-borne diseases in the geography.

SDG 4: Quality Education

SDG 4 envisages inclusive and quality education for all. The target related to skill development (4.4) have been addressed under the Namami Gange programme through a cadre of 'Ganga Mitra' that focuses on leveraging their eco-skills and capacity building in rejuvenation efforts of River Ganga and its biodiversity. In order to ensure that skilled labourers and artisans have access to gainful employment upon completion of their vocational training, collaboration with the Rural Development Departments have been established to provide work under Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA) for rejuvenation of ponds and construction of toilets in the basin area. A team of dedicated Ganga Task Force has been put in place by raising a 529 member Territorial Army Unit, for four years to support in patrolling of ghats & river, public outreach, afforestation, water quality testing,

among other pursuits. Finally, the Human Resource Development department has been on-boarded to raise environment literacy among common masses in 1438 Gram Panchayats in the five states of Ganga main-stem, which ensures knowledge is provided to promote sustainable practices (4.7).

SDG 6: Clean Water and Sanitation

Goal 6 of the 2030 Agenda for Sustainable Development recognizes the importance of ensuring the availability and sustainable management of water and encompasses a range of values for water, with sub-goals focused on equitable access to potable water (6.1), adequate sanitation (6.2), water quality (6.3), increase water-use efficiency (6.4), integrated water resource management including through trans-boundary cooperation (6.5), and the protection and restoration of water-related ecosystems, including rivers (6.6).

The Namami Gange programme has in its Vision Document identified an entire mission on sustainable agriculture practices that emphasises upon water use efficiency in the sector. This is also reiterated in the project approach of STP construction that relays importance on recycling and reuse of wastewater. Recycling further ensures that lesser fresh water is withdrawn for any industrial or municipal use (6.4). Provisioning of sanitation infrastructure to household level in being coordinated through Atal Mission for Rejuvenation and Urban Transformation (AMRUT) of Ministry of Housing and Urban Affairs in the Ganga basin States. Under the Swachh Bharat Mission, all the Ganga Grams have been declared open-defecation free. The adequacy of sanitation is also peripherally taken care in the Namami Gange programme (6.2).

The cooperation of basin provinces is important to ensure that trans-boundary river space and associated wetlands and aquifers are managed in an equitable and sustainable manner. This has been highly emphasised in the National Ganga River Basin Management Plan and is being propagated in the implementation of the programme. International cooperation with Bangladesh on sharing of water at Farakka and with Nepal on Mahakali River reiterates India's commitment to practise integrated water resource management (6.5).

The programme in totality is an effort to address SDG target 6.6 on protecting and restoring water-related ecosystems, including river, which reverberates with the larger ambition of restoring the wholesomeness of River Ganga. The overall improvement of river health will definitely augment the water quality levels of the region (6.3).

SDG 9: Industry, Innovation and Infrastructure

Through SDG 9, countries have determined that investing in more resilient infrastructure, cooperating across borders, and encouraging small enterprises will all be critical to ensuring sustainable industrial development. Sustainability has been envisaged through the targets of resilient infrastructure (9.1), increased resource use efficiency (9.4) and increased scientific research (9.5).

Industrial standards and quality output have been emphasised programme-wide. The design year of created infrastructures is for 2035 to ensure sustainability of use over longer period of time (9.1). Old, dilapidated and inadequate infrastructure have been rehabilitated and subsumed under the programme to create more resilient infrastructure and improve resource use efficiency (9.4).

Scientific temper and research is the backbone of Namami Gange initiative that keeps the programme contemporary (9.5). Significance of GIS framework has brought a paradigm shift in visualization of all crucial spatial and non-spatial information of Ganga basin. Further, decision support system developed with GIS domain helps in efficient decision making, execution and monitoring of projects as well as provides a platform for central repository of all data related to Ganga and geo-tagged assets. GIS Project on "Reconstructing the Ganga of the past from Corona archival imagery" being executed by IIT Kanpur will develop an Atlas of the Ganga River showing a comparison between 1960s and present, establishing the reference condition of the Ganga river and quantifying the changes in morphological characteristics and land-use /land-cover within the Ganga valley. This exercise will further propose a policy document on 'desirable' land-use within the Ganga valley.

SDG 11: Sustainable Cities and Communities

Urbanisation is the biggest driver of industrialisation. With India becoming urban at an accelerated pace, the population pressure is beginning to overwhelm and undermine nature's ability to provide key functions and services. The most constrained of these are fresh water systems that are mismatched with the replenishing capacity. It is, therefore, pertinent that SDG 11 be read together with SDG 6 to ensure better water management practice across the spectrum. Specific to the goal, with targets of integrated and sustainable human settlement planning and management (11.3), protect and safeguard the world's cultural and natural heritage (11.4), reduce deaths and property damage caused by water-related disasters (11.5), reduce per capita environmental impact of cities (11.6), provide inclusive access to green and public spaces (11.7) and provide access to sustainable transport (11.2), SDG 11 envisages to create cities that are safe, inclusive, resilient and sustainable.

Good river-sensitive urban plan requires consideration of all forms of water, including drinking water, wastewater, storm-water, groundwater and water for the environment. This approach is being increasingly adopted through 'Urban River Management Plan' for the 97 Class I towns in Ganga Basin that are aiming to create environmentally sensitive, socially equitable and economically viable plan that puts river at the centre of planning (11.3). In continuation to city approach, sustainable transport via the traditional river route is being explored through inland waterways on Ganga called "Jal Vikas Marg" (11.2).

Flood plains are integral part of overall river ecology and perform very important role in hydrological cycle, improving ground water recharge, providing base flow to the river during lean season and also protecting damage to life and properties during floods (11.5). Protection of flood plains is important for ensuring health of the river. NMCG 'Authority' Notification demarcates the bank of River Ganga and its flood plain as construction-free zone. NMCG has led a flood-plain demarcation exercise for Ganga from Haridwar to Unnao to identify no development zone and regulatory zone. The State Government has been on-boarded for implementation

of the Authority order. This measure also reduces the adverse per capita environmental impact of cities by reducing pollution sources, pressure points and by maintaining natural ground water recharge functions of the floodplains (11.6).

The river Ganga plays an integral role in shaping the geography, economy and spiritual life of civilization across the 300,000 square miles of the basin plain and throughout myriad number of years. The river is also a goddess, a gateway to salvation, the mainstay of cities, a focus of environmental activism, and a fulcrum of dynasties and kingdoms across centuries that ruled it. This rich cultural and natural history of Ganga is being documented by INTACH through cultural mapping of architectural, intangible, built and natural heritage along 42 cities of Ganga basin. This project will further strengthen efforts to protect and safeguard the cultural and natural heritage of Ganga (11.4). Apart from this, the river front development and the ghat development projects being constructed across the important nodes of the river for people's congregation usher in much needed space in the city boundaries for use as public and green space (11.7).

SDG 12: Responsible Consumption and Production

The eight substantive targets of SDG 12 and their 10 corresponding indicators cover issues that relate to lifestyles and behaviour generally, and chemicals and waste specifically. These include targets on promoting universal understanding of sustainable lifestyles (12.8); promoting sustainable public procurement practices (12.7); encouraging companies to adopt sustainable practices and sustainability reporting (12.6); substantially reducing waste generation (12.5); responsible management of chemicals and wastes, significantly reducing releases to air, water, and soil (12.4); and halving global per capita food waste (12.3). All these targets aim to achieve the sustainable management and efficient use of natural resources by 2030 (12.2) and implementation of the 10-Year Framework of Programmes (10 YFP) on Sustainable Consumption and Production (12.1). The 10YFP, adopted at Rio+20 Conference in 2012, is designed to develop, replicate, and scale up sustainable

consumption and production (SCP) and resource efficiency initiatives at the regional and national levels, while decoupling environmental degradation and resource use from economic growth.

Under the Namami Gange program, efficient management of natural resources (12.2) holds the key to ensuring sustainable pattern of growth. This is reflected in initiatives like developing an 'Urban River Management Plan' to ensure a city-wide urban planning approach that places river at the centre of planning and 'Urban Wetland Management Toolkit' that directs city administrations to identify and prioritise wetland conservation measures within their respective boundaries. These initiatives have been piloted in the city of Kanpur in Uttar Pradesh and Bhagalpur in Bihar and a scientific scaling up is being envisaged in the remaining Ganga towns (12.1).

In order to achieve environmentally sound management of chemicals and wastes, and significantly reduce their release to water (12.4) by 2020, NMCG in its approach of tackling waste dumping in Ganga, has ensured construction of Sewage Treatment Plant for domestic wastewater and Common Effluent Treatment Plant for industrial wastewater to check unpolluted flow in the river. A classic case of this approach can be seen in the clamping down of 128-year-old Sisamau Drain in the city of Kanpur that was notorious for dumping an equivalent of 140 MLD of wastewater directly into the river water. Besides, to reduce the consumption footprint itself, projects like Okhla STP in the NCT of Delhi, when fully functional, will be able to generate enough power through bio-gas from the sludge, to be able to meet half of its power requirement. Zero black liquor discharge has been achieved in paper and pulp industries and molasses based distillery. Estimated reduction in the fresh water consumption and effluent generation from this are about 45-50% as compared to 2012 standards.

Additionally, to substantially reduce waste generation through prevention, reduction, recycling and reuse (12.5) by 2030, within the broad ambits of sewerage projects, a component of recycle and reuse has been envisioned for treatment of wastewater and reuse of reclaimed water and sludge in active industrial and agricultural processes. This measure has been promoted in project

procurement process (12.7) itself with the concessionaire being incentivized to recycle and reuse the treated water for non-potable purpose and the sludge for other uses apart from generating biogas based power. The revenue earned from this venture is, further, independent of the Annuity and O&M charges paid by NMCG, which encourages companies to adopt sustainable practices first hand in project development (12.6). To this effect, a Memorandum of Understanding has been signed with Indian Oil Corporation to reuse treated wastewater from STPs in Mathura Refinery. On successful completion of the pilot, a policy directive is envisaged to be drawn based on the responses and challenges in implementation.

SDG 13: Climate Action

SDG 13 addresses climate change mitigation and adaptation but explicitly acknowledges that the United Nations Framework Convention on Climate Change is the primary international, intergovernmental forum for negotiating the global response to climate change. Given that the SDGs were developed at the same time as countries were negotiating a new international agreement on climate change, the targets under SDG 13 are few and less detailed, namely strengthening resilience and adaptive capacity to natural disasters (13.1), integrating climate change measures in national policies (13.2) and improving awareness and institutional capacity on climate change (13.3).

In line with the identified targets, Namami Gange has constantly endeavoured to promote mechanisms for raising capacity for effective climate change-related planning and management through its various initiatives. The Ganga River Basin Management Plan clearly identifies climate change measures to arrest and reverse the degradation of Ganga River (13.2). NMCG on 9th October, 2018 notified the minimum ecological flow in the River Ganga required to be maintained at different points in different stretches at all times, starting from all the head streams of river Ganga up to Haridwar in Uttarakhand and from Haridwar to Unnao in Uttar Pradesh. A mechanism for monitoring of e-flow regime has also been put in

place with the help of Central Water Commission. A similar exercise has also been initiated for some of the other important tributaries viz., Yamuna and Ramganga. National Institute of Hydrology is carrying out a study for assessment of environmental flows in river Yamuna for stretch starting from Hathnikund barrage to Okhla barrage.

SDG 14: Life below Water

SDG 14 on Life below Water addresses a set of problems becoming increasingly serious for reasons related to their direct impacts and the indirect stresses they place on the environment. SDG 14 has seven substantive targets and seven corresponding indicators that collectively aim to preserve the health and wellbeing of marine ecosystems. There are references to interventions to increase the economic benefits from the sustainable use of marine resources (14.7), and the ending of subsidies contributing to overfishing (14.6). There are also targets on the conservation of coastal and marine areas (14.5), sustainable fishing (14.4), and the reduction of ocean acidification (14.3). Lastly, there are targets to protect and restore marine ecosystems (14.2), and to reduce marine pollution (14.1).

River Ganga culminates at Gangasagar in West Bengal where it meets the Bay of Bengal and along with its natural components of deposition like water and silt, the river is also a carrier of anthropogenic discharges. Within the Namami Gange program, solid waste management is highly emphasised both in urban areas and rural hinterlands. A blanket ban has been imposed on dumping of any solid waste on ghats and in the vicinity of river for up to a distance of one kilometre of the drains from the point of meeting the river. Screens have been fixed at regular intervals to check any plastic miscreant and trash skimmers are used at certain points on the river to ensure surface cleaning. These efforts ensure minimising plastic pollution that ultimately meets the ocean (14.1). The treated discharge of effluents is constantly monitored for adherence to prescribed limits of Biochemical Oxygen Demand (BOD) and Dissolved Oxygen (DO) level, which precursory reduces ocean acidification levels (14.3).

For the conservation of fish & fisheries of river Ganga, a project has been awarded to Central Fisheries Research Institute (CIFRI), Barrakpore under which ranching of indigenous fish species along with capacity building & improvement of livelihood of fishermen (14.9) is being done. A Hilsa fish ranching station has been established at Farakka, West Bengal by CIFRI for the restoration of Hilsa Fishery around Farakka Barrage to enhance the understanding of the upstream migration of Hilsa fish in Ganga and to promote sustainable fishing practices (14.4) in the region. Essentially a saltwater fish, the Hilsa is found in the Bay of Bengal, but it travels upwards through the various rivers and its tributaries during the spawning season.

SDG 15: Life on Land

In many ways, SDG 15 attempts to achieve similar objectives to SDG 14, but with a focus on terrestrial ecosystems. Terrestrial ecosystems are linked to almost all the SDGs because they provide a basis for many essential goods and services. SDG 15 has nine substantive targets and 11 corresponding indicators to monitor progress. These focus on integrating ecosystems and biodiversity into governmental planning (15.9), preventing invasive alien species on land and in water ecosystems (15.8), eliminating poaching and trafficking of protected species (15.7), promoting access to genetic resources and fair sharing of the benefits (15.6), protecting biodiversity and natural habitats (15.5), ensuring the conservation of mountain ecosystems (15.4), ending desertification and restoring degraded land (15.3), and ending deforestation and restoring degraded forests (15.2). All these targets contribute to ensuring the conservation and restoration of terrestrial and freshwater ecosystems (15.1).

Integrating wetland conservation in Ganga River Basin Management and effective operationalization of State Wetland Authorities for conservation of wetlands (15.1) along Ganga have enabled conservation measures to be spelled out for scientific conservation of these endangered terrestrial ecosystems. Namami Gange programme has initiated a project based on the proposal received from Uttar Pradesh State Wetland Authority for development of detailed briefs and Integrated Management Plans (IMPs) for 101

wetlands situated in 27 Ganga districts in the State for up to five kilometres on either side of the river. A specific project is underway for rejuvenation of 9 kunds in Varanasi. In the State of Uttarakhand again, the State Government has identified 51 wetlands for creating a database of the wetlands and preparing IMPs for their conservation. This is in line with the Wetlands (Conservation and Management) Rules, 2017, notified by Ministry of Environment, Forests & Climate Change to operationalize State Wetlands Authorities and identify priority wetlands to be taken up for management and conservation.

NMCG is also implementing Forestry Interventions in Ganga as per the DPR prepared by Forest Research Institute, Dehradun in order to positively improve the health and rejuvenation capacity of river Ganga. Since launch of the program, an estimated 20,000 hectares of land have been brought under plantation in Ganga basin States. This measure has sustainably improved afforestation cover (15.2) and combated desertification that results from flood and drought in the region (15.3). The Ganga Basin, in its upper reaches, is endowed with springs, which are an important source of water for hilly settlements especially during lean flow periods. Ensuring conservation of these mountain ecosystems (15.4), a rejuvenation programme is underway for which, Survey of India, Dehradun and IIT, Roorkee have initiated a scientific mapping of the springs of Tehri Garhwal district in Uttarakhand.

One of NMCG's long-term visions for Ganga Rejuvenation is to restore the viable populations of biodiversity of the river Ganga. To address the threats to the aquatic biodiversity of Ganga, Wildlife Institute of India (WII), Dehradun was awarded a project for developing a science - based aquatic species restoration plan for Ganga River by involving multiple stakeholders. A special programme is in place for conservation of Gangetic River Dolphin – the national aquatic animal of India. It is one of the four freshwater dolphins in the world. Gangetic river dolphins fall under Schedule I of the Indian Wildlife (Protection) Act and have been declared an endangered species by the International Union for Conservation of Nature (IUCN). Through these measures, Namami Gange

programme envisages protection and prevention of the extinction of threatened species (15.5). These initiatives have systematically ingrained ecosystem and biodiversity values into national and local planning and development processes (15.9).

SDG 17: Partnerships for the Goals

SDG 17 seeks to strengthen the means of implementation and revitalizing global partnership for sustainable development. SDG 17 has 19 substantive targets, which focus on implementing all development assistance commitments (17.2), mobilizing financial resources (17.3), knowledge sharing and cooperation (17.6), promoting sustainable technologies (17.7), enhancing policy coherence (17.14) and global partnership (17.16) for sustainable development, encouraging effective public-private and civil society partnerships (17.17) and enhancing availability of reliable data (17.18) will further develop measures of progress (17.19) and will improve domestic taxation (17.1).

The World Bank is financially supporting Namami Gange programme with a loan of $1 billion for helping NMCG build institutional capacity (17.9) for rejuvenating the river. It is also financing key infrastructure investments in the five main stem states - Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal. Through it various approaches of ensuring achievement of identified progress indicators under National Ganga River Basin Management Plan, NMCG is progressively moving towards achieving all the identified development assistance commitments (17.2).

Under the Namami Gange programme, access to science, technology and innovation has been improved through global partnerships like India-EU Water Partnership wherein knowledge sharing on mutually agreed terms is practised (17.6). Technological partnerships with Israel, GIZ - Germany and OISCA - Japan as well as project partnerships with PTB – Germany, UK and Scotland have strengthened the mission in developing state-of-the-art solutions that are attuned to global practices (17.7).

In order to conserve the ecological integrity of the Ganga River, and, reduce the direct dependency of the local communities on the river, the NMCG and Wildlife Institute of India (WII) initiated a project aimed at preparing a science based restoration plan by involving multiple stakeholders and the local community as guardians of the river and called them "Ganga Praharis". The purpose of this initiative was to establish a motivated and trained cadre of Ganga Prahari to support the local level institutions and monitor the quality of the natural resources of the river by mobilizing local communities at the grassroots (17.17).

Further, to improve data collection and reliability (17.18), KPMG has developed a Project Monitoring Tool for online tracking of progress of projects sanctioned under Namami Gange programme. The monitoring of water quality of river Ganga is being carried by State Pollution Control Boards (SPCBs) in 5 Ganga main stem States at 97 Manual Water Quality stations. Central Pollution Control Board compiles the data collected by these stations and also uses a network of 36 Real Time Water Quality Monitoring Stations to substantiate the figures. This practice will definitely enhance the progress measures and the design of the programme (17.19). A repository of knowledge database has been created under Ganga Knowledge Centre that continuously endeavours to document best practices in the program and internationally and nationally recognised practices that have a scope of replicability in the basin planning.

An outline of relationship of river and Sustainable Development Goals is attempted in Figure 1. An integrated River Rejuvenation program like Namami Gange can make a substantial contribution towards attaining these goals. The interventions of Namami Gange are also interrelated as is the case with SDGs.

Figure 1

River and the SDGs

Way Forward:

While the Namami Gange Programme has progressively attempted to address impending goals under the SDG framework, efforts that have a long gestation period like change in microclimate and air quality, improvement in soil fertility, enhancement in water quality and increase in green cover will take time till their benefits are fully materialised on ground. Similarly, short-term efforts of cleanliness and sanitation require a sustained practice and behavioural change of the end-user. The programme continues to endeavour quality in efforts, consistency in practice and incremental growth in the outreach to stakeholders.

The NMCG and its legal framework have been crucial in promoting cooperation at the basin level and thus ensuring a progressive approach towards attainment of SDGs. However,

improvements in governance at many levels (e.g. at District and State level) are critical, together with the needs for technical solutions and a coordinated basin-wide investment strategy. The District Ganga Committee and State Ganga Committee that have been put in place will have to ensure sustainability of efforts of NMCG at the local level. Only then can the larger goal of localizing SDG and leaving no one behind will be fulfilled.

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Bharat R Sharma

Developing Sustainable Agri-scapes in the Ganga Basin

Introduction

Availability of abundant water resources, fertile soil, and suitable climate in the Ganga basin have supported a large agriculture-based population. The Ganga basin in India covers 860,000 km2 spread over 11 states and 17 major tributaries including Yamuna, Chambal, and Kosi. Total length of the river from origin in the Himalayas to the delta in Sunderbans is about 2,500 km. More than 500 million people with a population density of 520 persons/ km2, highest in any river basin of the world, live in the Ganga basin. The World Bank estimates an annual contribution of US$ 700 billion accounted for the basin. Despite this iconic status and religious heritage, the Ganga today is facing formidable pollution pressures and associated threats to its biodiversity, agriculture and environmental sustainability.

The main physical sub-divisions of the Ganga basin are: the northern high mountains comprising the Himalayan ranges and the foothills, the vast Gangetic fertile plains between the Himalayas and the Deccan plateau, the central highlands lying to the south of the Gangetic plains, and the Delta. The basin receives high annual average rainfall of more than 1150 mm spatially averaged across the basin, and 2000 mm or more in the upper northern Himalayan catchments. The Ganga is a gaining river with a discharge of 23,900 BCM at Haridwar; 152,000 BCM at Allahabad (Prayagraj) and 525,040 BCM at Farakka- an increase of 22 times. In absolute terms, the total amount of water in Ganga basin is enough to meet the social, economic and environmental needs of the basin. However, there are large variations in the temporal and spatial distributions of water resources. Water is

plentiful during the monsoon period and flooding generally occurs, but during the non-monsoon summer and winter dry period, parts of the basin become water stressed and flows may be inadequate to meet irrigation and domestic demands. Additionally, long stretches of the river have become highly polluted due to unregulated disposal of domestic sewage and industrial effluents; and contaminated by arsenic.

Agriculture and Agri-scapes in the Ganga Basin

Agri-scapes are extremely heterogeneous in the basin ranging from cold Himalayan upper catchments, fertile alluvial plains, semi-arid central highlands and the extremely fragile vast delta region. The actual primary productivity of agriculture, forestry, fisheries and livestock is only low-to-medium of the potential productivity (Table 1).

Most of the hill and mountain systems in the basin are still practicing low productivity rain-fed subsistence farming. The green revolution, which brought change in the northern plains was not able to penetrate the hills and mountains because high input technologies were not feasible in the uplands. The important reasons of slow growth and low yields are use of old varieties and seeds, limited use of fertilisers, water and other inputs, and lack of access to competitive markets and services (Sah, 2013). As a result, the region continues to be food deficit and net importer of food grains to meet its demands. On the other hand, the hills and mountain systems, which include forests, grasslands, wetlands and high-value horticulture, are also providing ecosystem services to low-land areas through freshwater that is captured, stored, and purified in mountain regions.

Table 1. Actual and potential productivity in the important Agri-scapes of the Ganga basin

Region	Agriculture		Forestry		Fisheries		Livestock	
	Potential	Productivity	Potential	Productivity	Potential	Productivity	Potential	Productivity
Upper Catchments	Low- to -medium	Low	High	Low- to-medium	High	Low	High	Low
Gangetic Plains	Medium-to -high	Medium	Low	Low	Medium-to- low	Low	High	Medium-to-low

Central Highlands	Medium	Low	Medium-to-high	Medium-to-low	Low	Low	High	Low
Gangetic Delta	Medium-to-high	Low	Low	Low	High	Medium	Low	Low

Spread largely over the states of Uttar Pradesh, Bihar and West Bengal in India; the Gangetic plains is one of the most fertile and populous region of the world. With major share of rice in rainy season and wheat in winter season; maize, sugarcane, pulses and oilseeds and fruits and vegetables are also vastly cultivated in the plains. Livestock, dairy and riverine and freshwater fisheries form integral part of agricultural system are more popular among the smallholder and marginal farmers and landless labourers. In spite of the rich alluvial soils, abundant surface and groundwater resources, favourable climate and large agricultural workforce the agricultural productivity remains low and as such the northern Gangetic plains may be described as 'low-productivity- high potential' region (Sharma et al., 2010).

Central highlands spread over parts of Uttar Pradesh, Madhya Pradesh, Rajasthan and Chhattisgarh receive insufficient monsoon rains, temperatures remain high and the annual deviation between potential evaporation and rainfall varies from (-) 561 mm to as high as (-) 967 mm. Rainfed minor millets, pulses, oilseeds, wheat and barley are the main crops and have low productivity. Vast areas are also covered under degraded grasslands, pastures, scrub and open forest and ravines and wastelands. Water insecurity is a constant threat for crops, large herds of unproductive livestock and the poor and tribal population dependent on these resources. Only about 15% of the net sown area is irrigated by different sources and as such value of agricultural output per hectare is only about one-third of the national average (Phansalkar and Verma, 2005). These central highlands offer the unique opportunity for enhancing rural livelihoods through water-centric investments.

The coastal region in the delta of the river Ganges in India and Bangladesh is known as the 'Sunderbans'. The Ganges delta is under increasing environmental pressure today in response to the needs of the rapidly growing and modernising population. Agriculture in the Sundarbans of India is mainly mono-cropped with kharif rice (aman)

grown in the monsoon season. Scarcity of freshwater for irrigation during the post-monsoon period is the main constraint for growing boro rice and other crops. The importance of inland fisheries for the livelihood and food security of the poor and landless is widely acknowledged in the Ganges delta.

In the basin as a whole, rainfed agriculture is the most extensive land use, covering 52% of the basin. Its water use is also correspondingly higher, an annual average of about 372,000 million cubic metre (mcm), or 32% of the total water used. Irrigated agriculture covers 25% of the basin, with 17% of the total area irrigated from surface water resources, and 8% from groundwater. The estimated mean annual water use by irrigated agriculture is about 210,000 mcm, or 18% of total water use. However, this demand is increasing fast, especially for the domestic and industrial uses and slowly for the agricultural uses due to constraints in development of water access and infrastructure (Fig. 1).

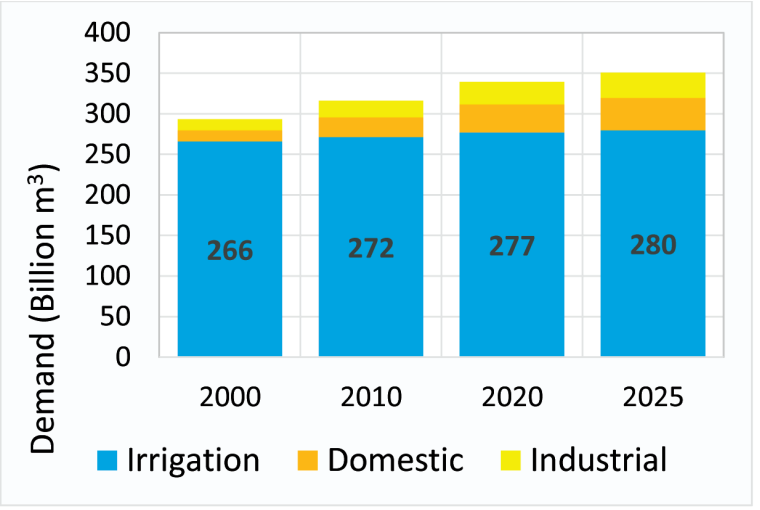

Fig.1. Increase in water demand under different sectors in the Ganga basin

The majority of the irrigated water use is from crops irrigated from surface water resources (70%), with the remaining 30% from groundwater irrigated crops (Fig. 2). Grasslands cover 14%

of the basin and consume about 100,000 mcm (8%) of the water used. Remaining 5% of the water (about 57,000 mcm) is used by woodlands, forests, bare ground and urban areas etc. (Eastham et al., 2010).

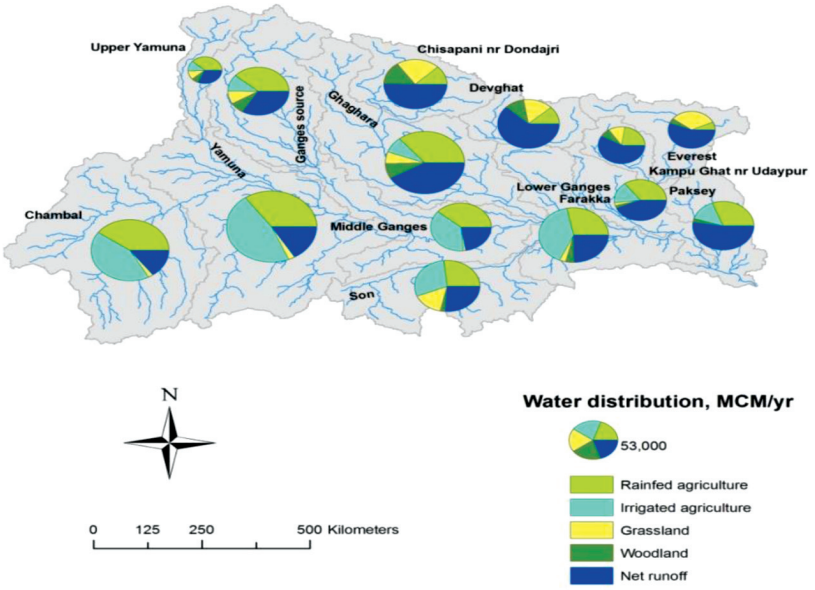

Fig. 2. Agriculture and related water uses in the Ganga basin.

Agricultural Productivity in the Ganga Basin

Agricultural productivity of most of the crops is low through most of the Ganga basin. The average rice yields are 2.53 t/ha - however large variations exist in different parts of the basin. The "bright spots" adjacent to the Indus basin in India have an average yield of 6 t/ha. The "hot spots" of low yield rice is found in the states of Madhya Pradesh, and Bihar. The trend of wheat yield variation is similar to that of rice. Western Uttar Pradesh and small pockets in Madhya Pradesh and Rajasthan states of India are the bright spots with average yield above 4 t/ha and hot spots with yield as low as 0.70 to 1.58 t/ha appear in the states of Bihar and parts of West Bengal. The upper catchments and central highlands in southern parts of the basin have low cropping intensity and agricultural productivity of cereals and other crops largely due to water stress

during non-rainy seasons. Several rice farmers in Bihar and West Bengal having access to irrigation have switched to growing maize during the non-rainy winter season. High yielding hybrids help to drastically reduce diesel-pump operation hours and thus double the economic returns. Co-cultivation of fish in the paddy fields is also a popular practice in the high rainfall areas of West Bengal and delta areas in Sunderbans.

Improving Sustainability of the Agri-scapes

Low and stagnating yields from tiny parcels of land, under-developed and inefficient water infrastructure and farm energy and insufficient technological diffusion threaten food security and livelihoods of about 500 million population of the Ganga basin. This challenge is even more severe when seen in the context of increasing rainfall variability due to climate change, over-exploitation as well as under-utilisation of groundwater resources due to inefficient energy policies and deteriorating water quality in the main stem of the Ganga River. Farming systems need to be reconfigured basin-wide for sustainable intensification through adoption of important components of conservation agriculture, soil health, high yielding varieties, integrated pest management and above all an efficient water management. But much more also needs to be done in improving governance, policies and institutions and transboundary cooperation for sustainable intensification of the agriculture.

Upper catchments

Agriculture in the upper catchments is characterised by low, middle and high hills with little or no agriculture in the snow covered mountains (> 2,300 m amsl). Agriculture is constrained by timely availability of quality production inputs and competitive markets. In spite of the large availability of freshwater resources in the region its access by scattered and small holder poor farmers is challenging and is the main bottleneck for agriculture diversification and intensification. Only about 15 % of the cultivated farms are irrigated in the hill districts of Uttarakhand. Impacts of small but critical irrigation are phenomenal as cereal yields improve by more than 55% as compared to rainfed crops. However, value addition and intensification of

agriculture shall happen through provisioning of necessary conditions to support the growing interest and opportunities for cultivation of high-value off-season vegetables, horticulture and floriculture, spices and medicinal plants, tea in the low and mid-hills and temperate fruit orchards in the high hills and mountains.

Following are some of the important interventions for improving yields and sustainability of agriculture in the upper catchments:

i. Rejuvenation of dysfunctional farmer managed irrigation systems

ii. Development of multiple water-use systems (MUS): In the upper catchments, only 5% of the existing water resources are used for economic activities. MUS can provide reliable water supplies for household needs and more productive agricultural activities in the hilly regions. The designs for MUS are based on: groundwater/lake water lifting and distribution; rainwater collection and distribution; spring water distributed by gravity system; and stream/river water supply after treatment. Most MUS are designed to cover 10 to 40 households.

iii. Revival of water springs in the low and mid-hills: Most of the local drinking water needs are met by the springs and the surplus water is used for small-scale farming. Through appropriate technology the springs can be developed to meet the larger needs of the community and successful examples exist in Kumaon and Garhwal regions of Uttarakhand where low density polyethythene lined tanks and small gravity-based drip irrigation systems have been integrated with the natural ones to hold great promise for meeting the critical water needs and transforming the hill economy. The developed springs can also use solar powered pumps for lifting of water from tanks and operation of micro-irrigation systems. Efficiency of the harvested water can be further improved through integration with micro-irrigation systems especially for off-season vegetables, floriculture and the horticultural orchards.

iv. Other sustainable agriculture options for the hill agriculture include adoption of organic agriculture for crops, vegetables and spices; and tea cultivation to enhance agro-ecosystem health, including biodiversity, biological cycles and soil biological activity. Adoption of agro-forestry and silvicultural systems, rejuvenation of degraded pasturelands and promotion of crop-livestock mixed farming systems shall greatly help in developing sustainable agriscapes in the vulnerable regions.

Gangetic plains

The north-western plains of the Ganga basin are characterised by a largely intensified crop production, achieved with adoption of green revolution technologies, and high market integration. In contrast, the eastern plains show poor crop yields, costly and scarce irrigation, high dependence on rainfalls and floods, and small and fragmented farm holdings. Together with lack of institutional finance and extension services, poverty and uncertainties of rural livelihoods are much higher (Ernestein and Thorpe, 2011). Potential interventions for sustainable agricultural intensification in the Gangetic plains may include the following:

i. Resource conservation technologies (RCTs): Most popular conservation agriculture technologies include zero-tillage, laser-assisted land levelling, retention of surface residues in the fields, permanent bed planting, dry seeding of rice and surface seeding of wheat (Ladha et al., 2009) and permanent raised beds produce more rice, wheat and income in less time, using less water, fertilisers and energy. The planting dates of both rice and wheat can be brought forward by new methods of crop establishment.

   - Zero tillage and direct seeding of wheat economize on time and also on water and fuel, saving an estimated Rs. 3,500 to Rs. 5,000 per hectare (Gautam, 2008).
   - For rice, substitution of long-duration rice cultivars with short duration one, and direct wet or dry seeding, eliminate the need for transplanting.

- Aerobic rice and 'alternate wet and dry irrigation' of rice reduces water consumption by 30 to 50%.
- Laser assisted land levelling achieved by a tractor-mounted laser beam projector, operated by private contractors, allows precise levelling of fields at prices smallholders can afford. Recent studies in northwest India found that the technology is far more efficient than traditional levelling, reducing water applications by up to 40%, improving the efficiency of fertilizer, and boosting rice and wheat yields by around 8% (IRRI, 2009).

ii. System of rice intensification (SRI): SRI produces more rice and income using less water, less fertilizer and even less seed. About 7 to 15 days old seedlings are transplanted singly, often in grid patterns with wide spacing of 25 cm x 25 cm per plant. Alternate wet and dry irrigation is followed with dry periods of 3 to 6 days. Weeding is done at regular intervals, and compost, farmyard manure and green manure are preferred to chemical fertilizers. The system was found to improve grain yields by more than 42 per cent and water use was reduced from 25 to 47% below that of flooded system (Thakur et al., 2009; Barah, 2009). SRI rice also made much more efficient use of mineral fertiliser and required less seed. Farmers' per hectare net income had increased by an average of US$ 110, owing to a 40 per cent reduction in production costs (Dzung et al., 2011).

iii. Smart water management options: A number of interventions can help in improving resilience of agriculture by improving the surface and groundwater storage, construction of underground pipeline systems to minimise the water losses, improved drainage for the waterlogged conditions, improving irrigation water productivity through large scale adoption of precision irrigation and adoption of conjunctive use practices for balanced use of surface and groundwater and freshwater and waters of poor quality. Underground Taming of Floods for Irrigation (UTFI) is a suitable technology to address the twin problems of urban/rural habitation flooding and the declining levels of groundwater.

Central highlands

Central highlands spread over the states of Madhya Pradesh, Chhattisgarh, parts of Rajasthan are dotted with small hills and rolling topography; degraded forests, pastures and wastelands; variable rainfall and mixed farming practices and inhabited by largely tribal population. The region offers a unique opportunity for enhancing livelihoods through investments in land, livestock and water management. As irrigation covers less than 15 per cent of the cultivated areas, most parts remain rainfed. Regions with low rainfall grow crops that require relatively less water, and crop mixtures that protect farmers against the precarious uncertainty of rain. The mean value of agricultural output per hectare in the central highlands is only about one-third of the national average for India. Important strategies for such Agriscapes in the Ganga basin include the following:

i. **Decentralised water harvesting:** Rainwater harvesting offers supplementary irrigation as well as protection against the drought and variability. Most past efforts in rainwater harvesting have been initiated by the government on the community lands and the outcomes show mixed results. Decentralized water harvesting approach emphasizes on construction of structures on farmer's own land with own resources. Creation of a large number of inexpensive decentralized water harvesting structures such as the '5 per cent Farm Pond', in which about 5 % of the farm at the most upstream spot is dug for capturing rainfall, will enable farmers to provide protective irrigation during critical periods of moisture stress. In Dewas district in Madhya Pradesh, more than 6,000 farmers allocated 6% to 10% of their lands for the ponds. The ponds are unlined but tractors are used to compact the soil in order to minimize seepage (Malik et al., 2014). These have led to significant improvements in availability of irrigation water and revival of agricultural economy.

ii. **Adoption of improved agronomic practices:** Water harvesting and access acts as a trigger of adoption of other improved agronomic practices like appropriate use of fertilisers and pesticides, timely sowing, high yielding crop varieties and diversification of

the enterprise. Experience shows that whereas only application of harvested water may improve the yields by 50 percent, total yield improvement can be as high as 81 per cent when augmented with improved agronomic practices in the rainfed areas (Fig. 3).

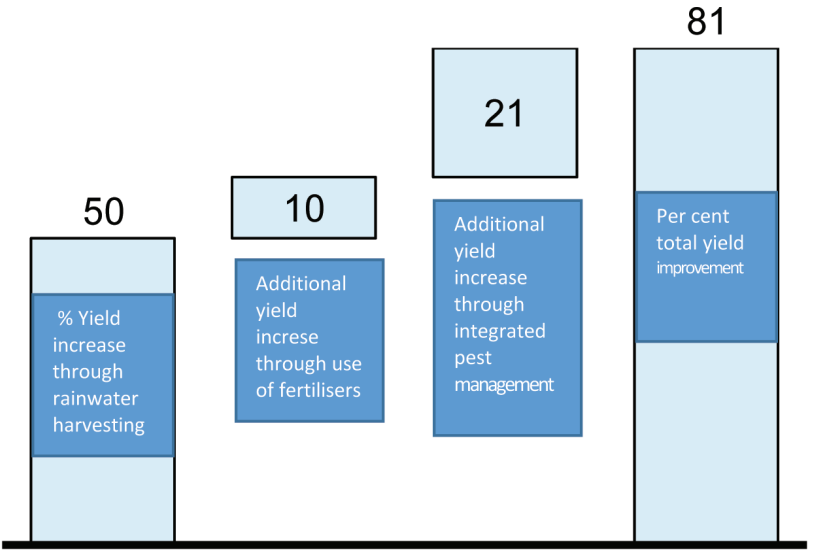

Fig. 3. Incremental yield increase through application of harvested water and other improved agronomic practices in the rainfed areas

Ganges delta

The limited land and abundant water resources in the coastal zone of the Ganges delta are vital for crop production, fisheries, ecosystem sustenance and livelihoods. The floods and salinity front moves seasonally as well as spatially in the coastal area. Agriculture in the Sunderbans of India is mono-cropped with kharif rice in the monsoon season. Scarcity of fresh surface water for irrigation during the post-monsoon period is the main constraint on growing boro rice and other crops. As such the productivity of the land is very low and the region is one of the most disadvantaged and poverty stricken areas in India (Burman et. al., 2013). Several innovative and sustainable agricultural systems have been designed for intensification of agriculture in the coastal areas:

i. **Rice-based system Intensification:** Most agricultural land in the coastal zone grows a single rice crop (aman) during the rainy season, mainly using the local varieties with low yield potential. The first step towards intensification was to develop and introduce high yielding aman varieties and for this major biotechnological breakthrough has now been made through development of submergence tolerance varieties like Swarna-sub 1 and salinity tolerance varieties which yield about 20% more than the local cultivars. The next step was to develop a two rice crop aus-aman (summer- rainy season) system for increasing the productivity of moderately saline regions of the coastal zone.

ii. **Homestead production systems:** Small homestead food production systems (HFS) are an important source of income, food and nutrition for millions of poor farmers in the Ganges coastal zone.). This intensive micro-production system on a land area of 400- 1300 m2 shall typically have an aquaculture homestead pond (33 % of area), vegetable and fruit production and poultry and small livestock with a very efficient integration and recycling of resources among different components of the system. HFS through its year round intensive and diversified production from a very small piece of land has the potential to improve the household food security of the poor irrespective of their land holding size.

iii. **Intensification of coastal aquaculture:** Coastal aquaculture to grow shrimp and fish has been a way of life in the Ganges delta. Productivity of the coastal aquaculture can be substantially improved with the new technology of suitable species combination and moving from traditional practices of year-round mixed aquaculture to cyclic monoculture or polyculture (Wahab et al., 2012). Saline water represents an asset to the coastal region that needs to be more efficiently used by both aquaculture and aquatic agricultural farming systems. There are new innovations like floating agricultural fields and "Srojan" method of high value crop cultivation in the coastal areas.

Conclusions

Agriscapes are highly variable and under severe stress in the Ganga basin. As irrigated agriculture covers only 25 per cent of the basin, crop and water productivity is low through most of the basin and is impacted both due to floods and water scarcity. Though several other factors are important, yet it is 'water' that remains the principal driver or the main set of constraints for development of agriculture in this vast basin. Strategies for sustainable intensification of agriscapes in the Ganga basin need to be regionally differentiated for the upper catchments in the Himalayas, northern Gangetic plains, Central highlands and the fragile Gangetic delta (Sharma et al., 2016). Rejuvenation of farmer-managed irrigation systems, multiple use systems and revival of water springs in the mid and lower hill catchments; large scale adoption of resource conservation technologies and system of rice intensification along with smart water solutions in the Gangetic plains; decentralised rain water harvesting and development of low-cost irrigation infrastructure to meet the critical needs of water in the central highlands; and rice-based system intensification and diversification through flood and salt tolerant varieties, innovative homestead production systems for land less farmers and intensification of coastal aquaculture for the poor farmers in the Gangetic delta are important strategies for sustainable intensification of agriculture and improvement or rural livelihoods in the Ganges basin. These interventions shall in itself shall be insufficient and need to be augmented with appropriate backward and forward market linkages, suitable energy and agricultural policies, availability of credit and supporting infrastructure, procurement of surplus produce at competitive prices, farmer institutions and safety nets to serve the farmers in times of droughts, floods and other externalities. The basin has all the basic resources to transform these into very productive and vibrant agriscapes for the vast millions of population of the Ganga basin.

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Environmental Flows for a Healthy Ramganga*

BACKGROUND AND CONTEXT

A healthy river is a resource sustaining water security, flood-risk reduction and eco-system services for people and nature, benefiting the economy of the land it flows through. WWF- India's programme River for Life, Life for Rivers aims to restore and conserve rivers in its natural state - thus sustaining services to people and nature, and benefiting the country's economy. With the increasing degradation of our river systems across the country, it is imperative to recognize the value of rivers beyond mere water sources for domestic use and development ventures. Policies and practices need to be developed by experts and implemented by decision makers and implementing agencies, recognizing and safeguarding benefits of rivers flowing through communities, cities and states.

The flow in the river is impacted due to decline in aquifer health and over abstractions for irrigation and other sectoral needs. The low base flows on other hand adversely impact aquatic biodiversity, groundwater levels and other riverine characteristics and associated ecosystems. This appeals for maintaining Environmental Flows in the river. Environmental Flows of a river maintains the ecological integrity of the river, their associated ecosystems, and the goods and services provided by them to people, flora and fauna. WWF-India has been working towards the adoption of sustainable water abstraction policies and practices leading to the maintenance of Environmental Flows in the Ganga and its key tributary, the Ramganga.

WWF-India's E-Flows work (since 2008) in the Upper Ganga (from its origin up to Kanpur) focused on developing, improvising and testing an E-Flows Assessment (EFA) methodology. E-Flows work in Prayagraj, Uttar Pradesh during Kumbh in late 2012 and

* Ramganga Environmental Flows Assessment Team (WWF)

2013, undertook some additional steps pertaining to actual flows monitoring in the Ganga and comparing it with the recommended E-Flows for the Kumbh. Following this, WWF-India and its partners felt that, it was imperative to pilot the EFA and its implementation in a smaller river system to build a base for demonstrating various mechanisms for the realization and monitoring of E-Flows. It would thus effectively strategize on implementation of the mainstreaming of E-Flows, both at river-system scale and at national levels. It was also important to address the concern "where will the water come from and what are the trade-offs?". River Ramganga, a major tributary of River Ganga, was selected for an E-Flows Assessment and pilot demonstration.

This paper attempts to brief about the process of the Ramganga E-Flows Assessment, with a trade- offs analysis. The work builds on the lessons learnt from the E-Flows assessment in the Upper Ganga (2008-2010) and in River Ganga during Kumbh (2013) at Prayagraj, with further improvisation in EFA strategy and approach namely:

a. Adopted 'River Health Categories' (RHCs) concept with clear-cut qualifiers for each category substituting the 'Environment Management Classes' (EMCs) concept.
b. Instead of considering water pollution as a theme, the team developed River Health, a holistic phenomenon as a thematic including water quality assessment, catchment health and biomonitoring.
c. Instead of one E-Flows regime recommendation, three scenarios corresponding to various river health categories for each site was suggested for the 'water-managers' and 'decision-makers' to consider, namely:
    - Improved scenario – a long-term vision.
    - Target scenario – a minimum immediate need to improve the health of the river
    - Additional Use scenario – an inevitable scenario, if the trajectory continues in a 'business-as-usual' manner.

d. The number of sites in this assessment were increased from the previous EFA exercises, for detailed year-long thematic field studies.

e. A stakeholder process was built in at various stages of the assessment to record the aspirations of the riparian stakeholders.

The earlier exercise of E-Flows assessment for Upper Ganga was conducted by various international and national experts. However, Ramganga E-Flows Assessment was conducted by local and national experts, under the guidance of an international expert establishing the capacity enhancement at national level in undertaking E-Flows work, which is a valuable outcome of this process.

THE RAMGANGA AND ITS SIGNIFICANCE

The Ramganga river flows for over 650 km (this figure is based on river surveys by the team, though some literature reports figures of 600 km or 596 km), predominately in a southerly direction until it joins the Ganga at Tehra Ghat village, Hardoi district, Uttar Pradesh. The mean annual regulated flow at the basin outlet is around 6.3 billion cubic metres (BCM) which is 2% of the total water resources of the Ganga. The total utilizable groundwater resource in the basin is approximately 5.6 BCM, and around 73% of that resource is presently abstracted, with groundwater taken both for irrigation purposes but also to supplement or replace domestic water supply systems. The Ramganga is a microcosm of the Ganga in many ways, encountering similar challenges as the Ganga; albeit at a smaller scale, but with a potentially similar severity of impact. River Ramganga is an abode of Golden Mahseer in the upper reaches of the Himalayas and supports a diverse fish base of Indian Major Carps in the plains. Besides this, the river supports several species of turtles and the gharial; dolphins have also been sighted in the lower reaches of the Ramganga, in and around Dabri during the monsoon season.

The Ramganga is a 'near-pristine' river in the lower Himalayas (100 kilometers from the origin) until it reaches the foothills, where it starts facing fragmentation at Kalagarh Dam,

abstractions at the Hareoli Barrage (for the Lower Ganga Canal and other canal systems), sewage and industrial pollution from Kashipur, Moradabad, and Bareilly; encroachment, over-abstraction of groundwater, degradation of wetlands and other unsustainable activities leading to reduced recharge and potentially reduced base flows. Despite this, before the confluence with the Ganga, the Ramganga restores its river health to some extent, which is evident from the fact that Dabri is a reasonable habitat for some of the native aquatic species of the Ramganga. For several decades, the Ramganga's water resources have been directly supporting or supplementing the irrigation needs of the farms. The water resource has been indirectly extending similar services by recharging groundwater levels and sustaining the wetlands and ponds close to the river and its tributaries.

The water released by the Kalagarh dam downstream to the Hareoli barrage is diverted into an 82 km long feeder canal taking the water (1,380 MCM, Million Cubic Meter) to the Ganga. This feeds/supplements the command areas of the Lower Ganga Canal system, which is located outside the Ramganga basin, though in the state of Uttar Pradesh. Diversions to the Lower Ganga Canal represent around 84 percent of water availability at the Kalagarh dam and 22 percent of water available at the outlet of the basin. The Ramganga's water resources from the Kalagarh Dam, beyond any doubt, contribute to the farm economy in the basin space and beyond. However, there is insufficient amount of water available in the river downstream of the Hareoli barrage from early November to early June, which has led to the deterioration of the river's health.

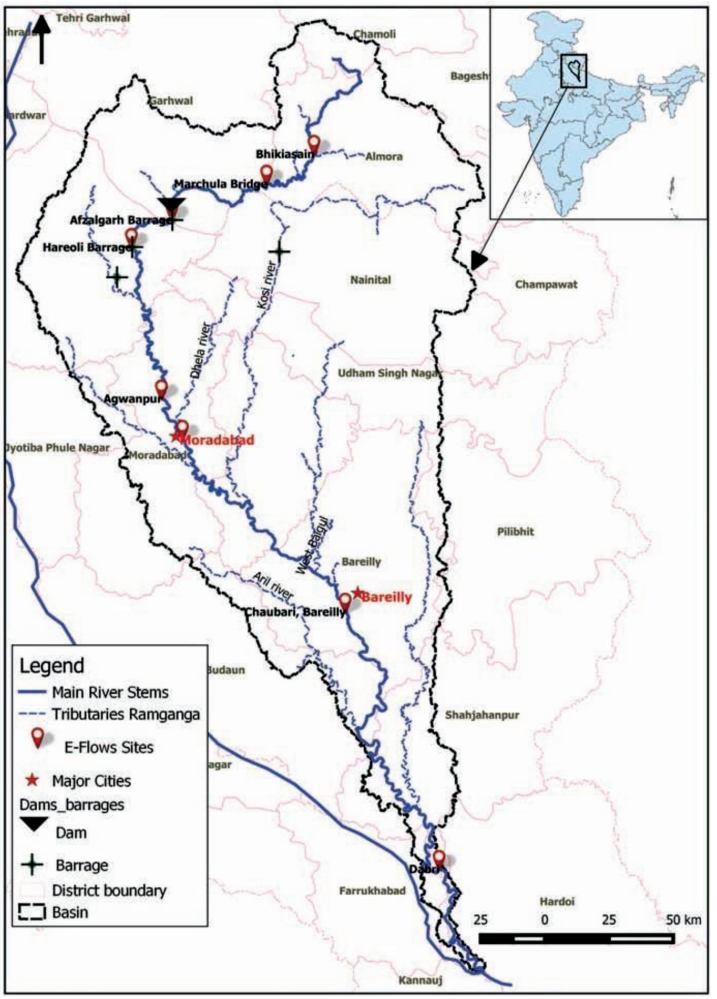
RAMGANGA E-FLOWS ASSESSMENT

Eight locations of the Ramganga River were identified for detailed all-season field investigations from the perspective of aquatic biodiversity, fluvial geomorphology, river health, socio-cultural and livelihoods aspects, while hydrology and hydraulic modelling remained the backbone of the study. The sites were:

- Bhikiasain
- Marchula

- Downstream of the Afzalgarh Barrage
- Downstream of the Hareoli Barrage
- Agwanpur
- Katghar at Moradabad
- Chaubari at Bareilly
- Dabri

A map depicting locations of detailed field investigations as part of Ramganga EFA are shown in the following figure.

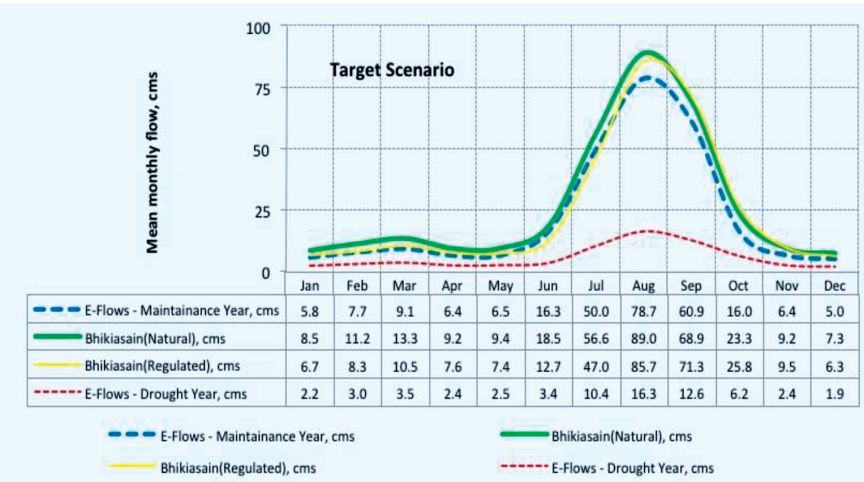


While three scenarios (i.e., Target, Improved and Additional Use) were developed for all the sites (barring a few sites, due to site-specific complexities), and the same are presented in the chapters, here in the executive summary only the 'Target' scenario is given for recommending E-Flows at critical sites.

Target Scenario graphs of downstream of Hareoli barrage, Katghar at Moradabad, Chaubari at Bareilly and Dabri.

- **Bhikiasain:** At this site, the E-Flows for the maintenance year (a normal year – not very dry and not very wet) for this site is met across all the months in a year.
- **Marchula:** Similar to the scenario in Bhikiasain, the present-day flows at Marchula fulfil the E-Flows requirements as the thematic group was satisfied with present-day flows.

Both Bhikiasain and Marchula are indicative of 'reference' conditions and are observed to be relatively intact, sustaining most of the ecosystem functions. The intactness of these sites is going to be critical for the health of Ramganga and it is worth recognizing that the current state of river health should be maintained at these two sites in the future.

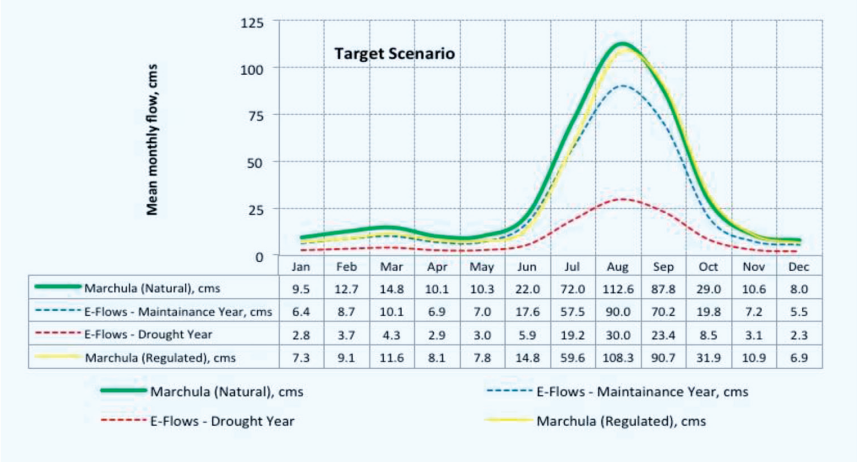


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
E-Flows - Maintainance Year, cms	5.8	7.7	9.1	6.4	6.5	16.3	50.0	78.7	60.9	16.0	6.4	5.0
Bhikiasain(Natural), cms	8.5	11.2	13.3	9.2	9.4	18.5	56.6	89.0	68.9	23.3	9.2	7.3
Bhikiasain(Regulated), cms	6.7	8.3	10.5	7.6	7.4	12.7	47.0	85.7	71.3	25.8	9.5	6.3
E-Flows - Drought Year, cms	2.2	3.0	3.5	2.4	2.5	3.4	10.4	16.3	12.6	6.2	2.4	1.9

- **Downstream of the Afzalgarh barrage:** E-Flows assessment for this site was not conducted, as communities living in close vicinity of this site were more concerned about the sudden

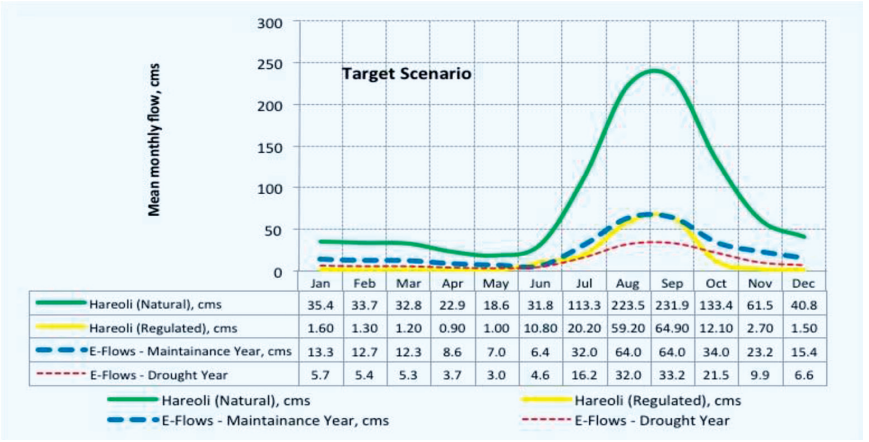
releases from the dam (given its location, just downstream of Kalagarh dam). Accordingly, the team suggested measures around early warning systems and flood forecasting mechanisms for this site. The current flows regime at this location is practically opposite to the natural flow regime as the released flows are driven by seasonal irrigation demand. During the lean season, there is water in the river at this location to meet the irrigation water needs. However, during wet season, the site has less water due to little release from the dam gate, except when the water level in the dam reaches its desired level.

- **Downstream of the Hareoli barrage:** This is one of the most critical sites in the Ramganga river, particularly in terms of water quantity. The graph indicates that the E-Flows requirements are not met throughout the year, except for the month of June and September.



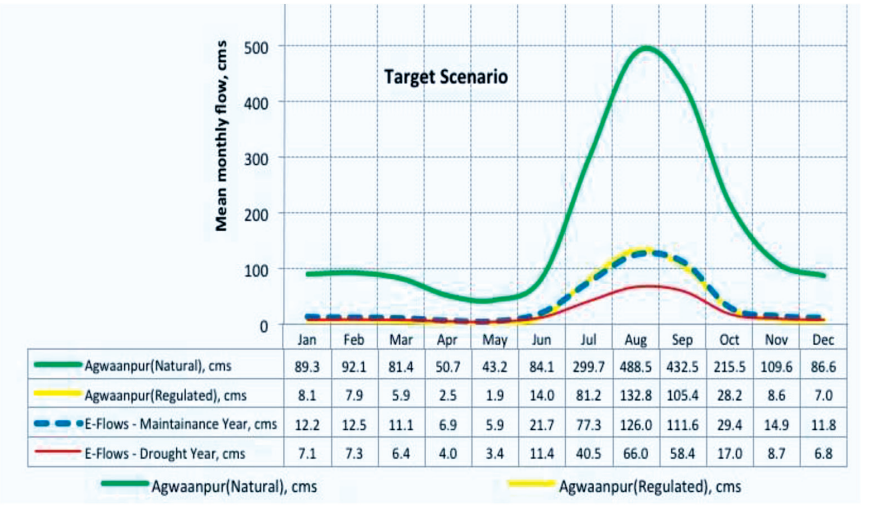
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Marchula (Natural), cms	9.5	12.7	14.8	10.1	10.3	22.0	72.0	112.6	87.8	29.0	10.6	8.0
E-Flows - Maintainance Year, cms	6.4	8.7	10.1	6.9	7.0	17.6	57.5	90.0	70.2	19.8	7.2	5.5
E-Flows - Drought Year	2.8	3.7	4.3	2.9	3.0	5.9	19.2	30.0	23.4	8.5	3.1	2.3
Marchula (Regulated), cms	7.3	9.1	11.6	8.1	7.8	14.8	59.6	108.3	90.7	31.9	10.9	6.9

- **Agwanpur:** This is the most difficult site in terms of hydrology and hydraulics due to local factors. The left side of the river bank is low lying and this is not a gauged site. However, the site is crucial as it is located upstream of Moradabad city, where the river undergoes major change owing to anthropogenic activities. With these complexities, the team recommended E-Flows for this site and the present-day flows are meeting E-Flows requirements only during two months of the wet season, i.e. July and August.



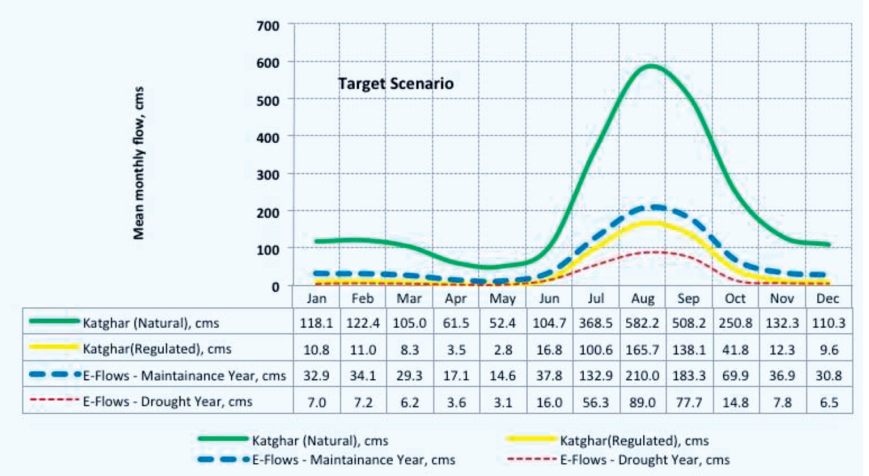
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hareoli (Natural), cms	35.4	33.7	32.8	22.9	18.6	31.8	113.3	223.5	231.9	133.4	61.5	40.8
Hareoli (Regulated), cms	1.60	1.30	1.20	0.90	1.00	10.80	20.20	59.20	64.90	12.10	2.70	1.50
E-Flows - Maintainance Year, cms	13.3	12.7	12.3	8.6	7.0	6.4	32.0	64.0	64.0	34.0	23.2	15.4
E-Flows - Drought Year	5.7	5.4	5.3	3.7	3.0	4.6	16.2	32.0	33.2	21.5	9.9	6.6

Hareoli (Natural), cms; Hareoli (Regulated), cms; E-Flows - Maintainance Year, cms; E-Flows - Drought Year



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Agwaanpur(Natural), cms	89.3	92.1	81.4	50.7	43.2	84.1	299.7	488.5	432.5	215.5	109.6	86.6
Agwaanpur(Regulated), cms	8.1	7.9	5.9	2.5	1.9	14.0	81.2	132.8	105.4	28.2	8.6	7.0
E-Flows - Maintainance Year, cms	12.2	12.5	11.1	6.9	5.9	21.7	77.3	126.0	111.6	29.4	14.9	11.8
E-Flows - Drought Year, cms	7.1	7.3	6.4	4.0	3.4	11.4	40.5	66.0	58.4	17.0	8.7	6.8

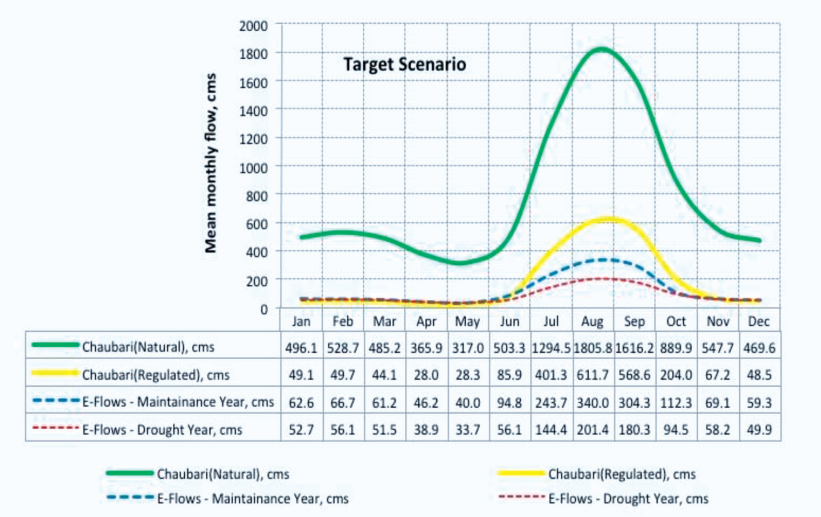
Agwaanpur(Natural), cms; Agwaanpur(Regulated), cms



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Katghar (Natural), cms	118.1	122.4	105.0	61.5	52.4	104.7	368.5	582.2	508.2	250.8	132.3	110.3
Katghar(Regulated), cms	10.8	11.0	8.3	3.5	2.8	16.8	100.6	165.7	138.1	41.8	12.3	9.6
E-Flows - Maintainance Year, cms	32.9	34.1	29.3	17.1	14.6	37.8	132.9	210.0	183.3	69.9	36.9	30.8
E-Flows - Drought Year, cms	7.0	7.2	6.2	3.6	3.1	16.0	56.3	89.0	77.7	14.8	7.8	6.5

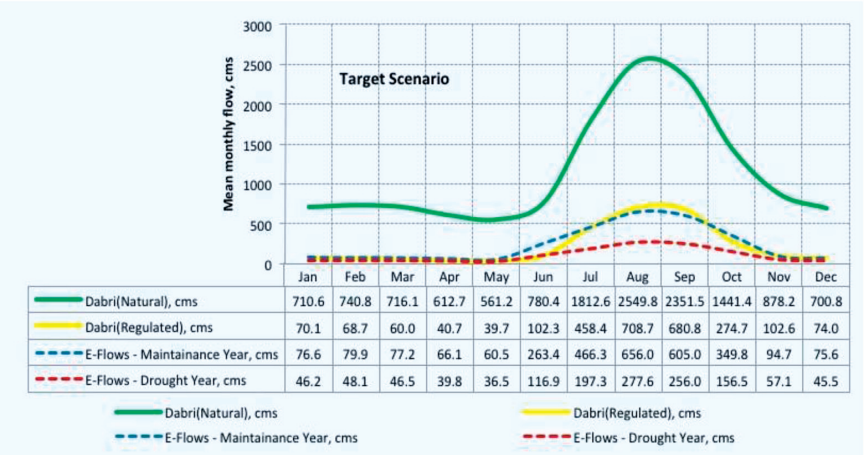
Katghar (Natural), cms; Katghar(Regulated), cms; E-Flows - Maintainance Year, cms; E-Flows - Drought Year, cms

- **Katghar at Moradabad city:** This is one of the most critical sites in terms of water quality and quantity. It is also the second-most important site from a socio-cultural perspective. The river health at this location is unsatisfactory and as per the above graph, the current flows regime is unable to meet the E-Flows requirements through the year.
- **Chaubari at Bareilly:** One of the important sites from a socio-cultural perspective. Given that a barrage is being constructed downstream of this site, it becomes a critical site for the study. The present-day flows are able to meet the E-Flows requirements from July to October only.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chaubari(Natural), cms	496.1	528.7	485.2	365.9	317.0	503.3	1294.5	1805.8	1616.2	889.9	547.7	469.6
Chaubari(Regulated), cms	49.1	49.7	44.1	28.0	28.3	85.9	401.3	611.7	568.6	204.0	67.2	48.5
E-Flows - Maintainance Year, cms	62.6	66.7	61.2	46.2	40.0	94.8	243.7	340.0	304.3	112.3	69.1	59.3
E-Flows - Drought Year, cms	52.7	56.1	51.5	38.9	33.7	56.1	144.4	201.4	180.3	94.5	58.2	49.9

- **Dabri:** The last E-Flows site on Ramganga, where the health of the river improves marginally from that of the sites upstream. The national aquatic animal- Ganges River Dolphin has been spotted close to this site during the wet season, so upkeep of this site is crucial. The site is also a good habitat for the Indian soft shell turtle, Nilssonia gangeticus; which is recorded only near the confluence of Ramganga and Ganga. As indicated in the adjoining graph, the present-day flows are not meeting E-Flows requirements from October to July. E-Flows requirements are met only for August and September.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dabri(Natural), cms	710.6	740.8	716.1	612.7	561.2	780.4	1812.6	2549.8	2351.5	1441.4	878.2	700.8
Dabri(Regulated), cms	70.1	68.7	60.0	40.7	39.7	102.3	458.4	708.7	680.8	274.7	102.6	74.0
E-Flows - Maintainance Year, cms	76.6	79.9	77.2	66.1	60.5	263.4	466.3	656.0	605.0	349.8	94.7	75.6
E-Flows - Drought Year, cms	46.2	48.1	46.5	39.8	36.5	116.9	197.3	277.6	256.0	156.5	57.1	45.5

The key motivation that prevailed in mountainous sites (Bhikiasain and Marchula – both in Uttarakhand) was largely related to the aquatic biodiversity aspects, i.e. fishes, their prey base, habitat conditions and life-phase requirements. Amongst the fishes, the Golden Mahseer has been one of the key considerations. The thematic group looking at socio-cultural and livelihood aspects concentrated on non-consumptive water uses and cultural rituals like bathing, cremation and worshiping. For the sites in the plains, Indian Major Carps and some native species were the key consideration from the aquatic biodiversity perspective. For the most downstream site, Dabri, the dolphins are also a factor in motivating E-Flows requirement during the wet season. At Chaubari and Katghar, the socio-cultural considerations played an important role in motivating E-Flows requirements.

Various aspects of geomorphology including the longitudinal and lateral connectivity, as well as bar complexities were considered for motivating E-Flows for various sites.

UNDERSTANDING TRADE-OFFS

For drawing up an Environmental Flows one-season site-specific demonstration and long- term implementation strategy, it was important to analyze trade-offs between Environmental Flows and already committed water allocations. The team recognized the pertinence of current committed water allocations; therefore,

refrained from considering the allocated water for E-Flows. Rather, the team attempted to estimate the amount of water available in the system, after meeting all the committed water requirements. The trade-off analysis was done keeping in-view one-season site-specific E-Flows demonstrations downstream of Hareoli barrage; however, strategies and approaches for long-term E-Flows realization across all the sites in Ramganga are also given in later chapters.

The choice of downstream of Hareoli barrage is an inevitable one, as this is the site which is immediately downstream of major water abstractions, and in the present-day scenario the river from this site is having lesser water. Therefore, any releases from the Hareoli barrage is expected to bring appreciable and notable change in the river health at this site.

ROAD MAP FOR IMPLEMENTATION

The Government of India and the National Mission for Clean Ganga has recognized 'aviral-dhara' or uninterrupted flows as one of the visions of the flagship Namami Gange programme, which aims to rejuvenate the Ganga. This has been one of the most welcomed policy declaration by the government.

Based on the E-Flows assessment and trade-offs analysis, a set of short-, medium- and long- term actions needed for restoring E-Flows, covering social, technical, policy and institutional aspects were developed. It builds on the experiences of Environmental Flows restoration across the globe.

Two strategies are presented below:

- **A proof-of-concept demonstration of lean-season E-Flows downstream of the Hareoli barrage**

Downstream of the Hareoli barrage is one of the sites chosen for the trade-offs analysis exercise, particularly since this site is only 20KM from the Kalagarh dam and any releases from the dam will show appreciable benefit at this site (i.e. downstream of Hareoli barrage). Such a demonstration will be useful for all the stakeholders to validate the framework suggested and to evaluate the benefits in terms of River Health. This will also help the U.P. Irrigation

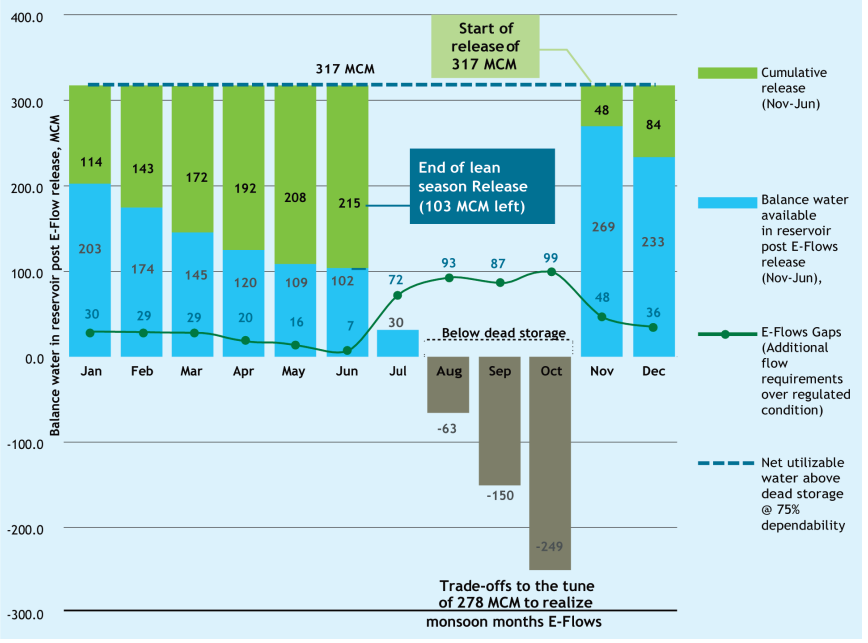
and Water Resources Department as well as others to review and strengthen a long-term plan for E-Flows restoration in the Ramganga. The trade-offs for the demonstration of E-Flows downstream of the Hareoli barrage takes three aspects into account:

a. Long-term water availability in the Kalagarh dam,

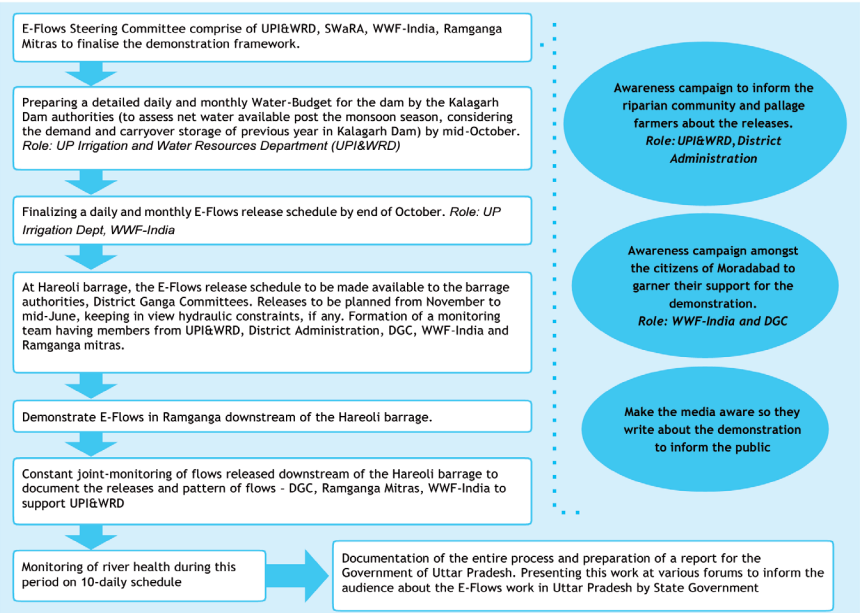
b. Water required to meet all the committed uses,

c. Available water in the dam above the Dead Storage and Normal Depletion levels

Based on this analysis, it was concluded that E-Flows at this site can be demonstrated for the entire lean season, starting from November to mid-June without affecting any current arrangement and commitment. This is depicted in the following graph.



Roadmap for demonstration of E-Flows



A Prospective Implementation Plan

As a first step towards implementation of E-Flows in the Ramganga, a demonstration pilot is proposed.

- **Long term E-Flows strategy**

A long term sustainable E-Flows strategy for a river like Ramganga, where surface-water and ground-water interaction is very strong (and not well understood) will require a combination of social, technical and institutional interventions. These aspects include:

a. Social

This calls for a strong demand management looking at irrigation water-use efficiency and yield enhancement, soil-health management in the command area of irrigation systems dependent on the Ramganga water resources. This will require large-scale awareness and capacity-building programmes for farmers with assistance from the agriculture extension systems.

b. Technical

Under this aspect, the 'supply-side management' needs to be focused, i.e. to consider rehabilitation and modernization of tertiary-level irrigation infrastructures (minors-outlets) that withdraws water from the Ramganga. Additionally, there will be a need to promote conjunctive use (of surface water and ground water for irrigation) along with groundwater regulation to support the base-flow contributions to the Ramganga.

c. Institutional

The implementation of the U.P. Participatory Irrigation Management (PIM) Act and promotion of water-use efficiency through Water Users Associations (WUAs) are going to be critical measures under this sub-head. Besides this, the concerned District Ganga Committees will be able to play a critical role in this initiative.

WAY FORWARD

As discussed, trade-offs for lean season E-Flows demonstration downstream of Hareoli barrage is manageable. Though long-term E-Flows implementation across different sites on the Ramganga will be a complex journey, there is hope that a combination of approaches can actually realise flows in the Ramganga. As a first step, WWF-India and its partners plan to engage and work with the NMCG and the Government of Uttar Pradesh and the UP State Irrigation and Water Resources Department in designing the E-Flows demonstration in Ramganga and making it operational. This will be the first of its kind organized E-Flows demonstration in India, and the state of Uttar Pradesh can lead the national and global discourse on E-Flows.

The E-Flows releases downstream of the Hareoli barrage would be critical to improve the health of river Ramganga, therefore as the first step, an E-Flows demonstration needs to be undertaken for one lean season, starting from November to May. A detailed plan of this is presented in Chapter 5. WWF-India, Ramganga Mitras, District Ganga Committees and the

U.P. Irrigation and Water Resources Department will closely

monitor and record the changes in the river system at this site, as well as at the Katghar site at Moradabad mainly to ascertain the benefits that will be achieved in terms of the health of the river Ramganga.

The integration of E-Flows requirements into the Ganga River Basin Management Plan (GRBMP) has been a stepping-stone in the recent past. It is envisaged that a long-term win for the E-Flows discourse would be its integration into basin-planning exercises at different river basins. As a long-term strategy, E-Flows needs to be integrated into the planning and policy discourse for water resources management at different levels, including at the national and state levels. One way is to have a comprehensive Ramganga River Basin Management Plan which integrates E-Flows in the water allocation policies.

Both the state and central governments, through their various schemes and programmes, are on facilitating water-use efficiency enhancements. Many of these schemes, if implemented, could deliver the vision of rivers with 'aviral jal pravah'.

We hope that this work will move the discourse on Environmental Flows from assessments to implementation in Ramganga and other rivers. As seen, it is important to understand the trade-offs and work out approaches to manage such trade-offs, if any. WWF-India and its partners remain committed to work with decision-makers and water-managers as well as all stakeholders to move on this path and realize the vision of healthy rivers in the country.

Team Members:

S. No.	Aspect	Team Members	Institution
1	Hydrology & Hydraulic Modeling	Dr. Sandhya Rao, Prof. A. K. Gosain, Mr. Arjit Mishra (formerly) and team	INRM Consultants, New Delhi (an incubated entity of IIT – Delhi)
2	Homogenous Zonation	Dr. Sandhya Rao, Prof. A.K. Gosain, Mr. Arjit Mishra (formerly) and team	INRM Consultants, New Delhi (an incubated entity of IIT – Delhi)

3	River Health and Water Quality	Prof. Vinod Tare, Mr. Suresh Kumar Gurjar & Dr. Vishal Kapoor	IIT – Kanpur
4	Fluvial Geomorphology	Prof. Rajiv Sinha Mr. Haridas Mohanta	IIT – Kanpur
5	Cross Section Surveys	Dr. Anurag Ohri, Mr. Lalji Yadav, Mr. Akhilesh Jaiswar and team	IIT – BHU, Varanasi
6	Socio-cultural and Livelihoods	Dr. Ravi Chopra Dr. Anil Gautam, Ms. Chicu L, Ms. Neha Khandekar and team	Peoples Science Institute – Dehradun
7	Biodiversity	• Prof. Prakash Nautiyal, Dr. Asheesh Shivam & Mr. Tarun Bisht – lower invertebrates (macro zoobenthos)	H N B Garhwal University, Srinagar CIFRI (Central Inland Fisheries Research Institute) – Allahabad
		• Dr. KD Joshi, Dr. Shyamal Das, Mr. Amaanullah Khan (fishes) • Dr. Sandeep Behera, Dr. Asghar Nawab and team (Dolphin and higher invertebrates)	WWF – India
8	Advisor	Prof. Jay O'Keeffe	Rhodes University, South Africa, formerly with UNESCO – IHE, Delft, Netherlands
9	Advisor – Hydrology and Contextual	Mr. Ravindra Kumar	Formerly with UP State Water Resources Agency
10	Overall Facilitation and Coordination	Mr Nitin Kaushal, with support From Mr Suresh Babu	WWF- India

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Vijai Saran

Drivers of Water Use Efficiency

Overall Water Resources Scenario

India sustains around 17% of the world population but has only around 4% of the world's fresh water resources. Even though India receives an average annual precipitation of about 1170 mm which corresponds to 4000 billion cubic metres (BCM) volume of water, there is considerable variation in distribution of rainfall, both temporally and spatially. Central Water Commission in 1993 made an assessment of average annual water availability in the country as 1869 BCM, out of which, it is estimated that owing to topographic, hydrological and other constraints, the utilizable water is 1122 BCM, comprising of 690 BCM of surface water and 432 BCM of replenishable ground water. Reassessment of water availability in India using spatial inputs has been recently carried out by Central Water Commission in collaboration with National Remote Sensing Centre, Hyderabad. The study report has assessed the average annual water resource of the basins for the period of 30 years (1985-2015) as 1999.20 BCM.

The quantity of utilizable water can be increased through non conventional approaches such as (i) Inter-Basin Transfer of Water from surplus to deficit basins wherever feasible (ii) Recycling and Reuse of waste water (iii) Desalination of saline water (iv) Artificial recharge of ground water, water harvesting, watershed development and revival of traditional water storage structures.

However, Climate change is likely to alter the hydrological cycle affecting spatial and temporal variations of water availability. The number of rainy days have been showing a decreasing trend and

about 75 to 80 % of the total rainfall occurs in a limited number of such rainy days. Groundwater recharge and other suggested approaches are of limited use to tackle temporal variability. Water from extreme events can only be stored by dams which would otherwise be lost as surface runoff. National Water Policy of India, formulated in 2012, also prescribes that the anticipated increase in variability in availability of water because of climate change should be dealt with by increasing water storage in its various forms, namely, soil moisture, ponds, ground water, small and large reservoirs and their combination.

Ganga basin, the largest basin in India, is also having a very large agricultural area with an irrigation system developed way back in 1850s, when the Upper Ganga Canal, which was considered the largest irrigation system at that time was developed. River Rejuvenation depends on flows and almost 80% of the water gets abstracted for irrigation and any improvement in water-use efficiency would lead to improved water quantity in river Ganga and help achieve the goal of 'Aviral Ganga'.

Water Demands of Various Sectors

Worldwide, Agriculture uses about 70% of available water resources. Developing countries require more water for agriculture and it is estimated that in India, irrigated agriculture consumes about 80% of total developed fresh water resources. With increase in population, urbanization and better standards of living, water demands for various uses are on the rise and will continue to do so. At the same time, the per capita availability of water has decreased from 5177 cu. m. /year in 1951 to 1545 cu. m. /year in 2011 and is projected to go down further. Water requirement for various sectors has been assessed by the National Commission on Irrigation and Water Resources Development (NCIWRD) in the year 1999 and by the Ministry Standing Sub-Committee of the MoWR for assessment of availability and requirement of water in the year 2000 as given in table 1.

Table 1

Sector	Water Demand in km3 (or BCM)					
	Standing Sub-Committee of MoWR			NCIWRD		
Year	2010	2025	2050	2010	2025	2050
Irrigation	688	910	1072	557	611	807
Drinking Water	56	73	102	43	62	111
Industry	12	23	73	37	67	81
Energy	5	15	130	19	33	70
Others	52	72	80	54	70	111
Total	813	1093	1447	710	843	1180

Irrigation requirement estimated by NCIWRD is on a lower side as compared to that estimated by the Standing Sub-Committee as it was assumed that the irrigation water use efficiency would increase to 60% from the present levels of 35 to 40%.

Demand Management is the key

Systematic development of available water resources was taken up since independence and in the process of planned development of water resources, live storage in the country has been built up from 15.6 BCM at the time of independence to present level of about 257.812 BCM. This has made a significant contribution in meeting water demand of various sectors in the country. Required live storage to utilise the utilizable surface water resources of 690 BCM is estimated to be around 450 BCM.

However, as postulated by the National Water Policy, 2012, 'given the limits on enhancing the availability of utilizable water resources and increased variability in supplies due to climate change, meeting the future needs will depend more on demand management'.

Inefficient use of water is one of the major concerns related to water resources sector in India requiring interventions at various levels. Improvement of water use efficiency is a thrust area for the Govt. of India as reflected in the unveiling of 'National Water Mission' under 'National Action Plan on Climate Change' with

'increasing water use efficiency by 20% in all sectors' as one of the five identified goals. The key identified strategies for achieving this goal are: research in area of increasing water use efficiency and maintaining its quality in agriculture, industry and domestic sector; incentivize recycling of water including wastewater; promotion of water efficient techniques and technologies; promotion of Water Regulatory Authorities for ensuring equitable water distribution and rational charges for water facilities; promotion of mandatory water audit including those for drinking water purposes; adequate provision for operation & maintenance of water resources projects; incentivize use of efficient irrigation practices etc. It is also proposed to set up a 'National Bureau of Water Use Efficiency' (NBWUE) which would evolve a system of efficiency labelling/certification for increasing water use efficiency in industrial and domestic sectors.

Irrigation sector has been struggling with low water use efficiency and poor standards of management and maintenance of infrastructure. Main causes of low irrigation efficiency can be attributed to the deficiencies in water delivery system, losses during conveyance and distribution, inequitable and untimely delivery of water, poor on-farm development, inappropriate methods of field application, lack of drainage etc. Any saving in water use in the irrigation sector releases substantial quantity of water for irrigating rain fed croplands or for meeting the increasing demand of other sectors as well as environmental flow requirement. Increasing water-use efficiency would make more water available for self cleansing of rivers through dilution and thereby contribute in rejuvenating our rivers.

Means for improving irrigation WUE – GoI initiatives

During 2015-16, Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) was launched by GoI with four components of Accelerated Irrigation Benefits Programme (AIBP), Har Khet Ko Pani (HKKP), Per Drop More Crop (PDMC) and Watershed Development with an aim to enhance physical access of water on farm and expand cultivable area under assured irrigation, improve on farm water use efficiency, introduce sustainable water conservation practices etc.

While PMKSY-AIBP & HKKP components are under DoWR, RD & GR, Ministry of Jal Shakti, PDMC component is under MoA & FW and Watershed Development component is under DoLR, MoRD. The HKKP component covers Command Area Development & Water Management (CAD&WM), Minor irrigation (both Surface and Groundwater) and Repair, Restoration and Renovation (RRR) of water bodies.

Under the PMKSY-AIBP, 99 prioritised MMI projects have been identified with a dedicated funding mechanism to complete them in a time bound manner. Drought Prone areas are given priority under PMKSY-AIBP with 54 out of 99 prioritised projects benefitting drought prone areas in 11 States. Many Extension, Renovation and Modernisation (ERM) projects have been accommodated to encourage lining of canals and adoption of Piped Irrigation Network (PIN) wherever technically feasible to help in improving conveyance efficiency of irrigation water. Notable initiatives taken up in the 99 prioritised projects include usage of underground pipelines in the last stretches of Kandi Canal project stage II of Punjab, extensive use of Underground Pipe Distribution Network (UGPDN) in Sardar Sarovar project of Gujarat to carry water from minor / sub-minors canal to farmer's field.

Central Water Commission in consultation with stakeholders has brought out 'Guidelines for Planning and Design of Piped Irrigation Network' for improving conveyance, distribution and application efficiencies of irrigation water. Piped Irrigation Network (PIN) system in comparison to Canal Irrigation Network (CIN) system offer advantages of higher WUE, regulated and controlled water supply for ensuring water to tail end farmers, minimal seepage and evaporation losses, minimal requirement of land acquisition etc.,

Field application efficiency of irrigation water can be enhanced by increasing area under Micro Irrigation. Efficiency of conventional canal water irrigation is reported to vary between 35% to 40%, while that of micro-irrigation varies from 60% to 90%, depending on the type of micro-irrigation used. Hence, any increase in the micro-irrigated proportion of command area will lead to overall improvement in irrigation water use efficiency. Adoption of Micro

Irrigation techniques may also lead to utilization of degraded or marginal lands, enhancement of both land and water productivity, energy savings in areas irrigated by groundwater, saving fertiliser through use of water soluble fertilizers through drip irrigation and income enhancement of farmers. It goes without saying that income enhancement of farmers will incentivise more farmers to adopt Micro Irrigation techniques.

Owing to high capital cost and the technicalities involved in design, operation and maintenance, the pace of its adoption of micro-irrigation was rather slow. Task Force on Micro Irrigation had estimated a potential of covering 69.5 m ha under micro irrigation. Till date around 10 million hectares of crop land has been covered under micro irrigation. Increase in area under Micro Irrigation technologies to enhance WUE, promotion of such technologies in water intensive crops and to increase agricultural productivity through precision water management through installation of devices like drips, sprinklers, pivots and rain-gums in the farms are the major objectives of Per Drop More Crop (PDMC) component of PMKSY. Physical achievements under PDMC component of PMKSY as obtained from dashboard of PDMC, MoA & FW are shown in Fig 1.

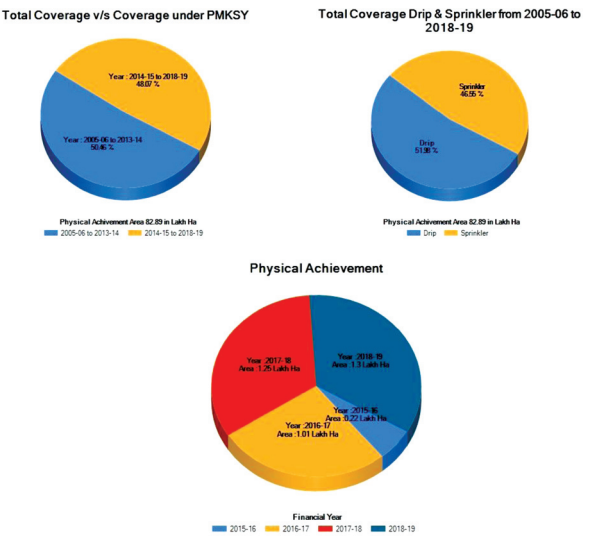

Fig 1

Group of Secretaries, in 2017, emphasized on target of 10 million ha under micro irrigation over 5 years which would require acceleration of the present pace of implementation. There is also a need for innovative ways of financing micro irrigation. GOI had set up a dedicated "Micro Irrigation Fund" which can be accessed by the States for innovative integrated projects, including projects in the Public Private Partnership (PPP) mode and also for incentivizing micro irrigation through an additional subsidy over and above the one available under Per Drop More Crop Component (PDMC) of PMKSY.

Another important step for improving the irrigation water use efficiency is by providing lined field channels to carry water to the farms from the minor canals under Command Area Development works which will overcome the losses encountered in the practice of flood irrigation. Besides, Participatory Irrigation Management (PIM) through strengthening of Water Users' Associations (WUAs) leads to optimal utilization of irrigation water and proper maintenance of field channels which in turn improves water use efficiency. WUAs must be provided financial assistance and handholding support so that they are able to maintain the field channels and prevent wastage of precious irrigation water.

Out of 99 prioritized PMKSY-AIBP projects, 86 have been included in Command Area Development & Water Management (CAD&WM) programme under HKKP component of PMKSY. Total CCA targeted in these 86 projects is about 42 lakh ha. Structural Interventions planned under CAD&WM programme includes survey, planning, design and execution of (i) On-Farm Development (OFD) works; (ii) Construction of field, intermediate & link drains; (iii) Correction of system deficiencies; (iv) Reclamation of waterlogged areas and (v) Micro Irrigation. Under Non-Structural Interventions activities are directed at strengthening of Participatory Irrigation Management (PIM) viz., (i) One time Functional Grant to the registered Water Users' Associations (WUAs); (ii) One time Infrastructure Grant to the registered WUAs; (iii) Trainings, demonstration, and adaptive trials with respect to water use efficiency, increased productivity, and sustainable irrigation in participatory environment.

Further a new Scheme, namely, 'Incentivization Scheme for Bridging Irrigation Gap (ISBIG)' has been proposed by erstwhile MoWR, RD & GR to take up the CAD works of other completed irrigation projects which is under consideration. ISBIG proposes that at the gross level at least 30% of the CCA under various projects be covered under micro irrigation instead of the present norm of minimum 10% CCA coverage of micro irrigation under 99 PMKSY. Whenever implemented the scheme will be helpful in increasing area under micro irrigation leading to increase in WUE.

Other drivers of WUE

CWC has been advocating promotion of cropping pattern based on water availability and has brought out relevant guidelines from time to time. CWC advocates that detailed soil survey/investigation are essential for land and irritability classification of the command which will help in identifying suitability of soil for irrigation and to know their likely behavior under irrigation, in deciding the appropriate cropping pattern, drainage requirements etc.,

Given the limitations of expansion of cropland in India and importance of irrigated agriculture in meeting the demand of food grains for growing population, irrigation water productivity assumes greater significance. A study on 'Water Productivity Mapping of Major Indian Crops' conducted by National Bank for Agriculture and Rural Development (NABARD) and Indian Council for Research on International Economic Relations (ICRIER), published in 2018, concluded that skewed incentive structures for water guzzling crops such as Paddy and Sugarcane led to their cultivation even in water scarce regions and restricting irrigation water availability for other major crops of the region. Further, the study says that relatively water abundant States in Eastern region lag behind in production of these crops as they have not been able to erect suitable procurement structures for Paddy or attract Sugar mills in their areas.

Govt. of Haryana has recently initiated a pilot project to encourage crop diversification and to reduce Paddy-Wheat rotation. Many State Governments in India provide free or subsidized power to farmers which has led to unsustainable practices such as overdrawal

of groundwater. Water is an economic good and its pricing should ensure its efficient use and reward conservation. National Water Policy 2012 advocates that 'equitable access to water for all and its fair pricing, for drinking and other uses such as sanitation, agricultural and industrial, should be arrived at through independent statutory Water Regulatory Authority, set up by each State, after wide ranging consultation with all stakeholders'. Few States such as Maharashtra and Gujarat have established such Authorities to regulate the use of water and promote water conservation. Further, recycle and reuse of water, including return flows, after treatment to specified standards, should be encouraged to improve overall Water Use Efficiency.

Conclusion

It follows from above discussion that for sustainable water resources management in India, efficient as well as productive water use is needed. Many efforts are underway to enhance the cropped area covered under micro irrigation, encourage adoption of piped irrigation network wherever feasible, execute command area development works, take up extension, renovation & modernisation of Irrigation projects and promote participatory Irrigation Management under various components of PMKSY, a flagship programme of the GoI. Further, long lasting solutions need to be considered through alignment of the cropping pattern with natural resources endowment of the region concerned, reallocation of water from lower value crops to higher value crops, effective crop produce procurement policy, effective regulation and pricing of electricity and water and promotion of recycle & reuse of waste water.

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* Disclaimer: The views / opinion expressed in the paper are personal views of the author and do not necessarily reflect those of organization to which he belongs.

SECTION II
INNOVATIONS

R Madhava Kumar

Sustainable Development and Operation of Waste Water Treatment

Genesis

At the beginning of the 21st century, the world faces a water quality crisis resulting from continuous population growth, urbanization, land use change, industrialization, food production practices, increased living standards and poor water use practices and wastewater management strategies. Wastewater management (or the lack thereof) has a direct impact on the biological diversity of aquatic water ecosystems including our rivers there by disrupting the fundamental integrity of our life support systems, on which a wide range of sectors, from urban development to food production and industry, depend. It is essential that wastewater management be considered as part of an integrated, full life cycle, of urban water ecosystem that operates across all three dimensions of sustainable development (social, economic and environmental), geographical borders, and includes both freshwater and marine waters.

Despite the enactment of the 74th constitutional amendment that devolves greater powers and responsibilities to local governments, Urban Local Bodies (ULBs) are themselves not in a position to deliver the entire infrastructure that their cities or towns require. Part of this can be attributed to weak financial abilities of the ULB's. In addition, the capabilities or competencies of most ULB staff are often inadequate when compared to the challenges, that the development and implementation of large scale, complex infrastructure systems present. This has plagued the earlier efforts to set up sewage treatment infrastructure under the erstwhile Ganga Action Plans (GAP), designed to abate the pollution arising from untreated domestic sewage flowing into the river. Despite

the interventions made under GAPs to address the, then gaps in the sewage treatment systems, most of the assets created failed to discharge the expected treatment services due to various factors such as lack of ownership, lesser support for sustainability of assets, and sub optimal performance of the treatment infrastructure etc.

Ganga Action Plan (GAP) launched in 1985 largely focused on creating sewerage infrastructure assets, and the State Governments and/or urban local bodies (ULBs) are expected to operate and maintain. This approach was primarily driven with a focus on developing the much-needed infrastructure, but failed to adequately invest in their operation and maintenance. As a result, the sustainability of the operations was not ensured. Most of these assets were either defunct or partially operational and not meeting the desired water quality parameters.

While formulating the Namami Gange Programme, the Government was faced with a unique challenge, that despite allocating significant resources over decades, there was no tangible impact on the pollution levels in the Ganga. There was a need to identify a sustainable and dependable solution that addresses four basic requirements, viz.; a) assurance of the desired levels of performance; b) assurance of the sustainability of these performance levels; c) distinct accountability at the entity level; and d) sustainability- both technical and financial, of the solution. The realization was that mere funding for the development & operation of the treatment assets may not deliver the optimal outcomes. Hybrid Annuity based PPP mode(HAM) of development for sewage treatment systems was an inevitable step to address the lacunae in the earlier attempts of Ganga Rejuvenation.

What is Hybrid Annuity Based PPP Model?

Under the HAM, a significant portion of the capital cost of the project is required to be financed by the private developer. This amount is paid by the Government to the developer in equal instalments over the term of the concession, subject to sustained performance. This portion was fixed at 60% for the HAM based public-private partnership projects under the Namami Gange

programme. National Mission for Clean Ganga, (NMCG) pays 40% of the project capital cost in 4 or more equal instalments during the construction period.

HAM has several advantages over, the other implementation models such as EPC and DBOT:

- It transfers more responsibility to the private sector, including financing responsibility to the extent of 60%. Since the private sector has a greater "skin in the game", they are more likely to sustain the level of performance
- Learning from the experience of the Annuity programmme of National Highways, it was decided that 40% of the capital cost would be borne by NMCG to ease the financing burden for the private sector.
- The structure provides detailed "Key Performance Indicators" that must be met by the private developer, failing which an elaborate system of penalties has been designed
- There is a fair allocation of responsibilities between the Government and the Private Developers, and the private developer is accountable for all factors under its control, but not held liable for events beyond its control.
- A major feature of the model is the tangible federal cooperation between the Central and the State Governments. While the state Government entities continue to be the Executing Agencies (EAs) for the projects, all funding, including contingent liabilities (in the form of potential termination payments) are the responsibility of NMCG. Unlike PPP projects in other sectors, NMCG enters in to tripartite concession agreement with the Executing Agencies and Concessionaires for execution of this developmental model. This is the single most important element of the HAM design, that has led to a significant interest from the investors and lenders.

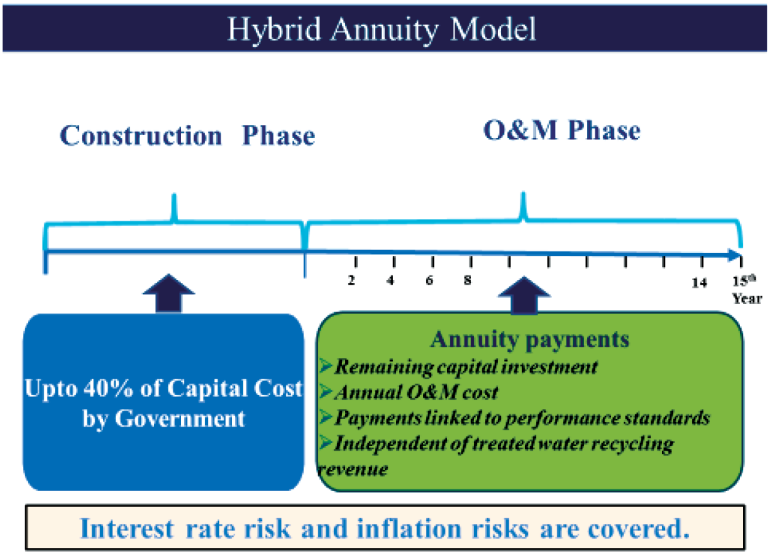


Figure 1: HAM concept

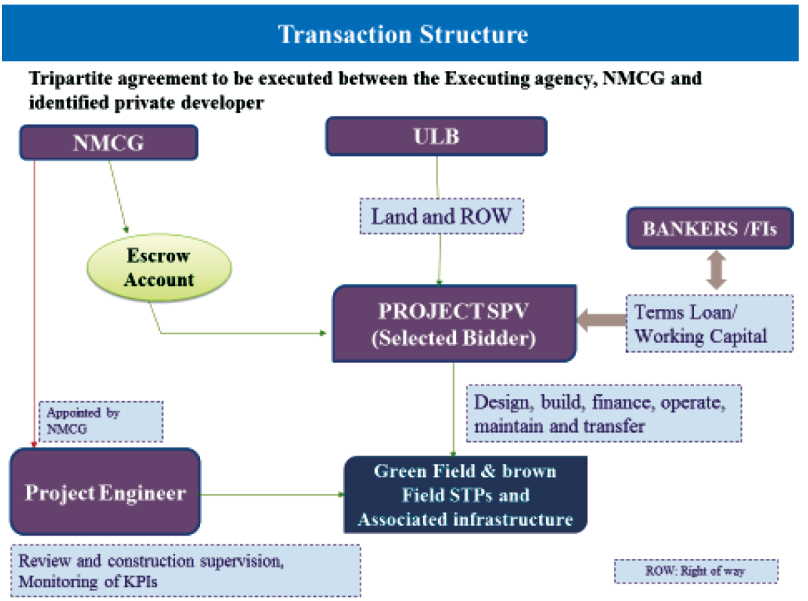


Figure 2: Transaction Structure under HAM.

The Journey:

Investors evaluate an infrastructure or urban development opportunity in relation to other asset classes such as government

bonds, equity markets and private equity. In other words, investors evaluate not just how to invest in infrastructure but whether to invest in it at all. Many investors, particularly long-term ones such as pension funds, insurance companies and sovereign wealth funds, want to allocate more capital to infrastructure, but struggle to find bankable projects. It is imperative to appreciate the perspective of investors, who assess infrastructure projects against a multitude of options in other asset classes and countries. A credible vision and clear project pipeline can mitigate investor uncertainty and public skepticism and can trigger productive collaboration between government and investors. Hence under Namami Gange programme following specific actions were undertaken to make the implementation of HAM mode successful:

- ✓ **Credible project pipeline:** Ongoing project pipeline linked to the objective of Ganga Rejuvenation and strategy to enhance attractiveness was developed. A set of realistic, comprehensive opportunities instead of ad hoc procurements to help investors see value in building capabilities and expertise under the programme was evolved. Till date National Mission for Clean Ganga(NMCG) has sanctioned total 29 projects worth of Rs 10816 Cr(US $ 1.4 Bn) to setup new treatment capacity of close to 1600 Million Liters per Day(MLD) and rehabilitation of existing treatment capacity of 900 MLD. These projects were combined to 18 packages for procurement purpose, in order to achieve economies of scale, bankability and make them attractive to the investors and financial institutions.
- ✓ **Viable role for investors:** Next step was prioritizing projects for private sector financing that are most likely to interest investors and achieve value for money for the public. First set of projects- 82 MLD Sewage Treatment Plant(STP) in Haridwar, Uttarkhand and 50 MLD STP at Varanasi, Uttar Pradesh attracted many investors. But the real challenge was to keep the same momentum for small projects. Hence cluster approach was adopted, by packaging nearby towns for procurement purpose. For example 32 MLD STP in Mirzapur and 21 MLD STP in Ghazipur were packaged together for bidding to attract small, medium and large players in the sewage treatment sector.

- ✓ **Robust Procurement process:** Bidding for a PPP project is time-consuming and costly affair for investors. Lack of standardization is a major obstacle to an efficient process. Enhancing transactional capacity and efficiency at the Executing Agency level needs standardization in the procurement process. The bid documents for procurement under HAM were standardized to a great extent, such that only project/site specific changes have to be made in each procurement. World Bank has also approved the documents developed by NMCG, as standard bidding documents for procurement of bank funded projects under Namami Gange programme. In addition to this NMCG has appointed suitable Transaction Advisors for assisting the Executing Agencies, in procuring the projects in a fair and transparent manner. Standardization also helped the investors to assess the risk of nonperformance, renegotiation, takeover etc.
- ✓ **Develop an investor value proposition:** Investors evaluate the risk-return of an infrastructure opportunity in relation to investments in other asset classes and jurisdictions. To develop a strong investor value proposition at the level of an individual project two crucial issues were addressed:
    - **Financial returns from the investor perspective:** Projects were analyzed from an investor's perspective to determine financial viability, support risk-allocation decisions and benchmark risk-return compared with other investment opportunities but without underplaying the importance of securing public value.
    - **Risk allocation:** A standard methodology for allocating risk was developed– a set of "guiding principles" to determine the level of risk allocation optimal to both deliver value for money and provide investors with an appropriate risk-return. . In the current environment, the allocation of financing risk and demand risk is of particular importance. Unlike the PPP projects in other sectors, there is no market for realizing the sewage treatment charges from the households by any private investor. Considering this Government of India (GOI) has approved Namami Gange as 100% funded central

sector programme, so that both capital cost and Operation & Maintenance(O &M) cost for 15 years of operation of treatment assets are fully funded under the programme. To manage financing risk, GOI has approved to set up a payment security mechanism under HAM, by creating a dedicated Escrow Account for each project/package and depositing an amount equivalent to two milestone payments during construction period and two year Annuity payment and O &M charges during 15 year Operations period. Further the interest rate risk and inflation risk are covered through additional payment of interest on the reducing balance of 60% capital cost at the rate of 3% over State Bank of India Marginal Cost of funds based Lending Rate (SBI-MCLR) and indexing both capital cost and O &M cost by a combination of Consumer Price Index(CPI) and Wholesale Price Index(WPI).

- ✓ **Market sounding:** One of the main success factors in implementation of HAM model was early Market sounding with potential investors. NMCG has conducted several interactive sessions with the potential investors & financial institutions to learn more about investor preferences and determine refinements needed prior to the tender process. Based on the inputs received from such interactions, the tender documents and procurement process are continuously reviewed and refined to ensure robustness and bankability. Apart from this project specific pre bid meetings were conducted for each package/project. In the first set of projects- 50 MLD STP in Varanasi and 82 MLD STP in Haridwar, about 800 queries were replied in the pre bid meeting.
- ✓ **Value based selection criteria:** The selection of the developer is through lowest price bid for the entire life cycle cost of the STP for both effective development and efficient operations. The bidder is required to quote for capital cost for construction and first/one month O &M Cost in the bid so that the quotes are at current prices. The one month O &M cost is multiplied by 180 months to arrive at the total O &M cost and added to

the capital cost for arriving at the lowest bid price cost. One of the major component of the O &M charges is the power cost. In order to optimize the power consumption, the bid process requires the bidder to quote minimum power guarantee against various flows and pollution loads (BOD) and average of these are considered for evaluation purpose. To ease the cash flow of the concessionaire and to avoid any undue advantage during operation, the actual power charges paid by the concessionaire is kept as a pass through, subject to the limit of guaranteed energy consumption quoted in the bid. This approach, along with penalty for consumption over and above the guaranteed energy consumption limits and mandatory bio gas based power generation for STPs above 40 MLD capacity, will ensure efficient and effective usage of electricity.

- ✓ **Robust qualification criteria:** The qualification criteria for selection of developer has been refined and adopted to suit to the availability of STP players in the market. While initial project procurement focused mainly on the experience in development of STPs of certain predefined capacity and financial capacity(net worth), the recent reforms adopted in the tender process after the market consultation conducted on 30th April 2019, include a comprehensive evaluation in the lines of PPP procurement process akin to other infrastructure sector in the country. The latest reforms have encouraged many infrastructure investment firms/funds to participate in the bidding process, by engaging with a suitable STP operator through sub-contractor route.
- ✓ **Performance based contracting:** Like any other PPP projects, the HAM model for sewage treatment under Namami Gange programme prescribes clear and objective Key Performance Indicators(KPIs) for measuring the outcome of the project. Both the Annuity and O & M payments are linked to the performance of the STP. Payments are subject to the achievement of KPIs .i.e. pre-determined treated effluent quality parameters such as BOD, COD, pH, Coliform level etc. Non achievement of these KPIs may lead to imposition of progressive penalty/liquidated damages and continued non-performance beyond a period can

lead to termination of the contract. At the same time the contract provides reasonable and justified time to the concessionaire, for restoring the plant operations during the operations period, before declaring nonperformance. However there is no penalty/ termination for not meeting the KPIs, if there is variation in input volume and quality of raw sewage beyond a certain prescribed level.

- ✓ **Additional incentives:** It is also proposed to develop a market for treated waste water for non-potable purposes and if the revenue generated through this measure is substantial, the same may be used for servicing future annuities. The concessionaire is incentivized to recycle/reuse the treated water for non-potable purpose and the sludge for other uses apart from generating bio gas based power. While the concessionaire is free to sell and realize the revenue from disposal of sludge, a small portion of revenue realized (10%) from the sale of treated waste water needs to be shared with the project Executing Agency/NMCG. These revenues are independent of the Annuity and O &M charges paid by NMCG. Further expediting and completing the construction of STPs before the scheduled completion time will entitle a payment of bonus for the same.
- ✓ **Ensuring Quality:** In order to ensure quality of construction, NMCG is appointing independent Project Engineers (PEs) during construction and operation period of the STPs. These PEs will assist the projects Executing Agencies in supervising the construction effectiveness and quality. Apart from this, the engineering designs and drawings will be vetted by an institution of repute such as Indian Institute of Technologies(IITs), before final approval.

Status of projects:

So far NMCG has approved 29 projects worth of Rs 10816 Cr(US $ 1.4 Bn) to setup new treatment capacity of close to 1600 Million Liters per Day (MLD) and rehabilitation of existing treatment capacity of 900 MLD. These projects were combined to 18 packages for procurement purpose. Out of these, 7 packages have already

been awarded, bids received for 3 packages and balance 8 are under tendering. The first set of projects under HAM include 50 MLD STP at Varanasi and 82 MLD STP at Hairdwar. The concession agreement for these projects were signed on 11th October 2017. While the commissioning of Haridwar STP projects will be attained by February 2020, Varanasi STP is progressing in its fourth and final milestone.

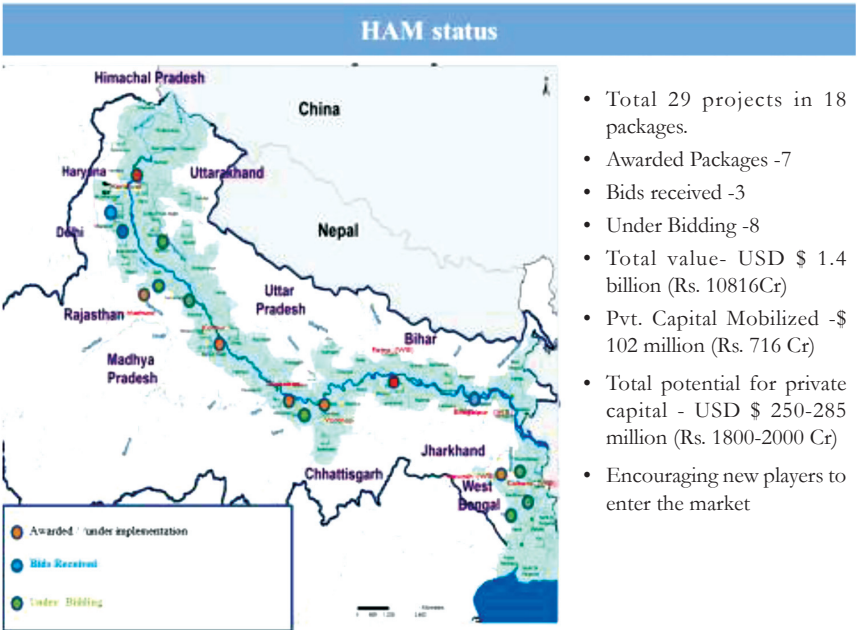


Figure 3: Status of HAM Projects

Roll-out of One city One operator under HAM – An Initiative to improve Governance in Urban Waste Water Management.

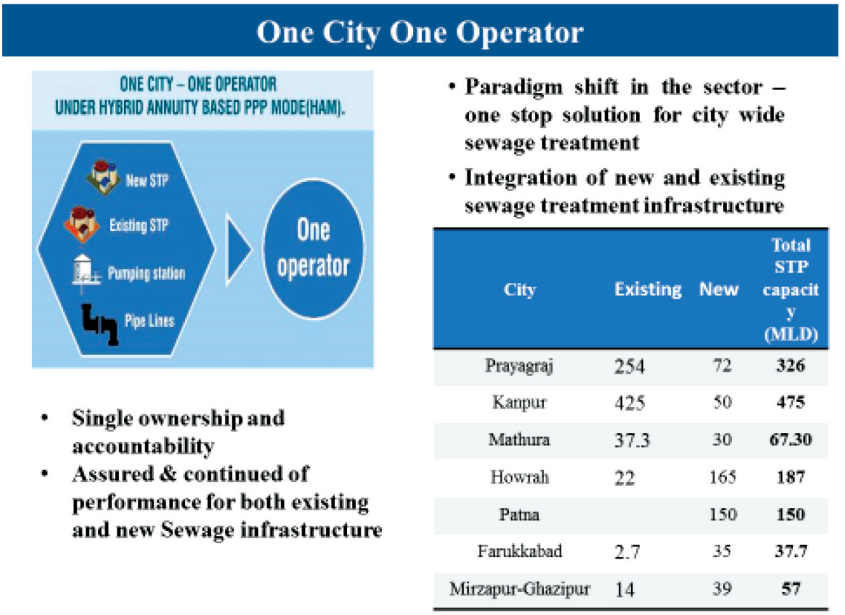
Learning form the experience of the first set of projects , NMCG has moved one step ahead by adopting the concept of 'One City - One Operator' by integrating the development of new STPs with the existing treatment infrastructure in the city/town under HAM, with an aim of achieving "no untreated sewage shall enter in to the river Ganga".

Mathura sewage scheme under HAM is the first of its kind project in the history of waste water treatment in the nation, for integrating the rehabilitation and operation of existing treatment infrastructure along with the development of new STPs. The project has also a capstone component of a 20 MLD Tertiary Treatment Plant (TTP), for supply of treated waste water to Mathura Refinery of Indian Oil Corporation Limited for non-potable purpose. The integrated Mathura project will act as a role model for a sustainable and futuristic developmental aspirations in the waste water sector of the country. The project has already achieved three construction milestones.

Other major cities in which the 'One City - One Operator' concept was implemented include, Pryagraj (256 MLD existing and 72 MLD new STPs), Kanpur(425 MLD existing and 50 MLD new STPs), Howrah- Bally- Baranagar & Kamarhati(22 MLD exisitng and 165 MLD new STPs) etc. Works in Kanpur and Prayagraj have already started.

Advantages of One city One Operator:

- Singular Accountability and ownership for the operation of entire sewage treatment assets of a city.
- Integration of existing assets will ensure rehabilitation/repair and long terms O & M along with the new assets.
- Key performance indicators for both existing and new infrastructure will ensure the treated water meeting the prescribed quality standards.
- Bigger project size will attract credible and established players in the industry.
- Better control by the Urban Local Bodies/Jal Nigams on the performance monitoring.
- Assured and better services to the inhabitants of the town.
- Opportunity to explore the possibility of reuse/recycle of treated waste water.



City	Existing	New	Total STP capacity (MLD)
Prayagraj	254	72	**326**
Kanpur	425	50	**475**
Mathura	37.3	30	**67.30**
Howrah	22	165	**187**
Patna		150	**150**
Farukkabad	2.7	35	**37.7**
Mirzapur-Ghazipur	14	39	**57**

Figure 4: 'One City- One Operator' model for improving governance and performance in sewage sector

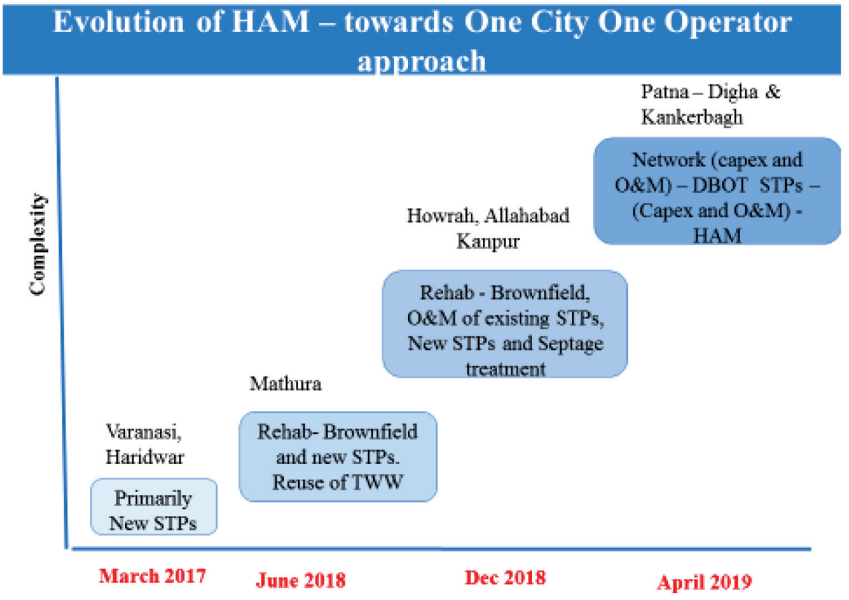


Figure 5: Evolution of HAM

International Collaborations & Recognitions:

The HAM model for waste water treatment has gained recognition both at national and global levels as a sustainable model for delivering urban waste water management services. Many international institutions including multilateral agencies have shown interest in working with NMCG for the successful development of the model. In fact the Transaction Advisory for first set of projects – 50 MLD STP at Varanasi, 82 MLD STP at Haridwar, 30 MLD STP & 20 MLD TTP in Mathura were provided by International Finance Corporation(IFC), a sister concern of World Bank. Apart from this many leading multinational consultancy organizations such as Deloitte, PWC, AT Kearney, KPMG etc were engaged by NMCG for successful project structuring and procurement.

HAM under Namami Gange has been recognized within the World Bank Group for innovative financing and has been awarded the Sustainable Development Vice Presidency Unit (VPU) Award for 2017-18. The Varanasi 50 MLD STP under HAM has been rewarded with recognized with the IJ Global Award - Asia Pacific Water Deal of the year 2017, by the International Infrastructure Journal, a leading global publisher in infrastructure sector. Further NMCG has been chosen as the Distinction Public Water Agency of the year 2019, by Global Water Intelligence (GWI) for adopting innovative approaches in the waste water treatment sector.

Conclusions and Way Forward

In any given setting, developing an overall wastewater management plan, encompassing wherever possible all wastewater components, should be undertaken based on appropriate boundaries. This may be a city or urban area, or conurbation. In any event, an appropriate administrative unit is needed to ensure effective oversight in design and operation. The systems must be flexible to accommodate new populations and sources, and indeed allow communities to have access to an improved level of service. The traditional asset procurement model will not help in delivering the waste water treatment services in the modern era. There is a dire need to convert the procurement to service model. HAM is the first step in this direction. However for

success of this model, it is important to adopt HAM at the national level with appropriate funding mechanisms.

Wastewater, in many cases, is rich in recoverable materials. This may be the nutrient value of domestic wastewater or indeed a particular fraction of an industrial discharge. In many regions the use of wastewater in agriculture is well-understood, albeit in a way that carries significant health risks. What is needed is a better matching of what is available to the needed reuse applications. Government of India has taken certain steps in this direction such as mandating the thermal power plants situated within the 50 Kms radius of STPs to use the treated waste water for cooling and other non-potable purpose through the notification in the Tariff Policy 2016. Some water scarce states have taken HAM model for recycling the sewage water for industrial usage. But the size is not sufficient enough to achieve the economies of scale and reduced treatment cost. There is a huge potential for the recycled waste water market in the nation.

Wastewater needs to be more fully recognized within the overall water cycle, as one of the greatest untapped opportunities to enhance sustainable development. There is now a growing realization that the opportunities that effective wastewater treatment and reuse could bring to sustainable development could be achieved with a concerted effort and more political will. This should be combined with the imposition of user charges/sewage treatment charges under the 'Polluter Pays Principle' for long term sustainability of the assets created.

At the same time there is a need to widen the market participation. Waste water treatment is a ULB subject and hence the players are small & local and most of them are EPC contractors with less interest in investment projects. There are few large multinational layers such as VA Tech Wabagh, Veolia, SUEZ, Thoshiba etc. Experience in Namami Gange programme indicates, that multitude of projects and time are required to analyze how far these multinationals could be cost effective in a developing nation like India. NMCG has attempted to widen the market by bringing suitable reforms in the qualification criteria and allowing the subcontractor route for the EPC players to participate in the process. But this effort needs further strengthening so that more indigenous developers emerge in this market.

The PPP in other infrastructure sectors such as Highways, Ports, Air Ports have slowed down due various factors such as over exposure of risk, high costs, project delays, land issues etc. Lending Institutions have become more cautious as some of the earlier investments have turned NPAs. The slowdown of PPP in other infrastructure sector has a cascading effect on the waste water treatment investment projects as well resulting lesser involvement of Public Sector Banks in project funding. While many Private Sector banks and Public Finance Institutions have contributed to the Financial Closure in HAM projects under Namami Gange programme, the involvement of Public sector Banks is taking time. This is further impeded by the one of the master circulars issued by RBI in 2016 which require the banks to only fund those PPP projects that have an independent revenue stream. This circular was issued before the introduction of HAM in Highways sector. It is pertinent to mention that HAM model by default is not dependent on any independent revenue stream and supported by specific fund allocation from Government. Considering the volume of investment and the environmental necessity to invest in waste water sector it is high time to declare the waste water sector as a priority sector for project funding and remove regulatory and fiduciary obstacles.

Finally the concerned agencies responsible for delivering the treatment services – Urban Local Bodies/Executing Agencies needs to be strengthened. Most of these ULBs do not have the technical knowledge, financial capacity and transaction wherewithal for adopting and implementing the PPP mode of development. It is time to adopt suitable policy measures and time bound actions for rationalizing the existence of ULBs by strengthening their governance, financial and service capacities. It is important to build suitable incentive and penalty mechanism for adopting the reforms envisioned in various development programmes so that the ULBs do not pollute our precious natural water ecosystems.

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Victor R Shinde and Others*

Reviving 'the connect' between River, City and its People

Ganga basin is the largest river basin in India in terms of catchment area, constituting 26% of the country's landmass and supporting more than 43% of its population. The basin extends over 4 countries namely India, Nepal, Bangladesh & China and its 79% area lies in India covering 11 states. River Ganga, undoubtedly the most sacred river in India, provides physical & spiritual sustenance for Indians. It has always represented the most significant sacred river with many religious centres having developed on its banks. It is widespread belief that river Ganga has the ability to purify all that comes in contact with it. However, the extreme overuse and misuse of its water, has led to adverse impacts on the health of river and the population sustained by it. As is well known, great cities and civilisations have developed on the banks of rivers throughout the history of mankind. But this very process of development of urban settlements also brings in increasing pressure on the natural system - rivers being the most important. It is important to study the interplay of urbanisation and river rejuvenation, the connect between river and city. Naturally, this connect would be interlinked with people who live in the city and surrounding areas.

The Government of India, through Namami Gange Programme, has given a much needed push for rejuvenation of River Ganga. It has allocated significant financial resources, INR 200 Million and adopted an integrated Ganga rejuvenation approach addressing various aspects such as Municipal Waste Water, Solid waste and Industrial Effluents Management, Biodiversity Conservation, Afforestation,

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Rural Sanitation, River Front Management, Capacity Building, Development / Rehabilitation of Ghats & Crematoria etc. The National Mission for Clean Ganga (NMCG), an Authority constituted by Government of India as the nodal agency for effective abatement of pollution and rejuvenation of the River Ganga, is implementing the Government's mandate for Ganga Rejuvenation.

NMCG while developing the interventions under the integrated Namami Gange Mission drew upon the National Ganga River Basin Management Plan developed by a consortium of 7 Indian Institutes of Technology (IITs). Various Short, Medium and Long term interventions were thought. The immediate attention was on reducing and eliminating polluted flow into river. While sustainability of sewerage infrastructure was ensured by including long term (15 years) Operation and Maintenance of assets created as part of project, improving further with introducing Hybrid Annuity based PPP and city wide composite contracts; it has been realised that the real challenge to be addressed in long run would be to make the Urban local bodies capable enough to themselves integrate river health into city /urban planning process.

Multiplicity of development plans from various departments, tend to overlook the broader picture of river rejuvenation. To maintain a long time perspective to River planning, it has been felt that the cities themselves should acknowledge River as part of their city boundary and involve integrated river management as part of their master planning processes.

The Urban River Management plan with this background, was envisaged to bring together respective city urban development plans and projects of the city in terms of effects and impacts on the river, under one roof. It was also felt, a necessity for the cities to acknowledge and own River rejuvenation as their mandate for comprehensive long term planning in their Master planning process. The first mention of URMP was made in one of the reports of IIT consortium.

What is a river?

Cities across the world have most often begun their development

journey on the banks of water bodies. The natural rhythms of the river were mirrored in the lifecycles of riverine citizens influencing local cultural and religious practices. From Indus valley civilization in India to Nile for Egyptians, Tigris and Euphrates for Mesopotamians, Yangtze for Chinese, rivers have been the focal point stemming not only sustenance but ready means of communication, a channel for civilizations to come together. Where riverine and river dependent cities developed, the environmental and social importance of the river was revered among communities. Several traditional practices were in tune with respecting rivers and water bodies as divine since our sustenance depended on them.

'The connect' between River and people rapidly declined post industrialization and the stewardship and care for rivers undertaken by citizens slowly disappeared. In its place, urbanization brought along a more commodified view of the river, where its waters were extracted for various functions and returned in a diminished and polluted form. Furthermore, rivers and streams were devalued in many cities and were realigned, channelized, covered up and essentially removed from view for economic benefit. The river has now become a means for water to sustain cities, the sewers that carry away a city's waste or as power sources. The modern city grew so big that rivers got lost into it, the city has turned its back on the river. Meanwhile it has urbanized over the lands belonging to tanks, water bodies and ponds that existed within the social urban fabric.

Water shortages, flooding and watercourse pollution are all a result of the troubled interaction between cities and their river(s) and associated ecosystems. Degradation of urban environmental heritage has started impacting the dependent cultural heritage. For example, Indians regard the River Ganga as a divine body and millions enter the holy waters of the river from constructed Ghats to bathe, as well as drink the river water as part of cultural heritage. However, River Ganga's degraded environmental heritage poses a grave threat to these physical spaces and practices which make up the cultural heritage of the region. Urban environmental and associated cultural heritage functions (e.g., flood storage, water purification and supply, wildlife habitat, fishing, bathing and recreation) are difficult to restore

once they are lost or damaged. The Namami Gange and other similar programs are trying to build a movement towards restoring and conserving urban environmental and associated cultural heritage that have been damaged over time.

There is growing consensus that cities must prioritize the restoration and conservation of environmental and associated historical heritage of the River for current and future generations. The fundamental identity of the river is not just to be seen as a carrier of water but as a complex ecosystem which sustains a thriving habitat. It enriches and nourishes aquatic life, its flow carrying essential sediments to the plains which grow food, providing livelihood for the people. Cities have to start looking beyond just economic benefits and renew their relationship with the River to accrue the tangible and intangible benefits of what nature has to offer.

The need for Integrated River Management

In order to restore the original vitality of the River ecosystem, and to build a case for the river-sensitive sustainable urbanization, it was felt that leveraging the cultural and traditional values of the River was fundamental. From experiences within the country and around the world, it is becoming increasingly evident that economic development does not have to come at the cost of the environment. In fact, true sustainable economic development will be impossible to achieve without harmonizing environmental considerations. Not all cities are blessed with rivers. River cities, therefore, have an added opportunity to leverage on a natural asset, and turn the city into a unique urban form. Planning for (and conserving) these assets should, therefore, be an integral part of the city's vision, as it moves up the urbanization ladder.

Urban Planning needs to be robust, sensitive and account for ecological sustainability. It also has to be flexible, something which has generally been lacking in our master plans inherited from British period. It has to be futuristic and regional considerations and inevitable growth of peri-urban areas also need to be accounted for. A prosperous city would ultimately have to be environmentally sustainable as well. "Cities can be sources of environmental problems

within and beyond their jurisdictions, but they are also best placed to provide most of the solutions. Environmentally sustainable cities are able to strike a healthy balance between economic growth and environmental preservation, in the process facilitating both prosperity and resilience, including to the climate change." (UN-Habitat, Cities and Climate Change: Policy Directions, Abridged edition, Earthscan, London)

Most cities have long-term vision plans, which outline the broad aspirations of the city, and the direction it should take in order to achieve those. An analysis of Master plans of prominent Indian cities brings out the inadequate attention that a River receives in their long term planning process. A river, which sustains the city with water, ecology, livelihood, economic benefits, weaving through the very character of the city, does not find prominence or mention in its planning. It is evident from the state of the river from when it enters, till the time it crosses the city boundaries, that the current city planning practices have not done justice to recognizing the river as part of its planning. A basic River-City connect showing a web of interdependency between water, river, city, citizens and their livelihood is shown below in Figure 1 –

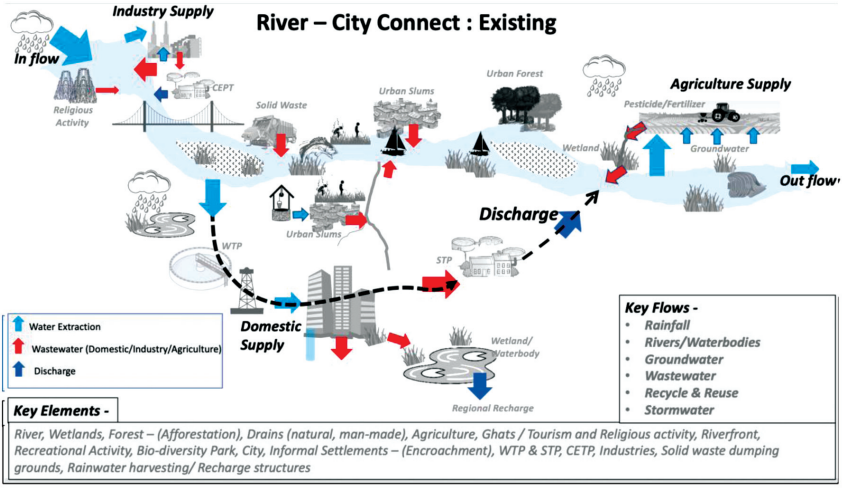

Figure 1: River City connect: Existing

As glanced, there are several concerns. First, untreated wastewater from domestic units, industries and agricultural fields finds its way into the river. Second, unauthorized colonies and slum settlements along the riverbanks add to the pollution problem. Third, water is abstracted indiscriminately for various uses, without a thought for the carrying capacity of the river. Fourth, there is hardly any recycling and reuse of water. Fifth, improper solid waste management increases the pollutant load in the river. Given its significance for human civilization, improving the health of river is, therefore gaining increasing international prominence, and becoming a prime mandate of governments all over the globe, including that of India. The 2030 Developmental Agenda also emphasizes on river conservation and restoration through the Sustainable Development Goal 6.

The thrust showed be on inculcating a sense of responsible urban development that shows respect to the river. A desired river-city interaction as seen below in Figure 2 can be one of the many changes required in the urban river management.

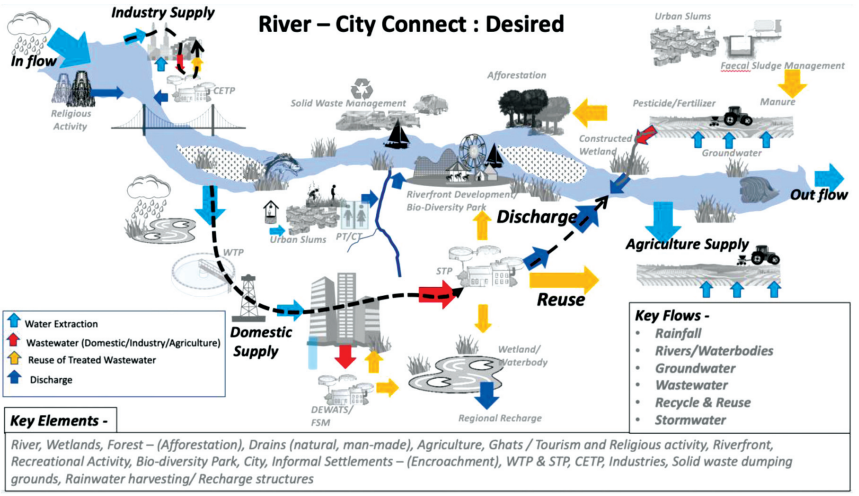

Figure 2: River City connect: Desired

As seen all wastewater is treated and disposed safely, making the river pollution free. There is adequate wastewater recycling and reuse that reduces the stress on the river. Both centralized and de-centralized solutions are used to manage the sanitation in the city.

All River towns should aspire to achieve this state.

Previous Work on the Urban River Management Plan

A consortium of IITs, led by IIT Kanpur has published general guidelines for Class I towns (population greater than 1 lakh) for the development of URMPs. The guidelines include recommendations as follows:

- Removal of encroachments and land acquisition for riverbank beautification and related development works.
- Restriction/banning of certain activities on the riverbank or in the river, viz., open defecation, disposal of solid waste, washing of clothes, wallowing of cattle, throwing of floral offerings, disposal of corpses, routine bathing (as opposed to ritual bathing), etc.
- Development/restoration of the riverbank area, i.e., construction/restoration of Ghats, provision of public baths and toilets, construction of walkways, parks, other public spaces, access roads, commercial establishments, etc.
- Prevention of the discharge of untreated sewage into the river through construction of sewers and 'nala' diversion works
- Pumping and other infrastructure for conveyance of collected/diverted sewage-to-sewage treatment plants and construction/renovation of sewage treatment plants capable of treating the sewage to tertiary levels.
- Reuse of tertiary treated sewage within the town or elsewhere for industrial, irrigation, horticultural, non potable domestic and commercial uses, groundwater recharge, etc.
- Disposal of sludge generated due to sewage treatment in an acceptable manner and reuse of sludge and sludge derived products, i.e., manure, compost, etc. within the town and/or elsewhere.
- The URMP framework builds on these guidelines to help define the common URMP framework for the Ganga towns.

The Urban River Management Plan

A project to mainstream river planning into the Master planning process has been initiated by NMCG and the National Institute of Urban Affairs with the development of India's first Urban River Management Plan (URMP). The URMP is a river centric development plan which feeds into the Masterplan of a city by combining environmentally sustainable, socially inclusive and economically viable programmes, projects and proposals based on improving the health of the river in the long run. The overall objective of the URMP is to assist cities along the River to improve the state of the river in their stretch. The planning framework will help the River towns systematically and holistically plan for interventions to revive and maintain the rivers in a sustainable manner. The URMP is embedded in the central idea that maintaining healthy rivers is crucial to enhance liveability.

The URMP framework has two distinct parts. The first is generic and can be applicable to all River towns. This includes the elements, visions, objectives, and a robust monitoring and evaluation mechanism. The second is town-specific framework that comprises interventions required to achieve drafted objectives. This essentially means that all river towns have the flexibility to choose appropriate interventions to suit their local context in order to meet the common objectives. For instance, one of the objectives can be to keep the river pollution free. One town may decide to strengthen their centralized sewerage infrastructure to meet this objective. Another town may opt for decentralized non-sewered solutions. Yet another may focus on softer approaches using a mix of incentives and disincentives. The choice of the intervention can, therefore, be up to the town depending of what it perceives as the most suitable in view of site specific and local factors and requirements.

As the URMP framework is based on the three pillars of sustainable development - Economics, Social, and Environment, it is envisaged that the interventions carried out will be Environmentally responsible, Social connectors and Economically beneficial. Furthermore, ten objectives have been fixed to achieve the above visions of the URMP. These objectives address each of the URMP

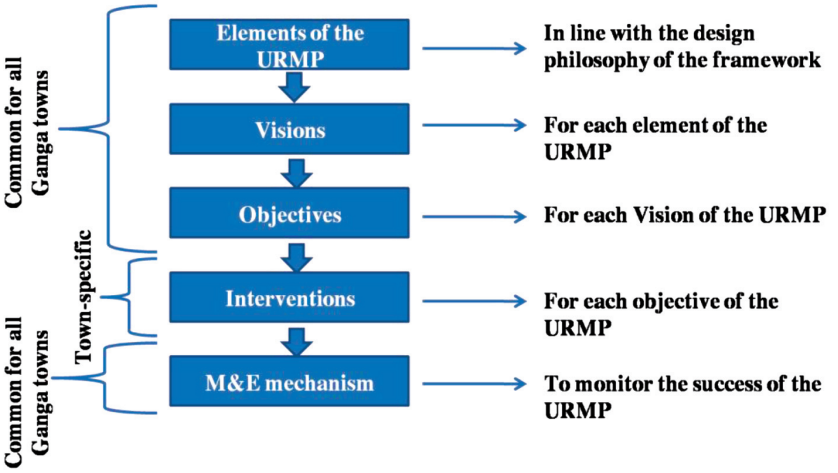

Figure 3: Conceptual Framework of the URMP

elements through actions/activities/interventions in the form of various projects. The elements, vision Statements and objectives of URMP are outlined in Figure 3.

Elements, Vision statements and Objectives of the URMP

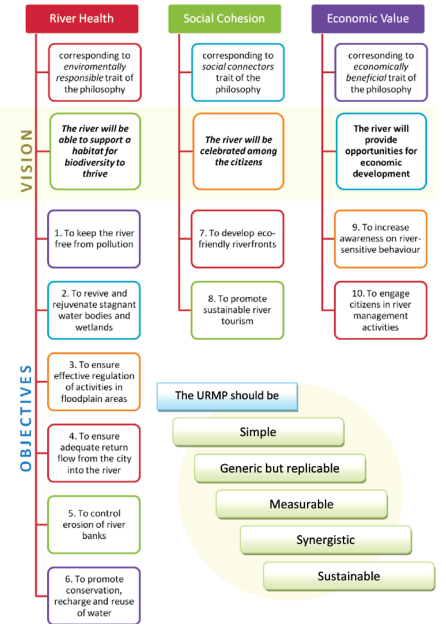

Figure 4: Urban River Management Framework

Vision Statements of the URMP

The vision for each element of the URMP shall be as follows.

Vision Statement for River Health Element - The River will be able to support a habitat for biodiversity to thrive:

This is the ideal situation from an environmental point of view. Rivers in the Ganga basin are usually unable to meet this condition in the urban stretches. This vision of the URMP seeks to change this trend by developing healthy rivers that are able to provide an environment for diverse species of plants and animals to flourish in their natural states.

Vision Statement for Social Cohesion Element - The River will be celebrated among the citizens:

Historically, towns have developed along the banks of the rivers in India. For such towns, the river was always the focal point for religious, social, and recreational purposes. However, over the years this connect between the citizens and rivers has diminished, and completely lost in some cases. This vision of the URMP, therefore, seeks to create an environment to make the citizens treasure the river and celebrate it as a valuable common asset.

Vision Statement for the Economic Value Element - The River will provide opportunities for economic development:

Rivers support the livelihoods of several communities, through the products it offers—timber, food, employment opportunities, among others. The vision for this element of the URMP seeks to enhance this aspect in a sustainable and river-friendly manner.

Planning Scales

Under the traditional planning formats available for municipal bodies, there are very specific and typical ways in which rivers are addressed through plans in India. On the one hand are the regional large-scale river basin management plans, which are advocated by national missions and priorities. For example, the National Water Policy (2012)[1] prescribes that "Integrated Water Resources

[1] National Water Policy (2012) http://jalshakti-dowr.gov.in/sites/default/files/NWP2012Eng6495132651_1.pdf

Management (IWRM) taking river basin/sub-basin as a unit should be the main principle for planning, development and management of water resources". Similarly, one of the goals of the National Water Mission (2008) is "promotion of basin level integrated water resources management", which is achieved through river basin management plans. On the other hand, some cities have plans for specific elements of the river, mostly in the form of projects on riverfront development, landscape, and recreation. Examples include the Dravyawati Riverfront (Jaipur), Sabarmati riverfront (Ahmedabad), Yamuna biodiversity park (Delhi), among others.

It is however, quite evident between these two aspects there is a space which is relatively unaddressed. This is related to river-sensitive planning, which essentially treats the river as an asset and ensures that the developmental activities in the city are not detrimental to the river. Hence, any planning for the city at large will need to take cognizance of the river and its interaction with the city.

Most cities have long-term vision plans, which outline the broad aspirations of the city, and the direction it should take in order to achieve those. As per the Urban and Regional Development and Plans Formulation and Implementation Guidelines (URDPFI, 2015)[2] there is a hierarchy of plans. It is envisaged that the URMP would be adopted in the Development/Master Plan of a city.

The negative impacts of rapid urbanization in cities on its rivers are multifaceted. These impacts go far beyond the usually publicized concern of water pollution, extending to structural changes in the natural state of the water channels. As the urban centres have expanded in number and size, the negative impacts on river ecosystems have become more severe and widespread. The core areas of concern for river management caused by urbanization include restriction of natural/storm water channels; pollution; over-abstraction of water; degrading stagnant water bodies/wetlands; depleting green cover; weak citizen-river connect and river governance. The Master Plan is a legally binding document for the city. Hence, there is a unique opportunity for the URMP to leverage on these documents to bring about a change in

[2] Urban And Regional Development Plans Formulation And Implementation (URDPFI) Guidelines, 2015 http://mohua.gov.in/upload/uploadfiles/files/URDPFI%20Guidelines%20Vol%20I.pdf

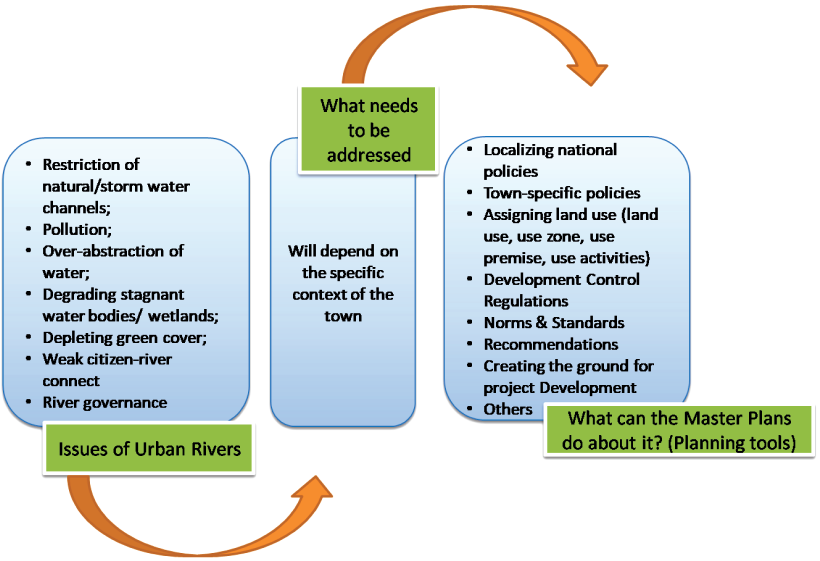

Figure 5: Master Plan Tools for River Management

the way, rivers are managed in cities. The Master Plan has several tools that can be used to address the issues mentioned above.

Process for preparing a URMP

Developing the URMP is simple but requires systematic flow of information and coordination among the relevant stakeholders.

Step 1: Identify a nodal agency for the preparation of the URMP

While all related organizations and agencies should be involved in the preparation of the plan, there will need to be a nodal agency to coordinate and lead the activities required for the preparation of the plan. Possible options include the Municipal Corporation, City Development Authority, or others.

Step 2: Develop a baseline for the town

Primary and Secondary data will have to be collected from all concerned agencies to develop the baseline. As far as possible, the baseline should be presented spatially to ensure that site-specific nuances are captured.

Step 3: Set the stage for shared understanding of the URMP objectives and expected outcomes

All the concerned stakeholders should have a shared understanding of the URMP and what it intends to achieve. The stakeholder mapping (carried out as part of the baseline) will help in identifying the relevant agencies. A workshop with these agencies can be organized to present the various components of the URMP framework—vision, elements, objectives, interventions, M&E.

Step 4: Identify the interventions required to achieve the URMP objectives

The core group can identify various interventions under each element of the URMP (river health; social cohesion; and economic value) that shall be undertaken. Both short-term (project-based) and long –term (planning-based) interventions need to be identified.

Step 5: Prepare an action plan for implementing the URMP

In the final step, an action plan has to be prepared for implementing the interventions. The action plan needs to include the following:

- Timeline of implementing the various interventions starting with the ToR development for DPRs; followed by the actual DPR preparation; and schedule of implementation activities
- Responsibility matrix
- Financial flows
- Mechanism for implementing agencies to report to the nodal agency
- Mechanism for M&E

Conclusion

The framework for preparing "Urban River Management Plans (URMP)" that all Ganga cities will develop in the next few years is unique in its structure. It sets out a common vision, objectives and performance indicators for all cities, while at the same time allows flexibility for site-specific interventions in order to achieve the objectives. It focuses on both short-term interventions (through priority projects), as well as long-term strategies (through planning-based interventions). The URMP's focus on leveraging on the cultural

and traditional value of the Ganga River and its ecosystem services, builds a case for the river-sensitive sustainable urbanization. The initiative is innovative and forward-looking. Rivers in the Ganga river basin (and largely all over the world) form part of the city's natural assets and heritage.

The development of URMPs is one of the major recommendations under the National Ganga River Basin Management Plan. The broad objective of a Urban River Management Plan is to promulgate sustainable urban development that makes judicious use of vital natural riverine resources. Further the URMP will demonstrate that maintaining healthy rivers in the Ganga River Basin is crucial to enhance liveability in urban areas of the basin.

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Meenakshi Dhote, Shivani Saxena and Jwnngma Basumatary

Management of Urban Wetlands in the Ganga Basin

The Ganga Plains of Northern India, occupying a total area of approximately 52.01 m ha, are a vast tract of fertile alluvial soil forming the food bowl for a river basin which supports the highest population density in the world. Traditionally dependent on rainfed irrigation to be gradually overtaken by canal network and followed by tube well irrigation, the food and water demand have resulted into a situation of water stress in most of the area. Rising population and rapid urbanization in the area is also adding to this stress. The towns and cities which are situated on the banks of River Ganga also exhibit a gap in demand and supply of water which is aplenty compared to settlements which are away from the main stem of the river. It has become imperative to look for alternate methods of water management to enable settlements to develop sustainably and become resilient.

The role of an indigenous method of irrigation, addresses sustained water availability irrespective of the location of the settlements from the main stem of the river, with an added function of channelizing the excess flow in the event of flood. The tradition is followed by a select few and the technique is slowly getting transformed or stopped due to fast pace of development. Yet the system seems to exist alongside modern methods of irrigation. The natural and human resources of the urban settlement co-relate with the methodology of traditional system of water management and the modification in the original and current execution. The need for mainstreaming these traditional methods in the process of urbanization is evident to understand and improvise innovative methods to elevate water stress and bring prosperity. The maintenance

of ecological processes underlying natural resource conservation is imperative to achieve a transition towards sustainability, with water being one of the natural resources which is under tremendous stress. The guidelines for Urban Water Conservation, Jal Shakti Abhiyan 2019, have emphasized the need to address sustainable Development Goal 6 (SDG 6) with respect to India which is facing the challenge of serving 18% of world population with 4% of world's fresh water resource.

At present, cultivated area of the country is almost 58% the total geographical area, a very high proportion by any standard. Of the remaining area, 22% is classified as forest for use, leaving thereby only 20% for all other land uses, including residential, industrial, infrastructure, public utility and others. The next four decades are likely to see major changes in our land use/landscape. Many competing land uses such as agriculture, residential requirements, recreation, mining, biodiversity support, forest protection, water provisioning, urban planning, carbon sequestration and others will be in conflict with each other. The Urban and Regional Development Plans Formulation and Implementation (URDPFI) Guidelines, 2014 state the need to strengthen the plan making process of urban areas by ensuring that cities and towns are able to generate enough resources to sustain themselves.

The National Mission for Clean Ganga, Department of Water Resources, River Development and Ganga Rejuvenation, Ministry of Jal Shakti has commissioned a study on preparation of a Toolkit for management of urban wetlands with a pilot study being conducted in Bhagalpur, showcasing both the traditional and modern methods of water management. The objectives of the toolkit are:

- Protection of the ecological processes that sustain water resources in urban settings,
- Mainstream protection of water bodies in the urban planning process, and
- Provide a step by step approach to identify, prioritize and prepare an action plan for protection of water bodies in urban areas.

Urban Wetlands as Multi-purpose urban infrastructure

Urban Wetlands provide useful services to the rivers and the overall water environment of the basin such as by trapping eroded soil, flood attenuation, groundwater recharging, water purification, enriching aquatic biodiversity, climate moderation, and enhancing aesthetic and cultural satisfaction. In modern times many water bodies have been stressed by water scarcity and pollution as well as encroachment and other anthropogenic activities especially in urban locales. Augmenting fresh water inflows to water bodies is therefore very important to revitalize them and maintain them in functionally healthy conditions.

Urban Wetlands further provide many direct and indirect functions and services within local watersheds, yet the economic benefits of wetlands are seldom appreciated by growing communities. The precise functions and services provided by wetlands depend on their size, type, and location within an urban watershed. It is difficult to generalize about wetlands due to their diversity with respect to their hydrology, plant communities and landscape position. On ground, no two wetlands are similar in their quantity or function. In addition, the nature of urbanization in the area draining to wetlands (watershed) often differs greatly from site to site. These "free" services are often taken for granted, but they can easily be lost as wetlands are altered or degraded in a watershed. Preventing the loss of wetland services can be challenging, particularly when financial gains for individual parcel development seemingly outweigh non-market wetland values reaped by the community at large. However, replacing the lost ecological services of wetlands can be expensive, assuming they can be replaced at all. For example, a community that loses wetland services may need to invest in costlier drinking water treatment, storm water management, and flood control infrastructure. Similarly, residents may also face higher flood insurance premiums, lower property values, and reduced recreational amenities when wetland services are diminished. Communities need to manage wetlands on a watershed basis rather than an individual basis to maximize the watershed value of wetland services. The table below emphasis the fact through an analysis of wetland services vs. their replacement options –

Table 1

Functions	Services	Alternatives
Pollutant removal	Maintain drinking water quality, process sewage, cycle nutrients, retain sediments, filter runoff, transport organic matter	Water filtration plants, Wastewater treatment plants, storm water facilities, Inter- watershed transfer, animal water storage
Flood attenuation	Storage capacity to reduce downstream flood volume, slow flow to reduce peak discharges and encourage particulates to settle out, protect downstream property, public safety	Storm water treatment practices(storage), dikes and levees, advanced floodplain construction design
Groundwater Recharge and discharge	Maintain base flow conditions in streams, protection, absorb storm surges	Deeper wells, alternative water source, injection wells
Shore line protection	Fringe wetlands provide vegetative bank protection, absorb storm surges	Revetments, stream bank stabilization and repair practices, stormwater treatment practices for channel protection
Wildlife habitat	Habitat for aquatic, terrestrial and avian species, protective spawning and nursery areas, support biodiversity, biomassproduction, connective wildlife corridors, foraging grounds for migrating birds.	Wetland restoration; species stocking

Others	Recreation, education and aesthetics (angling, bird watching, research opportunities, open space, quality of life),commercial products (peat, timber, fish and shellfish, cranberries and rice)	Wetland restoration

Direct & Indirect Impacts to Wetlands

Human settlements have historically evolved around wetlands and watercourses. Increased urbanisation has put natural wetlands under threat from conversion to land for development or through degradation from pollution. Wetlands located in the urban and urban fringe are particularly sensitive to unsustainable use; they are usually not included within urban planning decisions and are often not the responsibility of a single agency, thus leading to poor governance.

Urban wetlands need to be conserved, restored and managed to maintain the multiple services they provide. However, the fact that they are not usually included within urban planning decisions makes their conservation and wise use a very challenging issue.The very definition of a "Wetland" means an area of marsh, fen, peat land or water; whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters, but does not include river channels, paddy fields, human-made water bodies/tanks specifically constructed for drinking water purposes and structures specifically constructed for aquaculture, salt production, recreation and irrigation purposes.* Wetland conservation needs to be mainstreamed into urban decision making.

Direct impacts occur when a wetland is dredged, filled, drained or otherwise altered by activities occurring inside the wetland boundary. Most direct wetland impacts are regulated to some degree under federal, state, and local wetland permit programs. Examples of direct

* Wetlands (Conservation & Management) Rules 2017, Ministry of Environment, Forests and Climate Change.

impacts include draining wetlands for agricultural use by constructing drainage ditches or installing underground drainage tiles and filling wetlands to provide useable land on which to build.

Indirect impacts are caused by increased stormwater and pollutants generated by land development within a wetland's catchment area that stress the plant and animal community. Because wetlands are often located at the topographic low point of a watershed, they are often profoundly influenced by activity in upland areas. It is important to note that most federal, state, and local wetland permit programs start and stop at the wetland boundary and do not consider or regulate activities that occur within wetland catchment area.

The OECD Development Assistance Committee (DAC) formulated "Guidelines for Aid Agencies for Improved Conservation and Sustainable Use of Tropical and Sub-Tropical Wetlands" in which they provided an overview on wetlands issues, as well as policy orientations for aid donors and information for those seeking a more in-depth understanding of wetlands issues. Included are descriptions of wetlands types and functions, their potential uses, and details on the importance of wetlands and the threats to their viability from different types of development projects. The Guidelines also suggest a range of measures which can be taken to mitigate damage and to manage the wetlands sustainably. However, if there is an impact, it may have knock-on effects with loss of the wetland benefits and socio-economic consequences for the wetland dependent populations.

Wetlands within New Developments

Urban developments, if designed with green infrastructure and environmental sensitivity at their heart, can deliver numerous financial, environmental and socio-cultural benefits. Targeted at places where it can have a positive environmental impact, and designed integrating space for both wildlife, people and prosperity, newly built developments can make a positive contribution to nature and promote health and wellbeing of citizens. The use of green infrastructure (such as Water Sensitive Urban Design approaches, e.g. Sustainable Drainage Systems) in new developments is recognised as

a key approach to retrofitting wetlands into the urban environment; green infrastructure plays a key role in improving the quality of surface water and storing storm water therefore reducing flooding. In the case of housing developments in particular, the implementation of green infrastructure is known to deliver benefits for wildlife, residents, the economy and developers. Some of the key "benefits for all" include:

- Benefits for wildlife: creation of habitat for biodiversity; habitat connectivity
- Benefits for residents: enjoyment of nature; sense of community; contributing to health and wellbeing
- Benefits for the economy: financially sustainable green infrastructure; employment; reduced health care costs
- Benefits for developers: higher market value; satisfied customers; improved environmental performance (The Wildlife Trusts, 2018)

According to estimates, nearly 4 billion people now live in urban areas (United Nations,2014). This growth presents enormous environmental challenges as increased demand for land and resources has a direct detrimental effect on wetlands. Whilst cities currently only occupy 2% of the Earth's surface, they use 75% of the world's natural resources and generate 70% of all the waste produced globally (ICLEI, 2010).Continuing population growth and urbanisation are projected to add 2.5 billion people to the urban population by 2050 (United Nations, 2014).With an ever-increasing global urban population, sustainable development challenges will be increasingly concentrated in cities, especially in the lower income countries where the pace of urbanisation is predicted to be fastest. Wetlands should be considered as solution providers within an urban and peri-urban context, which can mitigate risks from a changing climate, support food production for a growing population and generate income through tourism and recreation.

There is a growing body of evidence that integrated urban planning can enable densification and agglomeration and at the same time reduce per-capita resource use (UN-Habitat, 2012). The drivers

of sustainable urban wetland planning and management have been identified as:

a) International and national city initiatives and accreditations such as Wetland City, Sponge City, City and Biodiversity, and Garden City
b) Recognition of the importance of small wetlands, in addition to larger scale wetlands, within urban planning
c) Water quality improvements
d) Flood management
e) Water resource conservation
f) Remediation of urban areas
g) Wetland agriculture and aquaculture – wetland products
h) Tourism

Urban Wetland Management Guidelines – A Toolkit for Local Stakeholders

Water bodies in the form of lakes, ponds, tanks and other wetlands are an integral part of the hydrological cycle. Properly managed wetlands, especially lakes, in urban areas have an important role as a source of water supply, controlling run-off and groundwater recharge. These water bodies host a wide variety of flora and fauna, provide recreational spaces and improve micro climate in the built environment. With rapid urbanization and expansion of city boundaries, a number of wetlands in urban areas are facing issues of over exploitation, encroachment, discharge of industrial effluents/ domestic sewage and uncontrolled siltation. This results in the destruction of the water body and its catchment area.

With this objective in mind, National Mission for Clean Ganga with the School of Planning and Architecture, New Delhi initiated a project titled "Urban Wetland Management Guidelines - A Toolkit for Local Stakeholders". The toolkit is targeted at providing a set of practical and policy-relevant methods for information collection which can be used by those involved in wetland conservation and development planning.

The main objectives of the toolkit are:

i. Preparation of interactive GIS map and Listing of parameters for classifying water bodies.

ii. Preparation of land suitability map for development of the water bodies & assessment of gross potential for water storage & ground water recharge.

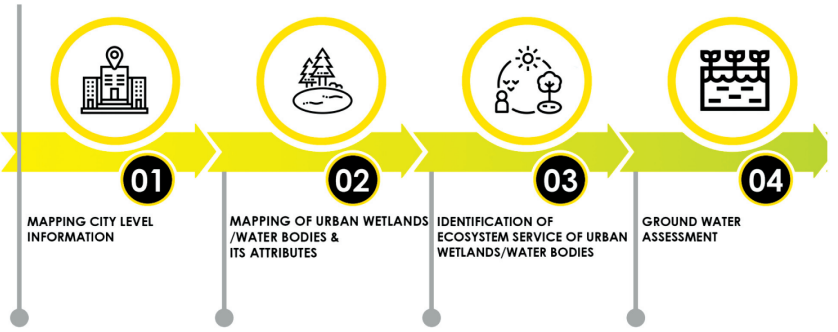
iii. Preparation of strategy to prioritize conservation of urban water bodies & identifying need-based roles of water bodies in different parts/zones of the city.

iv. Identification of set of indicators to evaluate urban water bodies & defining criteria for designating best use of urban water bodies.

v. Preparation of strategy for mainstreaming water bodies in the city and recommendations for Master Plan and its way forward.

The framework as developed for the toolkit to be used by Municipal bodies is a two stage process. Stage I involves Identification of Urban Wetlands for Conservation whereas Stage II focuses on developing an action plan for identified urban wetlands. The two stages along with their corresponding steps are shown below –

STAGE I



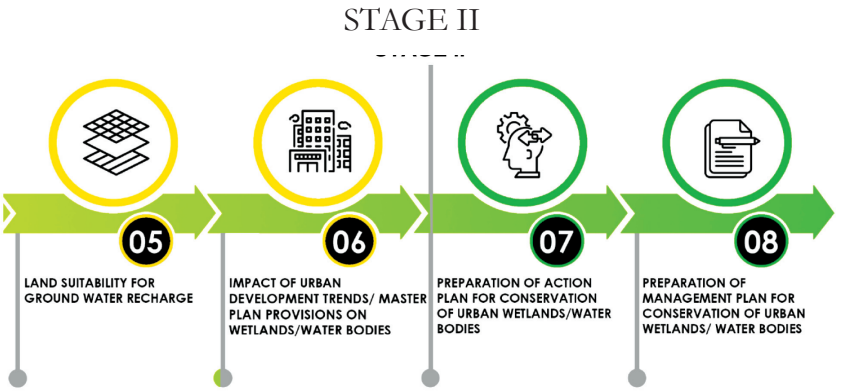


Figure 1

Steps 1 to 6 fall under the Stage I of the toolkit whereas step 7 and 8 fall under stage II of the toolkit.

Step 1 – Mapping city level information

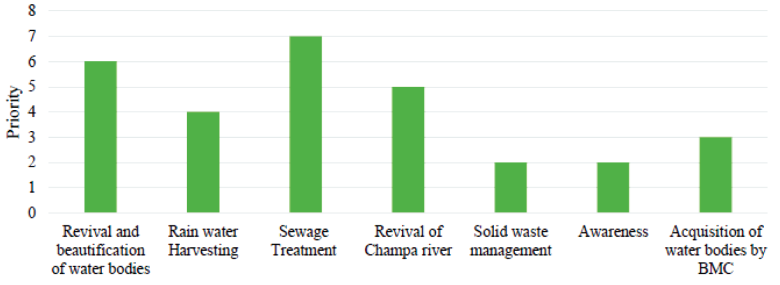
At this stage, a GIS & Remote Sensing expert is necessary for preparation of interactive database of city, urban wetland/water bodies and its associated attributes. Active involvement of stakeholders is essential for identification of various ecosystem services of urban

Pilot Study of Bhagalpur

During a stakeholder meeting with local officials an image of the city emerged. The officials while identifying what they think are the major issues plaguing Bhagalpur wetlands/water bodies highlighted disposal of solid waste in and around the water bodies. Other issues included -

- Sewage discharged in drains without treatment.
- Drains carry both sewage and solid waste from households into the River.
- Rain water harvesting was made mandatory by the building bye-laws but its implementation and maintenance is not monitored.

Possible suggestions to these issues highlighted were -



Source: Stake Holder meeting, School of Planning and Architecture, Delhi

wetlands/water bodies. Understanding hydrogeological parameters will help in identification of various parameters influencing the urban wetlands/water bodies. This in turn helps in identifying implications of urban development/master plan provisions and developing indicators and standards for management of urban wetlands/water bodies.

Step 2 – Mapping of Urban Wetlands/water bodies and its attributes

Preparation of interactive GIS map includes identifying and mapping of urban water bodies at cityscale. This may also include the peri-urban areas. This part will not only cover the demarcation of urban wetlands, but also the zone of influence and the catchment area. This is done collectively from primary survey and with the help of local stakeholders and Urban Local Bodies (ULBs).

Step 3 – Identification of ecosystem services of Urban Wetlands/water bodies

The ecosystem services of urban wetlands/water bodies are to be identified through local stakeholder surveys. The ecosystem services include Provisioning Services, Regulating Services, Cultural Services and Supporting Services. The ecosystem services of wetlands have already been very well documented in RAMSAR Wetland Management Report and Millennium Development Goals which forms the basis of ranking the services. Services are ranked based on their availability. The total ecosystem services value is presented in the matrix format in the form of scores for each service i.e., Provisioning, Regulating, Cultural and Supporting.

Step 4 – Groundwater Assessment

Watershed with well defined hydrological boundaries is an appropriate hydrological unit for ground water resource estimation. This will include delineation of sub-areas in the assessment unit, season wise-assessment of ground water resources, estimation of ground water draft, and estimation of ground water recharges during monsoon and non-monsoon season. This will help in identifying the stage of ground water development.

Step 5 – Land Suitability for Groundwater Recharge

The land suitability for ground water recharge can be undertaken based on whether groundwater assessment shows the area in semi-critical, critical or over-exploited stage. The process of preparation of land suitability map requires information on ground water depth (pre-monsoon and post-monsoon) to identify the areas that have declining trend. Drainage density is a measure of how well the areas are drained by water flow and thus becomes a good parameter in land suitability analysis. The prioritization of areas for recharge includes all available open spaces, agricultural land and scrub land. The three parameters i.e., ground water depth (pre-monsoon), drainage density and open areas/agricultural land/scrub land form a major input for land suitability analysis for ground water recharge. The suitability of area for recharge is further assessed to obtain the final output. Parameters such as climatic condition, topographic, soil, land use and hydrogeological conditions are important factors controlling the suitability of an area for recharge.

Step 6 – Impact of Urban Development trends / Master Plan provisions on Wetlands / Water bodies

This step deals with identification of drivers of changes in hydrological regime of wetlands/water bodies. Assessment of impact is carried out at the level of 'zone of influence' of wetlands/water bodies, 'catchment of Wetlands/Water Bodies' and within '200 meter buffer area' of wetlands/ water bodies. This will help in identification of all the possible drivers and impacts on wetlands/ water bodies. The assessment will provide a basis for formulating synergy between wetlands/water bodies and urban development within the city.

Step 7 – Preparation of Action plan for Conservation of Urban Wetlands / Water bodies

The action plan should be developed in two steps. The first step should be a comprehensive listing of activities which are required to be implemented such as wetland/water bodies boundary mapping and delineation or removal of encroachment at site level; afforestation and aided regeneration or small scale engineering measures (check

dams, etc.) at catchment level; selective dredging and desilting or interception, diversion and treatment of point sources of pollution, balancing water allocation for human and ecological purposes for water management; maintenance of breeding and spawning grounds for key species, management of invasive species; setting regulatory regimes, development of monitoring and evaluation system at institutional level, etc.

Step 8 – Preparation of management plan for conservation of Urban Wetlands / Waterbodies

The Management Plan should define all the indicative actions, core and non-core activities to be undertaken along with a complete costing (activity wise) for the entire tenure of the plan using the existing norms of the State and central government, as may be the case. Year wise requirement of funds for various work/ activities, bar and PERT charts for the works/activities should be prepared. For each of the activity, an analysis of ongoing development or conservation sector schemes should be done to assess the extent of funding that can be generated through convergence with these schemes. Opportunities for private sector participation should also be identified.

Mainstreaming Urban Wetland Conservation into Spatial Planning process

With about 8,000 urban centers, India's urbanization stands at 32% according to census 2011. The Urban and Regional Development Plans Formulation and Implementation (URDPFI) Guidelines classifies urban areas in five major categories - Towns with population range of 5000-50000 are classified as small towns followed by medium towns (50,000-5 lakh), large cities (5 lakh-10 lakh), metropolitan cities (10 lakh-1 Crore) and megapolis with a population of more than 1 Crore. Out of around 7935 urban areas (Census 2011) there are about 7467 small towns, 372 medium towns, 43 large cities, 45 metropolitan cities and the remaining 3 falls under the category of megapolis.

The growth and development of these cities/towns are directed

by various development plans formulated with their respective vision and scope. Master plans or development plans for cities is a legally binding document providing further necessary details and intended actions in the form of strategies and physical proposals depending upon the economic and social needs and aspiration of the people, available resources and priorities. Based on data availability (online) for around 530 urban areas (495 cities/towns have their development/ master plans prepared for their respective vision years and the plan for the remaining 38 cities/towns are in draft stage) planning is underway. It is important that protection and conservation of water bodies is integrated into the plan making process which will not only result into their revival but also result into contribution to water security in times to come. Since plans for majority of urban areas have yet to be done, the incorporation of a scientific and systematic process would result into ease of implementation by the local governments.

Best Practices In Integrated Urban And Wetland Planning And Design

The ecosystem services provided by wetlands and green infrastructure in general, are often undervalued during the planning and design stages for urban developments. The need to integrate green infrastructure in the urban environment has become more evident, especially where sustainability has been set as an objective for the development. Wetlands play a key role to achieve sustainability in cities, and it is crucial to identify and integrate the wider benefits they provide.

Urban planning and design should explicitly include wetlands as natural infrastructure for nature conservation, water management (storm water management, water supply and water treatment) and recreation. Examples, showcased in this manual, demonstrate how the integration of wetlands in the urban environment can deliver tangible benefits for the economy, biodiversity and local communities. The benefits provided by wetlands in the urban environment have been illustrated in a series of case studies as below including key successes and lessons learnt for each example.

Table 2

Lessons learnt	Example
Involve all stakeholders from the beginning to ensure that everyone has their voice heard and can provide input	Panama
Set environmental objectives and targets as well as regulations (by government)	China
Adapt the development to the existing environment (not the other way around)	Australia
Holistic thinking is key - financial, cultural, social and environmental considerations need to be taken into account from the beginning	Australia
Negative experiences from the past can serve as a "wake-up" call for government to change attitudes and consider wetlands as protection against floods and as storm water storage	United States
At the design stage, consider the restoration of the ecological functions; use native species during restoration	China
Ensure designs are in tune with the project objectives and integrate key elements to be successful (e.g. wildlife and culture; people and nature; legacy; facilities and operations; and learning)	United Kingdom
Establish partnerships between different sectors (nongovernmental, government and private businesses) as it proves to be highly beneficial for the successful delivery of the project	United Kingdom
Establish a committee to oversee the process through to construction as it can be highly beneficial in ensuring project objectives are achieved	Republic of Korea

Wetlands cannot be conserved as stand-alone water bodies without the involvement of the community. Hence, the use of consultative and participatory methods during design stage should enhance restoration outcomes	Sri Lanka
Involvement of multidisciplinary teams ensures integrated plans	Sri Lanka

Source: Collated from RAMSAR Best Practices -Integrating Urban Development & Wetland Conservation

Rejuvenation of Hauz Khas Lake, Delhi

The Indian National Trust for Art and Cultural Heritage (INTACH) and Delhi Development Authority (DDA) had undertaken a project to revive Hauz Khas Lake, a 700-year-old water body, lying dry for decades, with treated sewage water. In 2003, about 2.5 million litres/day of waste water from the Kishan Garh Sewage Treatment Plant (STP) in Vasant Kunj was diverted. Additionally, a number of fish species were introduced to keep the water clean by consuming algae and feeding on mosquito larvae. Overall, the project has been successful in rejuvenating the lake on economic, environmental and social fronts.

Development of Kankaria Lake, Ahmedabad

Kankaria Lake is the biggest lake of Ahmedabad, Gujarat with an approximate circumference of 2.3 km. In 2006-2007, the Government of Gujarat undertook rejuvenation of the lake. The lake conservation project involved cleaning, and de-silting. A large component involved the development of lake front activities and infrastructure such as jogging tracks, zoo, parks, libraries etc. Currently, the Ahmedabad Municipal Corporation charges an entry fee to cover the maintenance of the premises. Originally, ground water was used for refilling the lake which was causing depletion in the total available ground water for residents of Mani Nagar. To facilitate rejuvenation, a sub-surface infiltration trench was proposed to collect and store runoff water. The response to the rejuvenation project has been overwhelming.

Conclusion

The following general principles have been identified as key to ensuring an integrated approach to urban and wetland planning and design.

- Legislative and regulatory measures for wetland protection
- Wetland specific management planning
- Early engagement with stakeholders
- Mapping and demarcation of all wetland features
- Monitoring and baseline surveys of wetland physical, ecological and social characteristics
- Specific wetland regulatory and management agencies for wetlands
- Joint committees for development and environmental protection
- Coordination among relevant government agencies that have a role in wetland planning
- Partnership among private and public bodies within wetland planning and design
- Communication, education and public awareness raising regarding the importance of wetlands
- Community involvement in planning and design of wetland features
- Appropriate economic activities to promote sustainable livelihoods such as tourism or aquaculture, within wetland areas
- Management and activity financing through subsidies, payment for ecosystem services, economic activities
- The use of green infrastructure means better homes for people and the creation of habitat for wildlife

More systematic research is needed on the indirect impacts to wetlands, since it is extremely difficult to compare across wetland types, regions, plant communities, and landscape positions. In addition, it is not yet possible to directly link individual stressors

generated in the catchment to predict impacts and biological responses within individual wetlands due to the interactions among many different stressors. Several recommendations are provided to improve the future of urban wetland research.

i. The current research on indirect impacts to wetlands has been produced by a great number of different academic disciplines that rarely interact with each other. Urban wetland research has been published by hydrologists, herpetologists, landscape ecologists, botanists, wildlife managers, conservation biologist, toxicologists, storm water engineers and wetland scientists. It is recommended that a national meeting be convened, or a network be launched to improve communication among the diverse research community currently working on the topic of indirect impacts to wetlands.

ii. Researchers have used many different metrics to describe the impact of upland development on wetlands (% urban land use, impervious cover, land cover, adjacent land use, forest cover, and percent developed). The lack of a uniform metric or index of land development as well as differences in how the catchment is defined and delineated has hindered comparison of studies. It is strongly recommended that researchers adopt a common convention for defining the catchment to wetlands and agree to measure a series of different land development metrics within the catchment.

iii. In addition, researchers may want to explore whether a common method (or methods) can be used to assess direct and indirect impacts to wetlands from the catchment in the field. Researchers should engage in a dialogue to develop more standard methods for monitoring and modelling hydrologic changes to wetlands.

iv. More systematic sampling of a large population of watersheds would be helpful in defining how watershed functions and indicators change in relation to percent wetland cover. This watershed-level wetland information could be important to help managers understand the importance of protecting wetlands to maximize watershed services.

v. Perhaps the most critical research gap is the lack of understanding about wetlands whose water balance is dominated by groundwater, and more specifically, how these wetlands are impacted by upland

changes in groundwater recharge rates due to land development. Although it is understandably difficult to track groundwater movement, more directed groundwater research is needed on this important topic.

vi. More research is warranted to explore how hydrologic changes, pollutants and other stressors promote the spread of invasive wetland plants. Current research indicates a general link but does not yet indicate what causal factors can be manipulated by local wetland and watershed managers to reduce the spread of invasive species.

vii. A few studies have shown impacts to riparian wetlands due to stream constrictions. These studies are not necessarily conclusive as to the permanent effects on these wetlands, if any.

viii. Further research into the long-term impacts resulting from culverts, stream crossings, and other causes of flow constrictions is needed.

ix. A framework for using watershed planning to incorporate local wetland protection is provided in the report. Further tools available to local governments for protecting wetlands have also been specified. Local governments that wish to enact stronger local protection for wetlands and their functions can find a model ordinance to protect wetlands that are typically considered sensitive to storm water runoff.

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Savita

Anant Van, Aviral Van and Ganga Rejuvenation

RIVER ECOSYSTEMS

River ecosystems have been vital for sustaining life and throughout the history rivers have attracted oldest civilizations to establish. A river is much more than just the water, comprising of several inter-dependent components and links, and are influenced by the surrounding terrestrial ecosystems. Rivers are viewed as arteries of the catchment and they are the most fascinating, complex and dynamic ecosystems. Rivers exhibit high degrees of connectivity between systems longitudinally, laterally and vertically. Rivers are not only used as a source of drinking water, but are also exploited for agriculture, transportation, energy production, industrial processes, waste disposal and the extraction of fish and other products.

Threats to Rivers

In spite of enormous multiple uses and diverse values of rivers, man has significantly transformed most world's river ecosystems by creation of physical barriers (dams, reservoirs, barrages and canals) that directly alter system hydrology, water extraction, and filling or draining of shallow habitats, besides pollution of waterways by disposal of waste, effluents and sewage, and destructive land use practices in areas surrounding river ecosystems and thus, have greatly impaired them. As a result, very few of the world's large rivers retain their original functional integrity. Above all, regulation and fragmentation of rivers have created enormous ecological problems and are threatened by multiple stressors. Riverine biodiversity is suffering dramatic decreases that threaten the functioning of these ecosystems. Most problems of river management are the combined result of land-use changes, development of water resources, industrial

expansion and urbanization that not only alter the pattern of runoff but also influence the quality of river discharge, size, distribution and load of sediment transported.

Rivers and Forests - Strong Linkages

Forested basins and catchments supply a high proportion of freshwater for various uses and ecological needs in both upstream and downstream areas. A key challenge faced by land, forest and water resources is to maximize the wide range of multi-sectoral benefits without detriment to water resources, and forest and river ecosystem functions. There is an urgency to address this challenge and a need for developing better understanding between forests, water and hydrology. Freshwater benefits to downstream areas require sound management of upland and riparian forests. Riparian forests as 'natural buffers' and 'biological filters' are the single most effective protection mechanism for major water resources those are presently under severe pressures of waste and pollutants as they facilitate functions of purification of water for the dynamic flow of river water and its quality. The world over, the degradation of rivers and riverine landscapes is increasingly being recognized as a crucial political issue with enormous socio-economic repercussions. Indian major river systems including the Himalayan rivers (the Indus, Ganga and Brahmaputra) are no exception

THE GANGA RIVER CONSERVATION PROGRAM

River Ganga which is the lifeline of our nation has been under global scanner since the European rivers were able to rejuvenate themselves after being declared almost dead. Since mid 1980s the country has been engaged in ridding the river of the tag of polluted river considering the strong people sentiment attached with the river and also because of its economic, social and cultural importance.

Unique status of Ganga

The Ganga River has immense geographical, environmental, socio-economic, cultural and religious significance in India and beyond. Thus, India has aptly declared it as the 'National River'. Being, a trans-

boundary river that traverses across five states of India and also in Bangladesh with a total stretch of 2,525 km, the Ganga River forms one of the largest basins in the world, representing 26% of the India's land mass and supports about 43% of country's population. It is also a lifeline for millions of Indians who live along its course and depend on it for their daily needs. The Ganga River from its origin at Gaumukh in the Gangotri glacier and mouth in the Bay of Bengal represents three biogeographic zones: (i) the Himalayas, (ii) the Gangetic plains, and (iii) the coastal including deltaic region. Thus, the river is home to many threatened and sensitive ecosystems, viz., glaciers, alpine meadows, diverse upland forests, terai grasslands and swamps, riparian forests, mangroves, etc. along with a large variety of rare, endangered, and threatened faunal species that inhabit them. This includes the Gangetic River Dolphin, an indicator of river health which has been designated as the 'National Aquatic Animal' besides other important species viz., snow trout, golden mahaseer, smooth coated otter, river shark, gharial, etc. The Ganga River is the holiest river for the Hindus and is worshipped as the goddess Ganga. The Ganga River host a large number of National Wetlands of Importance, Important Bird Areas, Ramsar sites, World Heritage Sites, Biosphere Reserves besides other important protected areas. The river contributes immensely to the Indian economy as the country's agriculture sector is heavily dependent on the fertile plains of river Ganga and its tributaries. The river is a major source of navigation and communication thereby facilitating transport and commerce and is being planned to be developed as a major inland waterway system. Festivities and events associated with the river attracts millions of devotees from the world over. Many civilizations, empires, and kingdoms have flourished along its banks in the past. The majestic snow-peaked Himalayan mountains and various natural ecosystems along the river Ganga and its tributaries, besides wide-ranging religious, cultural and historic values, have enormous potential for recreation and tourism industry.

Rejuvenation strategies over decades – recognizing Riverscapes

First institutionalized effort for Ganga cleaning started in 1985 Ganga Action Plan (GAP), with focus on city wise sewage

management plans. It had several improvements through GAP 1, II and III but a satisfactory model for rejuvenation of Ganga remained elusive. Isolationist approaches to river management till recent times constrained the development of new scientifically based comprehensive approaches for river development and management. It is only in recent times that hydrological, geomorphological and biological researches have been integrated to establish a new understanding for the dynamic river systems. Recent approaches to river management emphasize the riverine landscape or 'riverscape' perspective as running waters are open ecosystems. Water flow is the key factor and it is being increasingly realized that accounting for natural differences in flow variability among rivers, and understanding the importance of such differences for the protection of river biodiversity and maintenance of goods and services that rivers provide are pre-requisite for successful river management and restoration. Longitudinal changes from the river source to its mouth, vertical interactions (river bed/aquifer) and lateral exchange processes across the floodplains play a major role in alluvial river landscapes. The riverscape approach integrates rivers with their surrounding landscape. The ecosystem approach seeks an insight through inter-disciplinary researches at all stages of the planning, implementation and evaluation process. 'Forestry interventions' on a scientific basis are pertinent for river conservation, specifically river rejuvenation and overall ecological integrity of river ecosystems.

Namami Gange Program- An Integrated Approach

Recognizing the significance as well as appreciating increasing national concern about environmental degradation of the river and its basin, the GoI initiated the Namami Gange Program (NGP) as a multi-pronged approach for Ganga rejuvenation adopting a river-basin focus with a multi-sectoral mandate to address both water quantity and quality aspects. The NMCG entrusted with implementation of the NGP identified seven important missions for focused interventions; (i) Aviral (continuous flow) Dhara, (ii) Nirmal (clean water) Dhara, (iii) Ecological restoration, (iv) Geological safeguarding, (v) Disaster management, (vi) Sustainable agriculture, and (vii) Environmental knowledge-building and sensitization.

One of the envisaged major activities for Ganga rejuvenation is 'forestry interventions' so as to enhance the productivity and diversity of the forests in headwater areas and all along the river and its tributaries. The availability and quality of water in the river have been increasingly threatened by over use, misuse and pollution, and both are strongly influenced by the extent and condition of forests in the upstream and downstream areas. More so, climate change is also likely to alter the role of forests in regulating the water flows and influencing the availability of water resources. These strong linkages between forests and water urgently seek high priority attention.

Afforestation – An important pillar of Namami Gange Program

Keeping in view the diversity, complexity, and intricacies of forest ecosystems and pivotal multiple functions performed by them and their inter-connectedness with highly dynamic river ecosystems, the NMCG decided to adopt a holistic approach of river basin management, for Ganga rejuvenation. This holistic approach also emphasized appropriate forestry interventions by way of protection, habitat management, afforestation, catchment treatment - soil and moisture conservation works, ecological restoration of vital riparian forest buffer, bioremediation, improved livelihood of forest dependent communities and forest dwellers, and alternate income generation activities through regulated tourism and awareness. It was envisaged that such concerted efforts and initiatives of forestry interventions for Ganga will greatly facilitate the major goals of accomplishing Aviral Dhara and Nirmal Dhara. There was a clear acceptance of the fact that **Anant Van leads to Aviral Dhara!**

The task of designing a scientific DPR for carrying out the afforestation plan and achieve **Aviral Dhara through Anant Van** was entrusted to the Forest Research Institute (FRI), Dehradun by National Mission of Clean Ganga.

PREPARING FOR FORESTRY INTERVENTIONS IN GANGA (FIG)

The specific objectives for the DPR exercise included: (a) review

the existing situation of Ganga riverscape, past river management, and lessons learned; (b) involve stakeholders and build consensus for design and development of strategies and approaches; (c) assess ongoing forestry activities of the states engaged, potential and possibilities for regeneration, improvement, and restoration of forest catchment for Ganga rejuvenation; (d) assess the condition of riparian forests as potential biological filters, and identify and prioritize critical areas/field sites for the implementation of plan; (e) assess the potential of cultivation of medicinal plants and identify appropriate species and suitable sites; (f) identify research and monitoring needs and develop a strategy for future research and monitoring; and (g) formulate strategies, develop approaches, and plan activities for project implementation.

The process was broken in following identifiable steps:

(a) The Consultative Process: The preparatory phase for DPR included review of literature, primary and secondary data collection and analysis, expert consultations and receiving inputs from the wide-ranging stakeholders. Accordingly, extensive and exhaustive consultations at the national and state levels were organized. Five states (Uttarakhand, Uttar Pradesh, Bihar, Jharkhand, and West Bengal) forming part of the Ganga riverscape and State Forest Department of these states were instrumental in planning and organization of state level consultations. The entire process of consultative process was facilitated by the FRI, Dehradun.

(b) Use of Frontline Technologies/Techniques: Developing a DPR for forestry interventions on Ganga required a better insight and understanding not only of the river and tributaries themselves but also of the surrounding land and expanding human in prints. Thus, remote sensing and geospatial modeling were used in identification of prioritized and suitable sites for forest plantations. The selected area for the planning, assessment and prescription have been referred as the 'Ganga riverscape' which includes the entire catchment of Bhagirathi, Alaknanda and Ganga sub-basins in the state of Uttarakhand and a 5 km buffer around either side of bank lines of Ganga stem from Haridwar to Ganga Sagar. In

addition, the riverscape also included a 2 km buffer on either side of different tributaries of the river Ganga except the river Yamuna and its tributaries. Consideration of 5 km and 2 km buffer was achieved based on scientific insight and extensive consultations. The use of geospatial modeling was made in identification of priority and selection of suitable sites. Image processing and GIS tools used were: ERDAS Imagine 2015, Geomedia Professional 2015, ArcGIS, etc. Satellite data (Landsat 8, Landsat TM and ETM) were used for preparation of bank line map and Land Use Land cover (LULC) map of the riverscape. Ancillary data on soil types, soil erosion, forest cover, were obtained from concerned national level agencies. 21 major land use land cover type classes were delineated and distribution of area under corresponding classes for the entire riverscape and state-wise were computed. GIS was used to generate different layers within the riverscape like land use pattern, soil erosion rates, and slope of the topography. Based on severity of the features, these combinations were then classified into (i) high, (ii) medium and (iii) low priority areas.

(c) Development of Plantation and Treatment Models: The multi-disciplinary expertise was used in developing potential plantation and treatment models for the proposed forestry and other conservation interventions in major three type of landscape components visualized in the Ganga riverscape. These were: (i) Natural, (ii) Agriculture, and (iii) Urban Landscapes. Suggested models broadly varied for the Uttarakhand Himalayas and the Ganga Plain in five states. The purpose of various models planned in the natural landscapes is primarily protection, eco-restoration and conservation. Details of potential models were sent to the five states for selection and to recommend appropriate modifications. In all, 21 different models relevant to natural landscapes were suggested to five states. In case of extensive agriculture landscape, landscape specific models were suggested. Likewise, considering extensive urban landscapes all along the river, five different models focusing on: (i) bio-filtration and bioremediation, (ii) riverfront development, (iii) eco-park development, (iv) institutional and industrial state plantations, and (v) avenue plantations were proposed to five states.

(d) Data Collation and Assimilation: The Project team designed and developed five elaborate formats for field data collection. These formats were sent to five states for collection of actual field information for proposed forestry interventions and other conservation activities. Altogether 8,042 field data sheets were obtained from five SFDs generating voluminous information. Out of this, nearly 34% data sheets were for proposed interventions in natural landscapes while 38% data sheets were for plantation activities and other treatments in agriculture landscapes. Remaining about 28% data sheets were meant for urban landscapes, conservation interventions and supporting activities. In order to effectively collate, analyze, synthesize, interpret and retrieve desired summary information, a software was developed for the purpose, which was web based and easily accessible via internet. The software was capable of generating reports in the desired formats e.g. State wise, District wise, Division wise, Model wise, Activity wise and Annual consolidated reports to obtain insight on areas under different landscapes to be treated and corresponding costs.

(e) Environment of the Riverscape : An understanding of overall environment of the riverscape under consideration from the perspective of its physical, biological and socio-economic environments was considered vital for proposed forestry interventions, Ganga rejuvenation, biodiversity conservation, involvement of local communities and institutions in these efforts, sustainable livelihoods and awareness. Much of the secondary information on the biological environment - forests, biodiversity, wildlife habitats, threatened species, protected areas, and conservation initiatives and efforts, etc. available from concerned national/state level agencies was also referred and optimally used for the purpose of present task. The demographic information in the context of riverscape was downloaded from the most credible source of information on demography (population characteristics) website censusindia.gov. in. A total of 183 Taluk (blocks) were covered either partially or fully in the riverscape. Out of this, about 102 taluks were found to be relevant for the main Ganga River itself. Relevant

information on demography and socio-economic situation for all talukas associated to the riverscape was extracted, collated and synthesized for better understanding. The services of an expert on bio-filters and bioremediation were also sought so as to suggest potential treatment models and sites for the purpose. A reconnaissance was made to potential field sites near Dehradun and neighbouring districts in Uttar Pradesh for the purpose.

STRATEGY OF ANANT VAN- AVIRAL DHARA

The riverscape is a mosaic of different land uses i.e. natural ecosystems, rural and agricultural ecosystems, and built-up urban environment and each of these broad land use categories harbour considerable proportion of areas, and their conditions, ownerships, use patterns, and management needs vary considerably. All these three broad land use categories have been referred as landscapes (natural/ agriculture/ urban) and they directly or indirectly influence the complexity and dynamic nature of river Ganga ecosystem and its Aviral and Nirmal Dhara. Thus a multi-pronged forestry interventions strategy named Anant Van- Aviral Dhara was built around these three broad land use types/ landscape categories as part of the execution of the implementation plan during the Phase I (2016-2021).

Lower order zone plans

The following lower 'Sub-Order Zones' (landscapes) of the riverscape and various 'Theme Plans' were identified for forestry interventions:

(a) Natural Landscapes: Altogether, 32 selected models/ treatment plans for natural landscapes (forests, grasslands, and wetlands) were included in the DPR for undertaking forestry interventions focusing on protection, habitat management by way of soil and moisture conservation works, weed control, plantations, eco-restoration, bio-filters and bioremediation, etc.

(b) Agriculture Landscape: The second lower order zone i.e. the agriculture landscapes largely in the rural environment seek enhanced agricultural production. Plantation of various agricultural and horticultural crops are undertaken by villagers/

farmers on their private lands. The purpose of this zone (agriculture landscapes) is to promote productivity of agricultural lands by appropriate soil and moisture conservation works and planting of economic and fruit trees so as to enhance the overall conservation values and other expected ecological functions and ecosystem services. Altogether, 03 different models in agriculture landscapes have been selected for five states.

(c) Urban and Peri-Urban Landscape: Proposed forestry interventions in the third lower order zone i.e. the urban and peri-urban landscapes specifically seek to develop a small number of pilot demonstration models of bio-filtration and bioremediation sites while four other models are specific to the development of riverfront, eco-park, institutional and industrial estate plantations. Avenue plantations in urban landscapes has been recommended.

Theme Plans

In addition to forestry interventions and specific treatment models included for three lower order zone plans, additional 'conservation activities' and 'supporting activities' those are common to two or all the three zones have been proposed. Theme based activities or 'Theme Plans' are grouped under the name of: (i) 'Conservation Interventions' such as (a) soil and water conservation, (b) riparian wildlife management, and (c) wetland management (natural and artificial), and (ii) 'Supporting Activities' such as (a) policy interventions, (b) concurrent action research, (c) capacity building, (d) awareness, (e) participatory monitoring, and (g) evaluation.

PROJECT PLANNING

The Project envisages following four Components for implementation.

(a) Implementation of Forestry Interventions in Five States of Riverscape: The State Forest Departments (SFDs) of the five states were identified as Implementing Agencies (IAs) for the forestry interventions. The organizational structure of SFDs, administrative units and management units existing in

the SFDs provide for greater scientific intervention options. The management units being based on natural micro-watershed boundaries made it easier for planning and implementation of activities and subsequent monitoring and evaluation of the impacts of such activities at micro-watershed levels. Besides five state level IAs (SFDs), select well known and established Central Armed Police Forces (ITBP and Eco Task Force) and Civil Society Organizations (NYKS –Youth and Eco Clubs etc. were also visualized as prominent partners in implementation of specific activities as planned in the DPR. This Component mainly includes: (i) Forestry interventions in three lower order sub-zones of the riverscape viz. (a) Natural Landscapes (NL); (b) Agriculture Landscape (AL); and (c) Urban Landscape (UL) by way of plantations through various specifically designed models; 'Conservation Interventions' such as (a) soil and water conservation; (b) riparian wildlife management; and (c) wetland management (natural and artificial); and 'Supporting Activities'.

(b) **Strengthening Knowledge Management and National Capacity for Forestry Interventions and Conservation of Riverscape:** Rivers serve as the chief source of renewable freshwater for humans and contain some of the highest levels of biodiversity on earth. Worldwide, threats to rivers have become severe for both securing human water supply and maintaining aquatic biodiversity. The situation of rivers in developing countries like India is more complex and severe owing to competing demands of various production sectors. Obviously, there are numerous challenges for sustainable management of rivers. Since streams and rivers are among the most endangered ecosystems, there is an urgent need for comprehensive methodological approaches to evaluate the state of these ecosystems, monitor their rate of changes, and ecological restoration. Political paradigms are fast changing away from river development to river conservation and river restoration. However, river conservation involves policy and planning with parties with disparate point of view. Better understanding of forest-river linkages and their intricacies and successful river conservation needs informed science and the involvement of

scientists. Beneficial outcomes from any such effort of river conservation are unlikely unless science can be actively engaged in the development and assessment of appropriate policies and management decision making. In the emerging scenario of transparency and public policy, comprehensive environmental planning and water management, there are many expectations for what role science can fulfill and what expectations science can meet. These expectations can vary based on the political climate, including different and often competing government agencies, the spatial and temporal scales of the river resources and complexity of the issues. The 'Best Available Science' is therefore, expected to play an important role and often insert into the policy, planning, and management arenas through major policy decisions (i.e. mandates or laws), regional planning decisions and management actions that can range in scale from local to national. In view of the priority emerging needs, the Component 2 of the Project aims to insert science into policy, planning, and management for informed decision making that can yield positive results for sustainable management of rivers in India. This Component will support improved knowledge and capacity building on learning and experience from the five pilot states in promoting riverscape conservation approaches nationwide by appropriate interventions and activities relevant to policy, development of knowledge management center, training, coordination, extension and monitoring and evaluation. In order to accomplish this, the national level organization for knowledge management and capacity building will require establishing a Project Facilitation Unit (PFU).

(c) Scaling Up and Replication of Successful Models of Forestry Interventions and Riverscape Conservation in Additional Sites/States: The DPR for Ganga focuses on five states in Ganga Basin and selected tributaries of river Ganga. The Component 3, therefore, seeks to support the further testing, replication, and scaling up of planned efforts in additional sites/ states by selecting some of the priority tributaries of Ganga those have been excluded from the purview of the present DPR or envisaged programme/ activities during the Phase I of the Project.

(d) National Coordination for Forestry Interventions and Riverscape Conservation: The Component 4, therefore, visualizes activities for: (i) the establishment of Decision Support and Management Information System (DSMIS) on riverscape conservation; (ii) facilitate activities related to policy interventions, riverscape level coordination and monitoring, impact evaluation; and (iii) administer the implementation of this pilot Project on forestry interventions and future replication in additional sites. In view of accomplishing this, the Component 4 visualizes a Project Management Cell (PMC) at the nodal ministry level. The PMC at the nodal ministry of MoWR,RD&GR will handle the execution of the Implementation Plan and coordination with implementing agencies at the state level in five states to begin with and other national and state level partner organizations.

IMPLEMENTATION, PROJECT OVERSEEING, AND FUND FLOW MECHANISM

The project envisaged two phases: (i) the Phase I including the Project Development Phase of 12 months (2015-16) and the Project Implementation Phase of 5 years (2016-21), and (ii) Phase II (2021-26) for upscaling and replication in additional sites. The Project Development Phase has been used for preparation of present Detailed Project Report (DPR) initially for 5 years (2016-2021). Subsequently, based on annual monitoring, evaluation, and lessons learned during the implementation of the Phase I, efforts to upscale and replicate in additional sites for the next 5 years will be made before the completion of fifth year for further execution of Phase II of project implementation (2021-2026).

The Project visualized setting of two Programme Steering Committees (PSCs), one at the national level in the Central Nodal Ministry i.e. National Programme Steering Committee (NPSC), while other at the state level in each of the five pilot states i.e., State Programme Steering Committee (SPSC). The DPR provides an insight on proposed constitution of NPSC and SPSCs in five states. The NPSC is expected to have about 20-22 members and would be responsible for approving the APOs submitted by the five pilot

states and national level partner organization besides overseeing and steering the execution of the IP. The funds against the approved APOs of the states will be transferred by the NMCG to the respective SFDs and other implementing agencies on approval by NPSC. The national level PFU will follow its own mechanisms of governance and if required will have its own monitoring and steering committee constituted for overseeing the Project.

PROJECT BUDGET

The Namami Gange was envisaged to provide the full financial support for execution of Implementation Plan incorporated in the DPR. Total projected financial outlay for the 5 year implementation Project (Phase I) was Rs. 2,293.73 Crore.

Treatment models

Rs. 2,064.03 Crore or 89.98% of the project budget was provided for 'forestry interventions in five states of riverscape', of which Plantation and Treatment models accounted for Rs. 1600.85 crore being 77% of the core forestry activity costs.

Of this since highest emphasis was on treatment models in Natural landscapes, an amount of Rs. 1,080.20 Crore was provisioned for afforestation activities in Natural landscapes. In addition, plantations through full engagement of two units of Eco Task Force in hills of Uttarakhand and Ganga Plains of Uttar Pradesh at a cost of 12.0 Crore was also planned, which takes total budget provision for plantations in Natural landscapes to 68.22% of the plantation budget.

Budget provision for Agriculture and Urban Landscapes was kept to the tune of Rs.159.71 Crore and Rs. 348.93 Crore or 9.97% and 21.48%, respectively of the plantation cost. Activities in agriculture landscapes chiefly focuses on plantations of economic and fruit trees on privately owned farmlands while activities in the urban landscapes include: (a) institutional/ industrial plantations, (b) bioremediation and bio-filtration, (c) riverfront development and ecotourism, (d) development of eco-parks, and (e) avenue plantations.

Conservation Interventions:

'Conservation Interventions' include three major types of interventions / activities namely (a) soil and water conservation measures, (b) riparian wildlife management, and (c) wetland management (natural and artificial). Budget outlay for this sub-component was Rs.419.33 Crore being 20.31% of the funds provisioned for implementation of forestry interventions by five states.

Other heads:

The budget provisioned for various supporting activities to the tune of Rs. 43.84 Crore or 2.12% of forestry funds for supporting activities such as (a) research, (b) capacity building, (c) awareness, (d) monitoring and evaluation, (e) contingency and miscellaneous activities, and (f) cost of PMUs at five states.

Around Rs 230 crores was provided for 'Strengthening knowledge management and enhancement of national capacity for forestry interventions and conservation of riverscape', preparation of DPR for Phase II, and to oversee, steer, and manage the priority project.

Thus, the bulk i.e 90% of project outlay was meant for field level activities relevant to proposed forestry interventions, conservation interventions, and supporting activities to be implemented by the five state. Notably, the highest amount of Rs. 885.91 Crore or 42.92% was to be provided to the state of Uttarakhand so as to provide extensive as well as intensive inputs in the high mountainous Himalayan part of the state as well as the part of the Ganga Plain in the state. The financial allocations for the other four states of Uttar Pradesh, Bihar, Jharkhand, and West Bengal were kept at Rs. 224.71 Crore, Rs. 333.67 Crore, Rs. 72.17 Crore, and Rs. 547.55 Crore, respectively.

Altogether, 111 Forest Divisions in the five states were mandated to carry out activities pertaining to forestry interventions including plantations, conservation interventions, and supporting activities.

PROJECT SCHEDULE

The project implementation period as designed and incorporated in the present DPR was for five years. Accordingly, various activities have been appropriately staggered during the 5-year period of implementation. The bulk forestry interventions including plantations, conservation interventions, and supporting activities are planned in the first three to four years. However, the cost for maintenance of plantations undertaken in third year of implementation will spill in the subsequent years post completion of 5-year Project.

Like proposed forestry interventions and field-based plantation activities are being staggered over 5-year project period, supporting activities (policy interventions, capacity building, research, awareness, monitoring and evaluation) by the national level partner organization and five state IAs are also appropriately staggered over 5-year period. In general, the first year of implementation would be more towards preparatory, inception, and engagement of contractual staff and initiation of various activities. The second and third year of the Project will have greater quantum of activities. Fourth year onwards, most activities will taper down. The mid-term and terminal evaluation of the Project has been specifically planned in the second half of the third year and the last quarter of the fifth year of implementation, respectively.

IMPLEMENTATION OF ANANT VAN –AVIRAL DHARA

This strategy suffered a setback even before the start of the program because the originally planned funding for the Afforestation and Bio Diversity conservation component of the Namami Gange program, promised to be in the range of Rs 1000 crore was slashed to Rs 150 crore only in the final allocation of Rs 20,000 crore. Thus the manner in which the afforestation program was to take off lost its direction even before start. The NMCG and State Forest departments in a damage control mode however decided to launch the plantation activities at reduced scale and the states submitted revised Annual Plan of Operations (APOs) as against what was submitted earlier based on the DPR. Since 2016-17 the states have been implementing small

portion of the DPR every year with funds provided by NMCG, which though does not meet in full measure the requirement of Anant Van the riverscape, it has kept alive the required focus on plantation as the single biggest contributor for Aviral Dhara. The efforts also found support from a renewed thrust on plantation all over the country during the last few years especially in the Ganga basin states, all of whom launched their own intensive plantation programs such as the "Haritima" in UP, "Har Parisar Hara Parisar" in Bihar, "Harela" in Uttarakhand and "Van Mahotsav" in Jharkhand and West Bengal. These dedicated programs have helped trees to become a rallying point for environment protection and people in large numbers especially school children have participated voluntarily in planting saplings and their protection. It can be safely said that realization for trees protection is now a given and the objective of Anant Van Aviral Dhara is well on its course despite the shortage of funds.

The table 1 gives summary of the forestry interventions undertaken and in process, in the Ganga states as part of Namami Gange program, under different treatment models during the period 2016-2020

Table 1

State	Natural landscape		Agriculture landscape		Urban and Peri-Urban landscape		Conservation-Interventions		Total	
	In Ha	Rs in Cr	In Ha	Rs in Cr	In Ha	Rs in Cr	In Ha	Rs in Cr	In Ha	Rs in Cr
UK	14805.5	66.03	3496.84	3.28	95.5	3.29	475	9.46	18872.84	83.18
UP	2746.5	17.55	3148.16	5.86	745.48	28.33	597.83	9.08	7237.97	62.84
BIHAR	1119.89	41.66	2551.91	4.83	0	0.65	0	0	6611.77	63.85
JH	784	17.38	0	0	0	3.8	0	2.83	784	24.41
WB	4306.8	14.1			2623.11	20.61			6929.91	35.76
Total	23762.69	156.74	9196.91	13.98	3464.09	56.67	1072.8	21.4	40436.49	269.76
$		68%		10%		21%		20%		
#		58%		5%		21%		7.9%		

($) Treatment model cost as percent of total cost on Forestry intervention as planned in FRI DPR.

(#) Actual cost incurred on different treatment models as compared to total cost incurred.

(Expenditure figures are approximates and may not add up)

As may be seen from the above table the Natural landscape treatment models accounts for lion's share in the plantations carried out as planned in the DPR. The share of plantation under Urban landscape is also as per the DPR at 21%. Some variation in Conservation interventions is on account of the fact that because of shortage of funds focus only remained on plantation and not many soil conservation activities were taken up. The variation in Agriculture landscape may be explained by the fact that farmers bear part of the burden in this model.

The similarity in expenditure pattern with that planned in the DPR reinforces the strength of the document and also establishes credibility of the Forestry intervention in Ganga. It gives hope of Anant Van leading to Aviral Dhara. With the reported acceptance by Ministry of Environment Forest and Climate Change to fund the balance portion of the DPR from CAMPA funds, Ganga is bound to get her aviralta back in not too distant future.

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S.K Singh and Others*

High Resolution DEM and GIS for Part of Ganga

Abstract:

Namami Gange is an Integrated Conservation Mission for Ganga and its tributaries, to accomplish the twin objectives of i) effective abatement of pollution; ii) conservation and rejuvenation of National River Ganga. The mission has basin based approach with interventions of diverse nature and there has been strong support to research, generation of high quality data to enable evidence based policy making.

Survey of India (SoI) has been entrusted to create GIS Ready datasets including High resolution DEM, which would aid major support to Ganga River Basin Management. Area for proposed work includes entire corridor along river Ganga and its tributaries with a 10 Km buffer on each bank. The project involves preparation of High resolution DEM (0.5m accuracy) for 10 km limit from the banks of the river including GIS Ready Database and integration of GIS dataset with available datasets of Public drainage network along river Ganga. Mapping of river Ganga in five Ganga main stem states has been proposed along major towns and cities in the river Ganga and its tributaries with an area of about 43,084 square km. These are fresh data acquisition using suitable sensors on Airborne platform, development of Geoid model, ground data validation, data collection of ground level discharge, capacity building etc. This project has been entrusted to the Geodetic & Research Branch of the Survey of India for its implementation and completion. This ambitious project is first of its kind which has been undertaken by NMCG and will be a trend setter for basin management, flood plain demarcation, preparation of interventions on scientific data.

* Neeraj Gurjar, Avinash Mishra, Arun Kumar, Peeyush Gupta

INTRODUCTION

River Ganga has been playing very crucial role in India so far as economic, environmental and cultural value is concerned. Millions of Indians who live in the flood plain of Ganga, are relying on it for their daily needs. Population living along its course takes holy dip during the festivals. River Ganga has got a variably different water use along its course so far as bathing, drinking, municipal supply, navigation, irrigation and fishing are concerned. Unfortunately, it is also being used as a wastebasket for discharging industrial effluent, municipal sewage and dumping of solid wastes.

Vigorously increasing population, industrialization and urbanization have unshrouded the water resources to various forms of degradation. Due to which several reaches of this holy river have become unfit for bathing. Various efforts have been made in the past to clean the Ganga. In 2014 the present government started Namami Gange Mission to ensure clean Ganga.

All type of pollutants have associated with various spatial components e.g., vent of sewerage and other discharge from all dwellings, industrial, commercial and all other units producing liquid waste. Therefore, the entire public drainage network, crematoria, Ghats, solid waste disposal sites are required to be mapped to show the stretches of river Ganga which are polluted or which are at high risk to get polluted in near future. GIS mapping of river is considered one of the most important steps in pollution abatement because it identifies the sources of pollution to plan for measures to be taken to reduce the pollution level in various reaches of river. Air borne imagery and GIS data can be a very powerful tool in locating and identifying the spatial component of river pollution for its subsequent micro level management. Air borne imagery gives a compendious view of the sources of pollution. They are used to measure and monitor the extent of stretches of river which are polluted and accordingly planning can be done for set up of STP/ETP/CETP to mitigate river pollution. Mitigation of pollution can be successful only when detailed knowledge is obtained about the sources of pollution, character and magnitude of pollution in an area.

'Namami Gange Programme', is an Integrated Conservation Mission, approved as 'Flagship Programme' by the Government of INDIA in June 2014 to accomplish the twin objectives of i) effective abatement of pollution; ii) conservation and rejuvenation of National River Ganga. The key intervation under Namami Gange programme includes, River front Development, creation of sewerage treatment capacity, River surface cleaning, Bio-diversity conservation, industrial affluent monitoring, Afforestation and Public awareness programs.

Keeping in view above said objectives, Survey of India (SoI) has been tasked to create GIS Ready datasets including High resolution DEM, which would facilitate major support to Ganga River basin Management. Area for proposed work includes entire corridor along river Ganga and its tributaries with a 10 Km buffer on each bank. However airborne data acquisition for generation of high resolution DEM and ORI, shall exclude the reaches which are already being covered under World Bank assisted NHP programme to avoid duplicity. Deliverables of mapping would be Digital Elevation Model/ Digital Terrain Model (The bare earth model has vertical accuracy better than 50 cm), contour of 1.0 m, ortho-photos (25 cm Ground sampling distance or better), GIS ready dataset, outlet/ vent of sewerage and other discharge from all dwelling units, industrial, commercial and all type of other institutions. The dataset will include the sources outlet to the public drainage network, the entire public network integrated with the present project mapping, crematoria, ghats, solid waste disposal sites, STP/ETP/CETP etc for defined project area of interest. Final Data will also be hosted on SoI Secure Portal and will be made accessible as service through simple customized applications for NMCG.

PROJECT AREA

NMCG project involves preparation of High resolution DEM (0.5m accuracy) for 10 km limit from the banks of the river including GIS Ready Database and integration of GIS dataset with available datasets of Public drainage network along river Ganga. Mapping of main stream of river Ganga in five major states namely Uttarakhand, Uttar Pradesh, Jharkhand, Bihar and West Bengal has been proposed

along major towns and cities in the river Ganga and its tributaries in these states with an area of about 43,084 square km.

Survey of India is currently engaged in implementation of National Hydrology Project (NHP)-III of Ministry of Water Resources (MoWR). One of the deliverables under NHP Project is preparation of High resolution DEM (0.5m accuracy) covering 5 km area from the banks of the River. As most of the area covered under NHP along main stream of river Ganga falls within the NMCG project requirements, there is an overlap of ≈ 17825 km2 between these two projects. Hence fresh Survey & Mapping of additional ≈26701 km2 area will be undertaken for generation of DEM, Ortho-Rectified Image (ORI) and preparation of GIS ready database, data validation/data collection and data hosting. For area under overlap with NHP project, only remaining activities i.e. feature extraction as per NMCG requirements for preparation of GIS ready database, ground validation/data collection activities and data hosting will be undertaken. This approach will not only avoid the duplication of work; it would also save considerable Government resources with added advantage of reduction in project timelines.

Major components involving field data acquisition of the project are –

- Fresh Data acquisition using suitable sensors on Airborne Platform, of Ganga Basin Area.
- Development of Geoid Model for area under NMCG, to transform elevation data acquired through Airborne sensor to Indian Vertical Datum (IVD 2009) heights.
- Extraction of features as per NMCG data model out of Ortho-Rectified Image (ORI) and point cloud; and preparation of GIS ready Database
- Integration of GIS database with available Public Drainage Network datasets.
- Ground data validation and Data collection of points of Sewerage/other discharge from all Dwelling units, Commercial, Industrial etc. as per deliverables

- Data/Service Delivery Mechanism with Applications Development for use of Final Geo-spatial data for NMCG.
- Training of officers and Staff from both Survey of India and NMCG/MoWR in Geospatial database creation, management, maintenance, application development, OGC compliant service creation & delivery

After completion of the project the main deliverables from these data will be:

a. DEM (vertical accuracy better than 50 cm), contour of 1.0 m for the project area of Ganga basin
b. Orthophotos (25 cm GSD or better) for the project area of Ganga basin
c. GIS Ready Dataset including for the Project area of Ganga Basin as per feature based Data Model of SoI
d. Outlet/vent of sewerage and other discharges from all dwelling units, industrial, commercial and all types of other institutions will be mapped, from the source outlet to the public drainage network.
e. The entire public drainage network in the project area will be integrated with the present project mapping.
f. Final Data will also be hosted on SoI Secure Portal and will be made accessible as service through simple customized applications for NMCG.
g. Capacity Building: Training of staff and Officers of NMCG and Survey of India.

This project has been entrusted to the Geodetic & Research Branch of the Survey of India for its implementation and completion.

METHODOLOGY

Data acquisition using suitable sensors on Airborne Platform for generation of high resolution DEM and ORI

Under NMCG project, mapping of main stream of river Ganga in five major states namely Uttarakhand, Uttar Pradesh, Jharkhand,

Bihar and West Bengal has been proposed along major towns and cities in the river Ganga in these states with an area of about 43,084 square km. This mapping will comprise of preparation of High resolution DEM (0.5m accuracy) covering 10km area from the bank of the river including GIS ready dataset.

Data acquisition for creation of High resolution DEM is proposed to be completed using suitable sensors on Airborne Platform. For generation DEM, LiDAR technique will be used.

LiDAR is a remote sensing technique which uses laser to measure distances to the Earth. This LiDAR data with other onboard data i.e. IMU and GPS gives precise, three-dimensional information about the Earth and its surface characteristics based on a Geometrical surface i.e. an ellipsoid. To convert these heights Geometrical to a meaningful physical height a Geoid model is needed.

Since NMCG project and NHP-III share overlapping area (17825 sq. km), for which the deliverables of NHP-III are of similar to the deliverables of NMCG project. In NMCG project only the left over areas will be covered which accounts for 26701 sq. km. Therefore fresh Survey & Mapping of additional area (26701 sq. km) will be done for generation of DEM, Ortho-Rectified Image.

Development of Hybrid Geoid for Project Area

As measurement of position of Aircraft during data acquisition is made by GPS observation, Data acquired through airborne sensor will give elevation data of intended area with reference to Ellipsoid. For hydrological modelling, required DEM should be referenced to IVD 2009. To transform acquired elevation data to orthometric heights, Geoid model will be required. Geoid is an equipotential surface, which is an irregular surface due to uneven distribution of mass density of earth and serves as reference surface of height. Three types of field data are required i.e. gravity value measurement, GNSS observation and High precision leveling data to develop a geoid model for intended area of survey.

The Geoid model would facilitate the conversion of the ellipsoidal height (hGNSS) obtained from GNSS technique to the physical meaningful orthometric heights (H) through the equation;

$$H = hGNSS - N \quad \ldots. (1)$$

Where 'N' is known as Geoid height or Geoid undulation derived from the Geoid model. In order to achieve the accuracy of 50 cm for DEM, the Fundamental Vertical Accuracy (FVA) of the order of 40 cm for the data to be required through LiDAR has been prescribed for the project. Therefore, the Geoid model should be designed to yield vertical accuracy of less than or equal to 10 cm. In order to achieve this objective following parameters for field survey are prescribed for intended area

1. Gravity observation at grid interval of 10 km
2. GNSS observation at every 40 to 50 km interval on Levelling Bench marks.
3. A Remove – compute – Restore (RCR) technique will be applied to develop the geoid model.

Feature Extraction from ORI

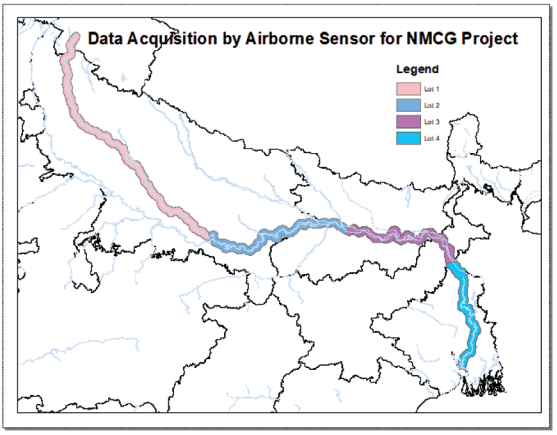
For abatement of pollution and, conservation and rejuvenation of Ganga River, understanding of river morphology, flood zonation, river habitat classification, the pollution sources along with sewerage and non-sewerage interventions are required. In order to achieve said objectives, Generation of GIS ready geospatial dataset for project area has been envisaged. This GIS data will further aid Ganga River basin management by fixing liability and amenability in different aspects of decision-making as well as it will also enable a sound process of monitoring development along River stream. GIS ready dataset then further integrated with available public drainage network data and Administrative boundary data upto village level. Public drainage data and village boundary data, will be collected by SoI, from respective municipal and revenue authorities. Data will be further validated on ground and additional data for point of sewerage and other discharge will be collected and integrated with GIS ready dataset.

Generation of GIS ready geospatial dataset by feature extraction from ORI and point cloud data; integration of available public drainage network data and Administrative boundary data; integration of field validation data and point of sewerage and other discharge collected from field shall be carried out under feature extraction work.

Feature extraction work, which includes Generation of GIS ready geospatial dataset by feature extraction from ORI and point cloud data; integration of available public drainage network data and Administrative boundary data; integration of field validation data and point of sewerage and other discharge collected from field, shall be done for the overlapping area (17825 sq. km) of NMCG project and NHP-III as well as the left over area (26701 sq. km) of NMCG project. Total area has been divided into four lots:

Sl. No.	Description	Area in sq. Km
1.	Lot -1 covering 10 km corridor from the banks of upper reach of Ganga River (Rishikesh to Allahabad)	16517.33
2.	Lot -2 covering 10 km corridor from the banks of middle reach of Ganga River (Allahabad to Patna)	11083.07
3.	Lot -3 covering 10 km corridor from the banks of lower reach of Ganga River (Patna to Farakka)	9532.18
4.	Lot -4 covering 10 km corridor from the banks of lower reach of Ganga River (Farakka to Haldia)	7393.74

This work includes extraction of features from point cloud and ortho rectified imageries for generation of GIS ready data set. This



GIS ready data set shall contain following features

a. Administrative boundary upto village level.
b. Habitation including dwelling units, Commercial entities, Industries.
c. Roads and Railways with all associated features.
d. Contours (1.0 metre interval) and 0.5 metre accuracy Digital Elevation model (DEM).
e. Streams, Rivers, River Banks, Ponds, Canals.
f. Outlet/Vent of sewerage and other discharge from all dwelling units, industrial, commercial and all types of other Institution from the source outlet to the public drainage network.
g. Toponyms shall be taken from largest available scale SoI Toposheet. In addition to this, name attribute for Major Roads, Major Road junction places of Antiquity and Major Residential/Commercial/Industrial zone shall be picked up during data validation.

Specification

Feature extraction work shall be carried out with following specification

- Projection : UTM
- Datum : WGS84
- Sheet numbering & layout : 1:2000 sheet numbering
- Scale of Map plot : 1:2000
- Sheet size : 36"×36"
- Graticule Lines : 12"×12"
- Horizontal Accuracy of Extracted features : better than 50 cm
- Annotations : As per SoI specification
- Data Model Structure : As per SoI specification
- Undershoots/overshoots : Nil

- Sliver tolerance : Nil
- Weed tolerance : 75 cm
- Units of Precision : mm (Meter with 3 decimal places)
- Level of Details : LoD0 and LoD1

QA/QC Mechanism

Quality Assurance - Quality assurance (QA) in this document will refer to a set of approaches which is to be consciously applied and, when taken together, will tend to lead to a satisfactory outcome for a particular process. Quality controls (QC) and Quality Audits shall be important checks within a QA system.

Quality Control- A quality control (or check) is a clearly specified task that scrutinizes all, or a sample, of the items issuing during, or at the end of, the geometric correction process in order to ensure that the final product is of satisfactory quality. The scrutiny involves review, inspection or quantitative measurement, against well defined pass/fail criteria which are set out in these guidelines.

Quality Audits- A quality audit is a qualitative quality control that covers an area of activity as a whole. Quality audits will be carried out by comparison of actual practice with the applicable quality assurance guidelines.

Two degrees of Quality Audits

- Normal
- Tightened

"Normal" audit checks which are carried out 'Once' will be repeated again if a corrective measure is requested. "Tightened" audit checks will follow an audit trail for suspect products or regions and will be introduced if

- earlier audits result in doubts about performance
- results from QC do not meet the specifications given in previous sections
- results from external QC do not meet the tolerances gve in specifications

The information used in a Quality Audit will mainly be provided by quality control records (QCRs) which are generated during the work, by the people doing the work. QCRs take a variety of formats, such as paper forms completed manually, printouts or computer files recording the result of a particular procedure, or just simply hand-written records in log books.

The key features of any QCR are that it

- is marked with a date
- uniquely identifies the item, operation or product to which it relates
- identifies the operator who generated the QCR
- may be countersigned by a supervisor or other independent inspector (only for the most important records)
- is stored in a well defined and predictable location so that it can be found easily by others.

Around 5-10% of output data will be subjected to Final Quality Check. Product files will be selected on a systematic basis to ensure that QC covers all the lot/site area. Deliverables will be selected on a random basis to provide a closer look of the areas where problems are anticipated more frequently (e.g. known quality problems with specific batches of original data or significant terrain variation, high view angles, etc.). If required, sample examination may also be carried out of the deliverables on ground.

Collection of Village boundary and Public drainage network and its integration with GIS datasets/Framework

One of the key objectives of NMCG is to generate geospatial data of river Ganga basin and its integration with available Public Drainage Network datasets. There are about 160 Subdivision falls in 5 states under area of interest of NMCG project. Collection of available public drainage network is a mammoth task, which will require considerable time, manpower and planning, so that available Public Drainage Network datasets, can be collected, scanned and archived before commencement of Data integration work.

In addition to Public drainages Network, Administrative boundary upto village level is also to be collected for purpose of creating GIS ready data set.

- Once collected these features needs to be scanned and integrated with GIS data set created from features extracted from ORI as per data model structure.
- As most of layout/blue print of available public drainage network data set and revenue maps are not geo-referenced, these layouts/charts/maps need to be geo-referenced by feature to feature registration.

Data Validation and Data collection of points of sewerage/ other discharge

GIS ready data set prepared from ORI and point cloud need to be validated on ground. In addition to this, collection of crematoria, ghats, solid waste disposal sites, STP/ETP/CETP etc along with outlet/Vent of sewerage and other discharge from all dwelling units, industrial, commercial and all types of other Institution from the source outlet to the public drainage network; and integration of collected data with available public drainages network and GIS ready data set has also been mandated as core project objective. This data will help decision makers in various aspects of river rejuvenation and conservation work i.e. identification of pollution sources; identification of alternate disposal sites; quantification of exact solid waste and sewerage generated from any particular dwelling, commercial or industrial unit; estimation of design parameters for STP/ETP/CETP to prevent pollution of river from incoming sewerage etc.

Data validation/collection will be done using GPS in RTK mode having positional accuracy better than 40 cm. GPS in RTK (Real Time Kinetic) mode is a positioning technique used to give precise real time position data from satellite based positioning. RTK systems involve use of a single base-station receiver and a number of rovers. Differential corrections from the base stations are transmitted to the rover station in real time. Rovers determine their precise position using complex algorithms which includes ambiguity resolution and differential correction. Position obtained in rover GPS in RTK mode

will be displayed into android/windows based tablet/laptop in any preloaded GIS software. ORI or Vector data from feature extraction uploaded into said GIS software, which also shows position of point of occupation of rover station on same screen. Using this technique already extracted feature can be validated on ground as well as new features can be captured.

Web hosting of GIS data and Application development

Final Data will also be hosted on SoI Secure Portal and will be made accessible as service through simple customized applications for NMCG.

CONCLUSION

Increasing pollution in River Ganga, water of which was once known for its purity, clarity and divine properties, has become a matter of concern for every citizen of this country. It has now been established that Ganga water is not fit for drinking or bathing at many places along its course due to presence of substances which are harmful for human being. Geospatial data is one of the important requisites apart from the other measures which provide an incredible input to the efforts being initiated to clean the River Ganga by various organisations. It is in this context the work of creating a GIS database has been assigned to the Survey of India.

The aim of this project is to create GIS ready dataset with Digital Elevation Model having vertical accuracy of 0.5m along the banks of the river Ganga. This GIS ready dataset will include entire public drainage network and administrative boundary up to village level falling in project area. Final data will be hosted on Survey of India secure portal. This dataset hence created will be useful in real time pollution abatement, River Front Development, creation of sewerage treatment capacity, River surface cleaning, Bio-diversity conservation, industrial affluent monitoring, afforestation and Public awareness programs. The dataset will also be shared with civic authorities for varied usage.

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SECTION III

SOCIO-CULTURAL ASPECTS AND COMMUNITY LED RIVER REJUVENATION

Ruchi Badola and others*

Ganga Prahari - Guardians of the Ganga

'Ganga' is not just a river but a lifeline for about 500 million people and has been the origin of beliefs, cultures and lifestyles in India. According to legends, brought down from heavens on earth by Bhagirath for salvation of humans, Ganga holds significant biodiversity within its waters and surroundings where ever it flows. Over usage and over exploitation of this pious river today has brought an array of stakeholders to work together for its conservation and rejuvenation; this includes an inseparable stakeholder group - the local community. These local communities, who have been residing along the banks of Ganga for generations, have a special connect with the river. For them, it isn't just a flowing water body but is mother and they hold it with the highest regards.

The Ganga Basin however, is one of the most densely populated river basins in the world and faces anthropogenic pressures such as reduced water availability, habitat degradation, pollution, and unsustainable resource extraction. In order to conserve the ecological integrity of the Ganga River, and, reduce the direct dependency of the local communities on the river, the National Mission for Clean Ganga (NMCG) and Wildlife Institute of India (WII) initiated a project - Biodiversity Conservation and Ganga Rejuvenation. Through, this project WII aims to prepare a science based restoration plan by involving multiple stakeholders and the local community as guardians of the river and called them **"Ganga Praharis"**.

The aim of this initiative was to establish a motivated and trained cadre of "Ganga Prahari" to support the local level institutions and monitor the quality of the natural resources of the river by mobilizing local communities at the grassroots level. This was done by:

* S. A. Hussain, Deepika Dogra, Pariva Dobriyal, Hemlata Khanduri, Aditi Dev and Sunita Rawat

(a) Creating awareness about the benefits of a clean and vibrant Ganga and a sense of belongingness among people towards River Ganga.

(b) Linking local communities with the overall efforts of various agencies working for a clean Ganga and thereby creating a convergence point at grass root level for such efforts

(c) Linking local people's livelihood and well-being with a clean and vibrant Ganga.

Community participation through Ganga Praharis program is promoting local pride and evoking a sense of belonging towards the Ganga River ecosystem.

Process of Identification and Recruitment of Ganga Prahari

In this programme Ganga Praharis were identified through a series of site level consultative meetings and workshops held in select villages located on the bank of the Ganga River in all the five Ganga states. Effort was made to identify motivated individuals who can mobilize others in Ganga conservation efforts. The local communities were also approached through other agencies like State Forest Departments, Educational Institutes, National Cadet Corps (NCC), National Service Scheme (NSS) Mahila Mangal Dal, Yuva Mangal Dal, Nehru Yuva Kendras and Ganga Vichar Manch to identify the potential Ganga Praharis. To ensure a fair and just representation of youth from all the districts and villages located along the Ganga River, one to one discussions were held with the school and college students. The primary criterion for identification of a candidate was their passion and zeal to serve the Ganga River and maintain its integrity in terms of its cleanliness and biodiversity value. The younger school students too have been recruited as Bal Ganga Praharis.

Capacity Development

Once recruited, the Ganga Praharis were trained in; ecological monitoring of the Ganga River, tree plantation techniques, awareness generation through meetings and workshops, community mobilization etc. so as to develop their capacity for their involvement

in various activities conducted by other stakeholders, such as Forest Department, State Project Management Group of NMCG, NGOs etc. Additionally, the Ganga Praharis have been linked to various local environmental authorities, non-governmental stakeholders in their respective states and various other national academic and research institutions through their national level database hosted at the NMCG web page. This database holds complete information of each and every individual with their contact details, residential address, number of training undertaken and number of output activities conducted by them.

Role and Responsibilities

Ganga Praharis are being groomed to be the leaders from their communities for their courage and enthusiasm in the field of conservation. They are the role models in inspiring other members of the community to join hands in the efforts for conservation of the biodiversity of the Ganga River. Thus, each Prahari is working on the model of 'Each One makes Ten'. Ganga Praharis are the torch bearers who ensure a proactive role at their respective sites. The Ganga Prahari are thus the key person for:

(a) Mobilizing the local communities in their respective villages in support for maintaining the integrity of the Ganga River ecosystem

(b) Liaising with the local Forest Department staff at their respective villages in maintaining a clean and vibrant Ganga by providing support for biodiversity monitoring, taking part in anti-poaching operations, and river side plantation programs

(c) Assisting the NMCG-WII teams in preparation, coordination and implementation of village level micro plans for sustainable development in aligning with Swatchh Bharat Abhiyan, and

(d) Act as the convergence point for developmental activities, livelihood programmes and biodiversity conservation at village level joining with alternate livelihood activities to reduce the direct resource dependency on the River Ganga.

Structure of Ganga Prahari Cadre

The proposed structure of Ganga Praharis in each of the five Ganga River States, a maximum of five villages from the riverside form a 'Cluster'. Each cluster will have a leader, who will be chosen by the WII in consultation with other members from the cadre. A Block Cluster Leader leads the entire cluster in a particular block. The Block Cluster Leader and Cluster Leader are selected from among the Ganga Prahari of these villages, on rotational basis for three months initially. Each Cluster Leader, with the support of Ganga Praharis, is supposed to conduct a minimum ten relevant activities in three months time. These activities are proposed to NMCG-WII team for approval. All the necessary logistics support during those activities are provided by WII through the NMCG-WII project. The Cluster Leader is paid a token amount as honorarium for each of the activity.

Team at Wildlife Institute of India, does the overall supervision and reporting to the NMCG. The performance of the Cluster Leader will be evaluated on the basis of their performance in the field and the best Cluster Leader award is be given to encourage the Ganga Praharis.

Connecting the Dots

Ganga Praharis are the mode to establish link with the local communities and in turn link them to various Ganga biodiversity conservation initiatives. The WII is the nodal agency for creation, guidance and facilitation of the Ganga Praharis. The implementation of joint actions between institutions and local actors strengthens conservation and management of resources. For this Ganga Praharis of these five states are being linked through mobile applications (such as Bhuvan Ganga, mygov.in, swatchta app.) creating a broad network among them in the future.

Benefits of Being a Ganga Prahari

Ganga Praharis are provided with a certificate after training on skills development. The database of the Ganga Prahari is shared with the NMCG and all its concerned organizations, institutes and

other line agencies. As per the interest/skills of the individuals they are further linked to the concerned agencies for further training/skill development and enhancement opportunities. They are recommended to the line departments such as the Forest Department, Irrigation Department, Fishery Department, State Programme Management Groups (SPMGs), District Ganga Committees and other research and development organizations for work opportunity. Ganga Praharis are given preference for work/assistance in field-based survey conducted by WII and other research institutes in the main stem of Ganga and now in its tributaries. They are recommended by the WII to various educational Institutions for pursuing higher education/training/skill development.

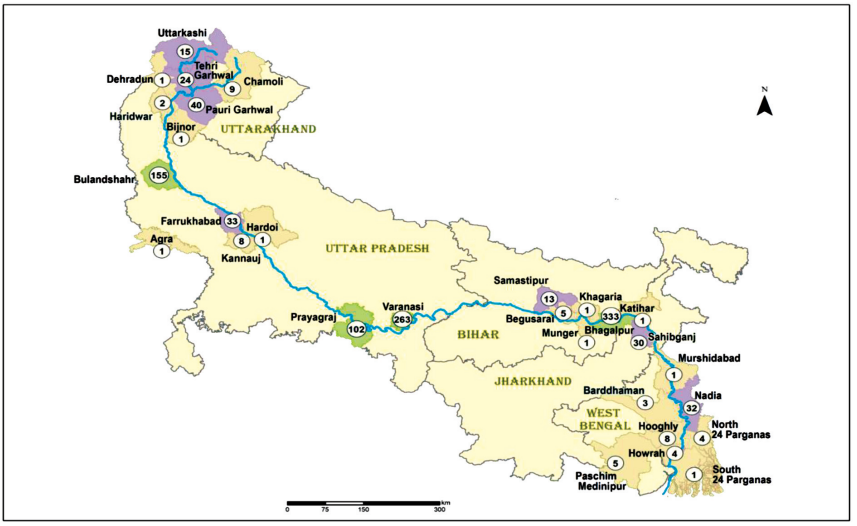
Programme Output

This trained cadre of Ganga Praharis has been successfully ensuring protection and conservation of biodiversity by local communities residing along the banks of River Ganga. They are motivating the communities residing along the stretch of Ganga to adopt sustainable practices for collection/use of its bio-resource. These volunteers are thus ensuring cleanliness of the Ganga River in their village and are a successful grassroots level movement for a clean and vibrant Ganga.

Achievements

Today, Ganga Prahari is a functional cadre of more than 1100 volunteers. Ganga Praharis, are conducting regular cleanliness and plantation drives, mobilizing community members using innovative methods like storytelling, street plays and poems in their respective areas. They are playing a pivotal role in successful execution of various activities pertaining to NMCG and WII project goals. The reward for their untiring efforts reached a new horizon when Sh. Darshan Nishad, Ganga Prahari from Varanasi got a chance to interact with the Honourable Prime Minister of India and brief him on the Ganga Prahari program, during a Mega Plantation Drive held during April 2019. Another successful display of their efforts was seen in the Kumbh Mela at Prayagraj, where, 149 Ganga Praharis participated in cleanliness drives, awareness campaigns,

rescue of reported distressed animals, guided visitors to shelter and health camps. As an appreciation of their hard work, Ganga Praharis were felicitated by the Honourable Minister for Jal Shakti Shri Gajendra Singh Shekhawat in New Delhi on the occasion of World Environment Day 2019. Ganga Prahari program has provided women of the rural households a unique window of opportunity to be in the forefront of conservation. Trained through various skill development workshops and training courses they have opted for an alternate source of livelihood, today. A successful model of this effort can be seen in the form of Jalaj- a floating market at Varanasi that has turned the Ganga Praharis into "Green Entrepreneurs". Two new extended program of this initiative are Bal Ganga Prahari and Pravasi Ganga Prahari. A total of 64 schools have been identified and citizens from 15 different countries across the globe have joined in the efforts of Ganga Biodiversity conservation, respectively. The Ganga Prahari program has successfully provided an identity and platform to the local people's efforts for biodiversity conservation of the Ganga River and its cleanliness.



Ganga Praharis location

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Lolia Mary and Bhawna Badola

A Community Participation Model for River Protection

Under its programme of Community Engagement for River Rejuvenation (CERRE), TREE Craze Foundation (TCF), has made a careful study of river conservation and rejuvenation strategies adopted on various international rivers including Thames, Rhine and Murray-Darling among many others. It has unambiguously emerged that active citizen engagement has been the mainstay for all successful interventions and has also ensured sustainability of major capital investments. Such community participation has mostly been in voluntary sector, though some government support has helped the process. However an institutionalised voluntary citizen engagement is sine-qua-non for an effective strategy. In the case of our country, there are many voluntary organizaions active at grass root level, but most of them function as individual organisations. TCF has evolved a River Trust based model to streamline the multitude of initiatives and efforts by various grass root level organisations. With a proposed framework of legal status, institutional arrangements, and a draft charter detailing the role, structure, membership and critical grass root level activities for river protection and rejuvenation; TCF, propose to test and evolve the River Trusts model through pilots, on ground. The article shares the learnings on community participation from across the world, and further details the proposed River Trusts model in the context of India's demographics, socio-economic and socio-cultural conditions.

INTRODUCTION

Involving communities in decision making is vital to ensure that the right development decisions are made. Rather than government solely regulating the actions of private parties or managing publicly

owned resources, collaborative environmental management implies that government shares decision-making power and authority with other stakeholders.[1] This allows to bring consensus from people who are going to be affected or benefited from the decisions made.

While community engagement, participation and awareness building has gained much importance, it still often uni-directional. However, too frequently the emphasis is placed on a one-way flow of information-from officials to citizens-with limited scope of providing feedback or negotiation. Therefore, citizens have to be heard and empowered to engage in decisions for the natural resources and environment that they live with. Many traditional practices and solutions which are indigenous to a locality is getting lost. This can be reversed only by supporting such practices indigenous to the locality thus rekindling a community's sense of ownership.

A partnership approach between statutory bodies (e.g. central, state and local agencies responsible for river restoration) and community-led organizations (e.g. local trusts, and local groups working for river restoration) should be a prerequisite to any river restoration proposal and in assessing and regulating large scale development within a rivers catchment[2]. A study suggest that 75 % of river restoration projects did not reach their minimal goals due to the lack of active stakeholder involvement[3]. A successful river restoration programme of Danube and Rhine are based on the Water Framework Directive that explicitly states that its success would rely on public involvement (Preamble 14 of the WFD), with decisions made in a collaborative and transparent manner[4] .

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[1] Koontz, Tomas M. Steelman, Toddi A. Carmin. JoAnn. Korfmacher, Katrina Smith. Moseley, Cassandra. and Thomas, Craig W. 2004. Collaborative environmental management : what roles for government?. RFF Press book

[2] URBEM - best practice guidance for citizen involvement in river restoration, August 2005, Newcastle City Council

[3] Heldt, S. et al. 2016. Social pitfalls for river restoration: How public participation uncovers problems with public acceptance. Environmental Earth Sciences 75:1053, DOI 10.1007/s12665-016-5787-y

[4] Voulvoulis, Nikolaos, Arpon, Karl D., Giakoumis, Theodoros. 2017. The EU Water Framework Directive: From great expectations to problems with implementation. Science of the Total Environment 575 (2017) 358–366

Any major programme on the clean-up of river Ganga initiated by the Government of India, including Ganga Action Plan (GAP), is a 'people's programme' because of the powerful and deep-seated cultural and religious meaning associated with the Ganga. Ironically, the major critic of Ganga Action Plan (GAP), the first ambitious program by Government of India in 1985 to clean river Ganga, was an over-reliance on conventional approaches, conceived and implemented by the central government, failing to involve the public and local stakeholders.[5] The top-down approach, where the planning and sanction of interventions are through central government with minimal participation from local government and public, assumed that people are the problem, rather than the institutions. Hence, all efforts to create awareness and monitor pollution does not involve sharing information about the program with the public, and hence, did not create any lasting sense of ownership.

'Namami Gange' programme launched in 2014 by the Government of India has tried to handle this issue through strategic communication and enhanced public participation and outreach. Public awareness is considered as one of the eight pillars of the Namami Gange programme where numerous IEC activities are being organized to make a strong pitch for public outreach and community participation in the programme[6]. Some of these activities include Ganga Quest, an online quiz on Ganga launched in collaboration with TREE Craze Foundation; Meri Ganga Quiz, a joint program with Doordarshan, The Great Ganga Run, developing a cadre of trained volunteers (such as Ganga Praharis, Ganga Vichar Manch, Ganga Task Force, Ganga Mitras) amongst several others.

In 2016, a notification was issued by Ministry of Jal Shakti to empower National Mission for Clean Ganga (NMCG) as an authority, District Ganga Committees is constituted in every district abutting

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[5] Das, Priyam, and Tamminga, Kenneth R. 2012. The Ganges and the GAP: An assessment of Efforts to Clean a Sacred River. Sustainability 2012, 4, 1647-1668; doi:10.3390/su4081647

[6] https://nmcg.nic.in/NamamiGanga.aspx, as accessed on 3rd Dec 2019

[7] https://nmcg.nic.in/writereaddata/fileupload/47_AuthorityNotification.pdf, as accessed on 3rd Dec 2019

River Ganga[7] and its tributaries for the prevention, control and abatement of environmental pollution in the River Ganga. A separate budget is also assigned to support and empower District Ganga Committees which is considered a significant step to strengthen the involvement of local stakeholders. However, there is still a question on how representative the Committee would be to evaluate interests of all sections of society.

During last year or so, attempts have been made to fully activate these District Ganga Committees through several activities of public outreach and conduct of meetings of the committees. The full success of these efforts are yet to be witnessed and it is observed that the actual potential of these efforts doesn't entirely reflect on ground. However, this is a strong formal framework with required authority to guide the program in right direction if an institutional arrangement is made to involve stakeholders and develop community participation. There continues to be gap between government entities and community based organizations/groups working at grass root level. Bridging this gap and strengthening the link is essential. TREE Craze Foundation did an extensive study of the international and national examples available as of now for community participation. The study indicates that there is a need to bring together the strengths of individual efforts, into a model for community engagement that is coordinated, integrated and holistic; which emerges from grass-root level action and having positive impact at regional/national or even international level. In the case of rivers, we can paraphrase this idea as; ***'From rivulets/sub-tributaries and watersheds to River and River Basin.'***

Hence, TREE Craze Foundation has developed a concept of River Trust that addresses the issues observed in existing set-up of community based organizations which is summarized in Figure 1. This chapter will summarize the learnings of our study on community engagement and also discusses the concept of 'River Trust' – a model of institutionalizing community involvement – which TREE Craze intends to pilot in one of the districts in river Ganga.

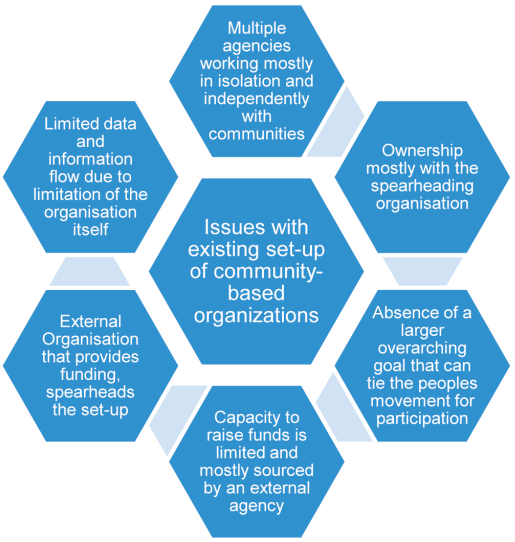

Figure 1. Issues in existing set-up of community-based organizations

LEARNINGS FROM INTERNATIONAL AND NATIONAL EXAMPLES OF COMMUNITY PARTICIPATION

A number of case studies, on community participation models, from across the globe, was studied in detail, to understand their key strengths and weakness.

- **The Rivers Trust of UK;** was formerly called, "Association of Rivers Trust" - ART. It is the umbrella body of the Rivers Trust movement in UK, working to protect, promote and enhance our freshwater ecosystems for both people and wildlife. The trusts concentrate much of their effort on practical improvements in their local areas such as the removal of barriers to fish migration, improvements
- to river banks and increasing the amount and quality of spawning grounds. ART continues to provide an important link between established, new and emerging rivers and fisheries trusts, as well as offering a national platform for regional trusts to showcase their work.

- They have initiated many collaborative programs such as 'Source to Tap', Catchment Based Approach, PINPOINT, amongst others, where partnerships are developing a collaborative vision and plan for their catchments, bringing together all those with a stake in the health of the water environment, aligning funding and actions to achieve benefits for the environment, business and local communities.
- They develop ideas, exchange best practices, and offer policy guidance.
- The development programme also funds an information pack and a series of seminars to help new trusts set up. Over 60 member Trusts across the UK and Ireland have been formed to work on the ground, in the heart of the community, and to promote a sustainable future for our river environments.
- This project has raised the profile and influence of the rivers trust movement and created the capacity to promote a trust on every river in England and Wales. It has achieved its aim of enabling local people to influence the management of their river. Now, government agencies and departments in England are increasingly using rivers trusts to consult and involve local people in the management of rivers. The model is robust and organised with institutional arrangements to ensure that all the small river trusts functions without conflict under the larger umbrella organisation called the Rivers Trust of UK.

The Mississippi River Trust (MRT), a charitable, nonprofit conservation organisation established in 2002. The MRT has two sister organisations: Wildlife Mississippi and the Mississippi Land Trust. A unique technique used and promoted by MRT is, supporting land owners in conservation easement of lands for conservation purpose instead of selling the land for development. There areas of focus include; Habitat conservation, Conservation education, and Conservation Policy. The Mississippi River Trust (MRT) works with private and government partners to protect, restore and enhance bottomland forests and other wetland and riverine habitats, focusing on the active floodplain of the Lower Mississippi River.

The MRT holds conservation easements on 49,873 acres of private land. Conservation easements are one of the newest and most owner-friendly tools available for private landowners wishing to preserve or promote a certain conservation ethic on his or her property. In donating a conservation easement to the MRT, a landowner agrees to restrict certain property uses, such as subdividing land for residential or commercial development. In return, a landowner typically receives certain tax benefits.

The easement model relays on land owners stewardship, which can succeed only once the land owners are convinced of its benefit. Hence this may take longer time to establish in the context of India and may not be applicable across all income groups. The easement tool may be used as one of the tool but cannot be used as the singular exclusive tool. It cannot be applied in critical riverine or riparian or vulnerable areas as it is a choice based model. Also given the speculative nature of land value and real estate, compensatory tax exemptions cannot be viable.

Community Involvement in Danube under the ICPDR (International Commission for the Protection of the Danube River); The International Commission for the Protection of the Danube River (ICPDR) is an International Organisation consisting of 14 cooperating states and the European Union. An expert group within ICPDR, named The Public Participation Expert Group (PP EG) deals with activities concerning public information and consultation, outreach and awareness raising, as well as environmental education. The activities include public consultation measures for the Danube River Basin Management and Flood Risk Management Plans, publications and outreach initiatives such as Danube Day or environmental education.

Community Involvement Model in Rhine; is an International Cooperation with contributions by respective governments and other external project based funds. Involvement of the general public is mainly focused on awareness-raising at local level based on the initiative of motivated actors such as local environment authorities. Hence, grass root level engagement is under the purview of the formal framework of organised meetings and hence not entirely

owned by the local community. These are international cooperation based models and are led and funded by participating governments, hence not exactly community led initiatives. But the key takeaway here is the relevance of such cooperations for the countries which share rivers and river basins. Conflict resolution, sharing of resources and managing them will be smoother and coordinated with such cooperations. These commissions have Public Participation Strategy Plan framed to ensure that governments follow community participation and engagement protocols.

SMURF (Sustainable Management of Urban Rivers and Floodplains); is an EU LIFE Environment demonstration project based on the Thame Catchment in Birmingham. It looks to change the way that land use and water management planning is carried out within urban floodplains. Multiple projects were designed, and community members were chosen for long term engagement focused on achieving the objective of a project is important along with other overarching engagement projects. These select members would also act as the agents or leaders w.r.t the project concerned and citizens can directly approach them w.r.t the specific project. This enables clarity to citizens as well.

Further, we reviewed, international guidebooks, publications and toolkits on best practices in community participation. These include; URBEM Report on best practices for Community Participation and The BTwC Toolkit was launched by the Environment Agency (EA). Highlights from these are summarised below;

- Community participation efforts are built on trust among communities
- Discuss, deliberate and empower the citizens based on benefits of being involved
- Handhold newly formed initiatives through technical and funding support until they are self-reliant
- Target focus groups and develop programs and activities designed for these focus groups especially children, young adults and people with livelihood stakes

- Continued, persistent efforts on ground that involve or inform people
- Communication modes, materials that updates and inform community members
- Carrying out pilot community based models to learn and evolve a workable model for communities
- Define hydrological boundaries as units and limits of organised efforts instead of administrative boundaries
- Data sharing with government agencies, where flow of information and data is in both directions
- Systemic integration of consultation with community based organisations into the planning and development process

The review of Indian case studies of community engagement threw light into the many strengths and weakness. The Indian cases that we studied, include; Ganga Prahari, Ramganga Mitra, Ganga Mitra (Task Force at Grass Root level), Water Projects-Art of Living, Eco-Friends-Kanpur (NGO), India Water Project - Arghyam, Centre for Science and Environment (CSE). NGO Tarun Bharat Sangh (TBS) (Registered Society) - Save the River Ganga Campaign, Ganga Action Parivar (GAP)-NGO, Other Literature reviews on programs under CSR, research organisations etc. Some of these are grass root level organisations, while some have evolved into research based organisations that not only carry out on ground activities but also provide technical and training supports. Some of them also have rich learning materials and platforms which can be openly accessed, but many a times citizens are unaware of these resources. A summary of select Indian case studies on community engagement gives a glimpse of endeavours by various organisations across the country.

1. Ganga Prahari			
Implementing Agency	**Funding Agency**	**No. of People Engaged**	**Area of Implementation**
Wildlife Institute of India (WII)	National Mission for Clean Ganga (NMCG)	-	The five Ganga states (Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal)
Method to identify volunteers/ engage citizens	The Ganga Praharis are identified through a series of site level consultative meetings and workshops held in select villages, located on the bank of the Ganga River, in all the five Ganga states. Focus is to identify self-motivated individuals who can mobilize others in Ganga conservation efforts. Additionally, the local communities, are approached through other agencies like State Forest Departments, Educational Institutes, National Cadet Corps (NCC), National Service Scheme (NSS) Mahila Mangal Dal, Yuva Mangal Dal, Nehru Yuva Kendras and Ganga Vichar Manch, in order to identify the potential Ganga Praharis at some sites. To ensure a fair and just representation of youth from all the districts and villages located along the Ganga River, one to one discussion are held with the prospective candidates. The primary criterion for identification in a candidate is passion and zeal to serve the Ganga River for maintaining its integrity in terms of its cleanliness and biodiversity value. These 'Praharis' have to be above 18 years of age on the date of joining the project, preferably from the Ganga River side villages. The younger school students, too, have been recruited for Bal Ganga Praharis which have been launched recently.		

Activities in which community is engaged	Establish a motivated cadre of "Ganga Prahari" to support the local level institutions and monitor the quality of the natural resources of the river by mobilizing local communities at the grassroot level. - Mobilising the local communities in their respective villages for maintaining the integrity of the Ganga River ecosystem - Liaisoning with the local Forest Department at their respective villages in maintaining a clean and vibrant Ganga by providing support for biodiversity monitoring, taking part in anti-poaching operations, and river side plantation programmes - Assisting the NMCG-WII teams in preparation, coordination and implementation of village level micro-plans for sustainable development in alignment with Swachh Bharat Abhiyan - Convergence of developmental activities, livelihood programmes and biodiversity conservation efforts at village level thus to ensure ecological integrity and reduce direct dependency of local community on the Ganga River
Outcome of the Project	Strong mobilisation capacity of communities through Ganga Prahari volunteers

2. Ramganga Mitra			
Implementing Agency	**Funding Agency**	**No. of People Engaged**	**Area of Implementation**
Wold Wildlife Fund (WWF)	HSBC	4000 Conservationists	Ramganga Tributary
Method to identify volunteers/ engage citizens	The Mitras are made up of various members of communities, institutions and authorities; a testament to the Ganges' significance in Indian society. Members include doctors, academics, citizens, students, NGO members, local government members and also corporates.		

Activities in which community is engaged	- Educating fellow community members on threats to the river, giving individual and collective solutions they can participate in, like sustainable farming practices - Implementing ongoing conservation initiatives as part of the Rivers for Life, Life for Rivers programme - Monitoring river health with seasonal assessments - Engaging with the government and advocating for policies that improve river health
Outcome of the Project	Trained community members who volunteer in capacity building of fellow community members for implementation of WWF programme; Rivers for Life-Life for Rivers

3. Ganga Mitra (Task Force at Grass Root level)			
Implementing Agency	**Funding Agency**	**No. of People Engaged**	**Area of Implementation**
MMRCGRD & WRM*, Banaras Hindu University	NMCG	-	Ganga Basin
Activities in which community is engaged	To provide eco-skills and capacity building training to GANGA MITRA as resource person for inculcating awareness among people & school children to help in the Ganga Rejuvenation and Flagship Programs of Prime Minister such as Swacchha Bharat, Digital India, Unemployment, Pradhan Mantri Gram Sinchai Yojana, Swadesh Darshan, Skill India and Make in India etc. Provide technical support to communities dependent on the river for livelihood etc.		
Outcome of the Project	Skilled volunteers who can take forward monitoring of river health, identification and mentoring of local resources.		

*Mahamana Malaviya Research Centre for Ganga, River Development & Water Resource Management

4. Water Projects-Art of Living			
Implementing Agency	**Funding Agency**	**No. of People Engaged**	**Area of Implementation**
Art of Living-Volunteers	Various funding agencies based on programme	-	Many rural areas/villages across states of Maharashtra, Karnataka, Tamil Nadu, Delhi and Uttar Pradesh.
Activities in which community is engaged	Some major projects are; (i) Vedavathi River Rejuvenation: based on a bottom-up democratic change and community partnership, this INR 150 crore project has been undertaken under the ambit of MGNREGA scheme. (ii) Kumudavathi River Rejuvenation: This project aims to reduce Bangalore city's water dependence on River Cauvery, addressing water crisis.		
Outcome of the Project	Women Empowerment Community Engagement Climate Resilient Agriculture Water Security		

5. India Water Project - Arghyam			
Implementing Agency	**Funding Agency**	**No. of People Engaged**	**Area of Implementation**
Arghyam (encouraged by National Knowledge Commission)	Through partnerships with non-profit organisations, CSR divisions of multinational corporations and the media	- (full time staff engaged in data management)	Web-portal for data and information, related to water resources in India

Activities in which community is engaged	- Mass awareness building: Open access web-based information and data source on all the latest information, updates and news (both technical and non-technical) related to water resources
Outcome of the Project	- Generating mass awareness
	- Ease of data access for those who have IT infrastructure and internet - Curated technical information and data

6. Centre for Science and Environment (CSE), NGO			
Implementing Agency	**Funding Agency**	**No. of People Engaged**	**Area of Implementation /Activities**
CSE implements its projects and programmes	Donors	-	India's environment
Activities in which community is engaged	- Communication for Awareness: CSE's publications and informational products have been its strength and they have always combined research and readability to get the message across. CSE's tools for awareness raising are periodicals, publications, films/short spots, briefing papers, exhibitions, posters and other products. - Research and Advocacy: CSE's efforts are specifically designed to create awareness about problems and propose sustainable solutions. - Education and Training: CSE conduct developing programmes in the area on non-formal environmental education programmes for professionals, public administrators, private sector executives NGO professionals, students and others in environmental issues. - Knowledge Portal: Hosts a resource centre with information -- printed and visual -- on sustainable development issues.		

	- Pollution Monitoring: CSE's Pollution Monitoring Laboratory is an independent, analytical laboratory that monitors toxic contamination of the environment and uses the results of this monitoring to advocate for improved regulation of the use of toxins in the country.
Outcome of the Project	- Generating mass awareness - Technical information on pollution monitoring and evaluation - Review of policies and projects related to environment

7. Tarun Bharat Sangh (TBS) (Registered Society) - Save the River Ganga Campaign			
Implementing Agency	**Funding Agency**	**No. of People Engaged**	**Area of Implementation /Activities**
TBS in partnership with communities	Various funding partners (Swiss Agency for Development and Corporations, Ford Foundation, Irish Aid, ICCO, Oxfam India, Ramon Magsaysay Award Foundation etc.) and donations	-	India's environment, water resources and rural communities
Activities in which community is engaged	TBS is working for the empowerment of communities; anchored on Gram Swarajya - village self-rule. The unique part of TBS's modus operandi for development is to make community self-reliance. This is done by inviting the community to participate at every stage of development-work for them. Key efforts are;		

	- Expansion or Restoration of social and cultural values by setting examples in welfare action - Finding a balance between human and natural resource development - Ensuring women participation in the process of decision making - Improvement of the level of education in the community - Incorporation of better health facilities to create healthy - Energising human power, especially youth power, to harness energy to value-based work
Outcome of the Project	- Capable citizens and individuals of the community who have ownership and accountability towards their efforts - Self-driven community members who are willing for continued engagement as every community members voice is heard and opportunity given to voice opinions.

8. Ganga Action Parivar (GAP)-NGO			
Implementing Agency	**Funding Agency**	**No. of People Engaged**	**Area of Implementation /Activities**
GAP along with funding partners and communities	Donations and Funding Partners	-	Ganga Basin
Method to identify volunteers/ engage citizens	Ganga Action Parivar (GAP) is a global family of professionals, engineers, scientists, activists, spiritual leaders, environmental specialists and dedicated sevaks (volunteers) dedicated to the preservation of the River Ganga and Her tributaries in their free-flowing and pristine, natural state and to the protection of over 500 million people who are dependent upon Ganga's clean waters for their lives and livelihoods.		

Activities in which community is engaged	Some of the Actions in motion are; - A petition for National Ganga River Act is proposed - Project Hope: Relief, Rehabilitation & Restoration for the Victims of the Disasters in the Himalaya - 6T's program: Toilets, Trash, Trees, Taps, Tracks & Tigers: Ganga Action Parivar's 6T's Program provides a foundation for a cleaner, greener, more sustainable Ganga and environment - Green Pilgrimages: A joint effort with Green Pilgrimages Network to "green" not only the temples, mosques, shrines, gurdwaras, churches and other sacred buildings along Ganga, but also to "green" the pilgrimage routes used to reach these places. - My Tree: Teaching school children the importance of building healthy, fertile soil as well as techniques for planting and caring for a wide range of fruit and nut bearing trees. One can sponsor a fruit tree under this program.
Outcome of the Projects/ Programmes	- Rehabilitation and support for victims of disasters - Awareness building and advocacy for greening of pilgrimage sites and routes - Outreach and advocacy for fertile and healthy soil to school children through teaching of techniques for the same

What is interesting, is the diversity in the multitude of initiatives taken up by the many governmental and non-governmental agencies. There is immense potential given the good work done by these non-governmental and government agencies. There is also huge funding opportunities through various CSR funds given the size of our economy. The missing link is, coordination between these many different players; cooperation and partnerships that are guided through systemic action is the need of the hour. There is immense potential if the existing grass root level organisations are identified,

streamlined and mobilised to work together. And such stock taking will also in turn help identify regions and areas that are not covered by grass root level activities/efforts.

These learnings and insights were examined in the context of existing models of community engagement, as well as the geographic, demographic and socio-cultural conditions. The key features and characteristics, for community led, integrated watershed based river rejuvenation, is summarised in the following section.

RIVER TRUST MODEL FOR CITIZEN ENGAGEMENT IN RIVER BASIN MANAGEMENT PROPOSED BY TREE CRAZE FOUNDATION

The Guiding Principles adopted by TREE Craze Foundation for the proposed River Trust Model are;

1) Two directional flow of information between government and communities
2) Awareness
3) Empowered citizens
4) Transparency
5) Ownership
6) Collaboration and partnerships to work together
7) Bridging gaps between participating stakeholders and decision makers
8) Participation through focus groups
9) Results on ground through multiple activities/action programs lead by focus group leads

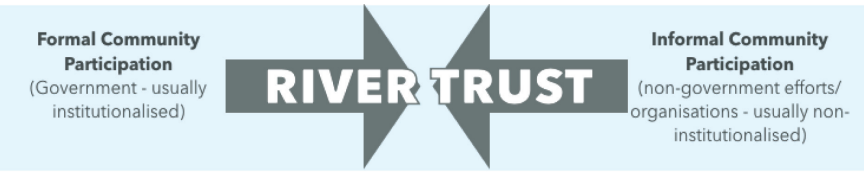

Figure 1: An illustration showing the role of a River Trust in bridging the gap between formal and informal community participation efforts/institutions

To ensure that all the above principles are followed in a community participation model, it will have to be based on;

- Ownership and stewardship among citizens,
- Local and regional action,
- Mobilisation of non formal entities already functioning in the field, for holistic and integrated management.

The two main factors in community engagement and collaboration models are; Resources (human, technical and financial) for collaboration, Group Structure and Decision-Making Processes.[9] Hence for collaborative community engagement to function smoothly, legal, institutional and organisational guidelines are critical along with human, technical and financial resources so as to evolve strategies and take action on ground.

The proposed **River Trust model is based on the creation of not for profit legal entity of a Trust as per the Indian Trusts Act - 1882,** which is owned and run by the local community members/ citizens in a given hydrological area. The coming together of many such like-minded local trusts to work in a coordinated and integrated manner is critical for results at local level, regional level and national level as river rejuvenation/protection can be successful only through an approach of Integrated Basin Management. Hence, we suggest Local Chapters of River Trust for local, community driven action on ground and a River Trust at National Level or specifically for a River that can mobilise action for regional and national impact.

RIVER TRUST MODEL

Hierarchy of River Trust Units Across Scales

- Local chapters as the smallest unit hosted at the major ULB/ PRI with a smaller hydrological unit (watershed) as influence area
- Many "sub-tributary" river trusts together forming the largest river trust,

OWNED BY THE PEOPLE

Figure 2: An illustration showing the nature of the hierarchical River Trust Model

[9] Koontz, Tomas M. Steelman, Toddi A. Carmin. JoAnn. Korfmacher, Katrina Smith. Moseley, Cassandra. and Thomas, Craig W. 2004. Collaborative environmental management : what roles for government?. RFF Press book

The area of influence of a local chapter should be defined by the extents of a hydrological unit at a scale that works for the community members of the local chapter. Community consultative approach is the essence of evolving and establishing a local river trust and therefore TCF emphasis the need for workshops and discussions among the citizens locally, to integrate contextual factors/aspects/ strengths and concerns, finalise the area of influence etc. for each local chapter. These initial workshops would handhold the local community members to form the first local chapter of the river trust.

INSTITUTIONAL ARRANGEMENTS FOR THE PROPOSED RIVER TRUST MODEL

Because the model involves a hierarchy of multiple trusts as functioning units, which has to work in individual capacity and across scales; it is important to establish well defined institutional arrangements. Such arrangements include;

- Legal status of the River Trusts
- Defining the units and their functions
- Drawing a Charter for the River Trusts Model
- Organisational structure and role

Legal Status and Membership in the proposed River Trusts: The River Trusts will be registered as a Welfare Charitable Trust as per the "The Indian Trusts Act 1882".

Membership to the local river trust (Local Chapters of the River Trust) will be open to; All individuals as a citizen from the area of influence, All elected representatives, Institutional membership will be open to all schools and educational institutions, local CBOs, NGOs working in the area.

Membership to the River Trust of a River or National River Trust will be open to; all local river trusts of the basin city/town/village.

Formal government administrative entity/agency/organisation may engage as Observer's thus preserving the liberty of such an independent citizen forum.

The Local Chapters of the proposed River Trusts, are the fundamental unit of the model. By having smaller hydrological boundaries as the area of influence for each of these local chapters, there is the possibility to cover the entire basin of a given river, thus enabling unified action at ground level.

The National River Trust or The River Trust of a River, is as important as the individual local chapters. This National River Trust or the River Trust of a River will function as the head quarters of the River Trusts and will help coordinate activities at larger scales. Such an integrating unit at a larger scale will also help to liaison with international organisations, central and state government agencies. This is especially important because river basin's transcend national and state boundaries. Such an umbrella organisation will also help local chapters of river trust with matters beyond their individual capacity. It has to be noted again, that such an umbrella organisation at National level or at the level of a River Basin, can be built up only once considerable number of functioning local chapters are established.

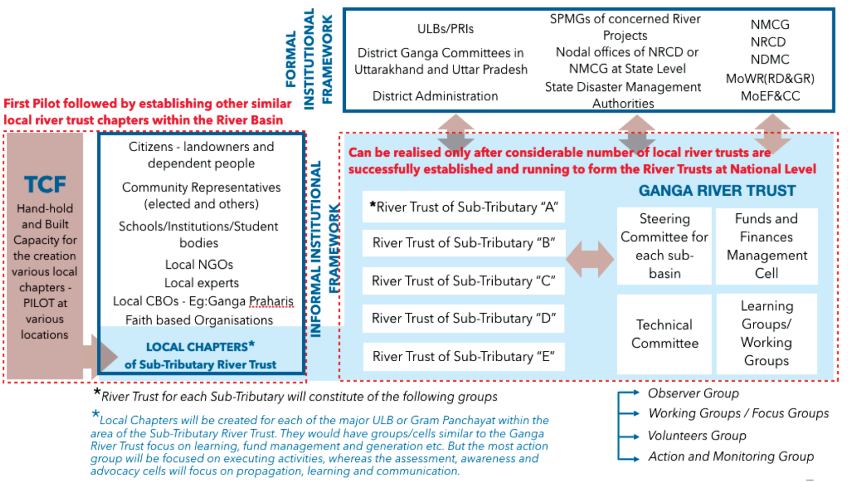

Figure 3: An illustration of the River Trust Model in relation to other Stakeholders and the role of TREE Craze Foundation in Handholding the River Trust Model

ACTION ON GROUND - STRENGTHENING OWNERSHIP AND STEWARDSHIP AMOUNG CITIZENS

While the proposed model and institutional framework of River Trusts enables inter-scalar integration and coordination, there are some fundamental activities that can to be taken up immediately. These activities have to be contextualised to be compatible and viable to the people carrying them out as well as to the geographic/ ecological conditions of that part of the riverine/riparian ecosystem. Evolving local activities for each local chapter by its people is the core function of each of these local river trusts.

TCF, has identified a list of 12 activities/tasks/strategies which has to be evolved by every local river trust. These are listed below. Each of these, should be finalised and programmed locally, to fit into local opportunities and constraints.

- Database Inventory creation and monitoring which is lead by the community
- Educational and Skill development of River Trust volunteers and River Trust action force
- Cleaning and maintenance of the water bodies and green spaces
- Organising regular activities in collaboration with local schools and institutions in the water body precincts
- River and water bodies cleaning drives on a weekly basis
- Take up Water Body Restoration projects on a need and status base
- Take up learning partnerships with research organisations
- Fund sourcing and management training of River Trust employees/volunteers
- Host and hold citizen forums for discussions (weekly or monthly) regarding various development projects and initiatives, issues concerns related to rivers and environment within their locality
- Collaborate with local governments, district administration to convey concerns and provide database (data-sharing and collaboration)

- Develop Toolkits (capacity building), learning products (awareness building), and communication products on a regular basis
- Formulate engagement and collaboration protocols to seek professional services from urban/environmental planners, designers, landscape architects, conservation and restoration experts, environmental engineers, civil engineers, etc.

It has to be noted that to carry out some of these activities, the volunteers and members of the local river trust will have to be trained in certain easy-to-learn skillsets. TCF intends to assist the local river trust to identify and train few members and volunteers and we propose a Training of Trainers model in association with various partnering institutions/organisations/experts.

CONCLUSION

Careful study of national and international efforts of community engagement for river rejuvenation clearly brought out gaps such as lack of coordination, external-organization led efforts that are unable to sustain, weak collaborations & partnerships, and uni-directional flow of information. Unlike the formal system of stakeholders who have a defined framework within which duties, responsibilities and action for implementation of various environment and river projects exists; citizen based framework for active engagement, action and implementation of tasks/responsibilities on ground is absent currently in India.

Preparation of Public Participation and Stakeholder Strategy Plan and establishment of an institutional arrangement which can anchor, host, manage, initiate and hand-hold community members and other stakeholder and decision makers. Given the scale of rivers, multiple types of rivers, and the population to be engaged, TREE Craze Foundation has formulated a River Trust Model which plans to formulate local river trusts for each sub-tributary or tributary of the river, each of which is represented at the larger body which would be the River Trust for a given River. The hierarchical model of local chapters of river trust under a larger umbrella organisation of

National River Trust/the River Trust for a given River, enables inter-scalar integration and coordination of community based activities.

A pilot project in this regard is planned to formulate first River Trust which can initiate a people initiative that acts as an exclusive platform for all non-formal stakeholders in actively engage and participate in river environment management and development. This will thus open up the considerable role citizens can play in directly participating through action at grassroots level as individuals, families, and community members.

The establishment of such an institutional arrangement and structure of participatory action on ground will help bring actions and efforts together ensuring true change on ground. By bringing all the multiple efforts and initiatives together a collaborative movement is triggered where conflicts can be resolved by integrating all efforts to find optimal solutions to problems while strengthen individual efforts.

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Nerupama Y. Modwel

The Kumbh: A Confluence of River, Religion and People

If one were to ask a diverse array of people to briefly describe the Kumbh Mela, one would likely get an equal number of varied replies. 'A sacred tradition,' 'The Supreme Pilgrimage,' 'An Ascendance,' 'A holy confluence of rivers,' 'Divine meaning, divine order, incarnate in tangible, holy chaos,' 'A gathering of people so large, it is beyond all comprehension of sight and sound.'

It is widely believed that the Kumbh Mela is an ancient religious festival with its origin deep in the formative stages of Sanatana Dharma. It was routine for early Aryan communities to organise yearly fairs at a specific time in various different locations.

Indeed, there are many Puranic references highlighting the significance of Prayag, sangam, magh month and the sagar manthan story, but the word Kumbh is not mentioned in the context of a mela. Despite its absence in early texts, there are accounts by foreign travelers of a mela similar to the Kumbh in early periods.

Megasthenes, for example, who was the Greek ambassador to the court of Chandragupta Maurya, is said to have visited a mela for seventy-five days in the 4th century BCE. Later, in the 7th century CE, the Chinese, Buddhist monk Xuanzang travelled to India and visited Prayag during his visit. He writes of a grand mela, an "age-long festival," organised here, and records the benevolence of King Harshvardhana at Prayag during the event, writing that he generously donated his property among the public.

Niccolao Mannuci, the Italian traveler who visited India from 1655 to 1717, mentions a quinquennial festival held at Prayag. A reference to the Kumbh Mela is also found in the Yadgar-e-Bahaduri (1834 CE) by Bahadur Singh, which states that the attendance at the

Mela was drastically reduced that year because of impositions of pilgrim taxes by the British.

Mark Twain, the American author, visited Prayag in 1895 and marveled at the Kumbh Mela, "These pilgrims had come from all over India; some of them had been months on the way, plodding patiently along the heat and dust, worn and poor, hungry, but supported and sustained by an unwavering faith and belief. It is wonderful that the power of faith like that can make multitudes upon multitudes of the old and weak and the young and frail enter without hesitation or complaint upon such incredible journeys and endure the resultant miseries without repining."

The earliest mention, by name, of the Kumbh Mela is found in the Persian records Khulasatu-t-Tawarikh (1695 CE) and Chahar Gulshan (1759 CE), which describe the fairs held at Haridwar, Prayagaraj, and Nashik. The Khulasat-t-Tawarikh, a contemporary chronicle of the Mughal Empire by Sujan Rai, gives a description of the Kumbh, mentioning the specific yearly cycles and astrological significance of the fairs.

Regardless of the debate over the exact historicity and antiquity of the Kumbh Mela, one cannot deny that it is a spectacular event that is unique to India. As the world's 'largest peaceful gathering of pilgrims on earth', it is quite remarkable and a subject of great interest globally.

There are three types of Kumbh Mela, which are organised at four holy sites in India. Prayagaraj, which is considered one of the supreme tirthas, witnesses all three types of Kumbh. Every six years, an Ardhkumbh is organised here. Every twelve years, when Jupiter enters the Taurus constellation and the Sun enters Capricorn in the Vedic calendar, Poornakumbh is celebrated. After twelve cycles of twelve years—a hundred and forty-four years—the Mahakumbh is celebrated.

Another major pilgrimage centre is Haridwar, in Uttarakhand. In a region with the appellation devbhumi, or abode of the gods, the Ganga gushes through this city in its journey down into the plains from its source at Gaumukh. Every sixth year, an Ardhkumbh is

held in Haridwar, while every twelfth year, when the Sun is in the constellation Aries in the Vedic calendar, the Moon is in Sagittarius, and Jupiter enters the position of Aquarius, the Kumbh is held.

The Kumbh is, in a sense, not an organised event so much as a phenomenon, intrinsic and ancient and constant. An enigmatic event, systematically engaged with by millions. The fair is an occurrence of enormous religious, cultural, mythological and economic significance for the Indian subcontinent. There are two key aspects to it that distinguish it from other religious pilgrimages. They go hand in hand, these two aspects: the first being that all the four Kumbh melas must take place on the banks of a 'sacred' river, deeply connected as they are to the rites of bathing. The second key aspect is that these always take place during predetermined, unique, and auspicious astrological arrangements, which involve the Sun, the Moon, Jupiter and other constellations.

To understand its impact, we must begin by considering it elementally. Water, of the five elements, has held deep, innate importance for humankind for about the same amount of time that humanity has had conscious existence. Water, the substance of spirit and giver of life, is the greatest constituent of both planet and body. In India, water's significance has been textually recorded since the Vedic period. The Rigveda states this reverently:

या आपो दिव्या वा स्रवंति खनित्रिमा उत वा याः स्वयंजाः।
समुद्रार्था याः शुचयः पावकास्ता आपो देवीरिह मामवंतु।

[Of the cloud and the drop, of the canals and the rivers and the oceans; all are extensions of the same. Let this water, which holds divine qualities, protect us.]

Add to this the legend of the nectar of immortality, amrit, falling at the four locations where the Kumbh Mela is observed today, and the belief in the beneficial qualities of bathing in the holy Ganga or at the sangam, and one begins to comprehend the powerful draw of the Kumbh.

It stands to reason then that the Ganga, India's biggest river, fed by tributaries and smaller rivers, a divine being deeply revered, would hold the most degree of sacredness. In a text of the Mahabharata, Bhishma, son of the river goddess Ganga, declares that all the hills, dwellings, and kingdoms located in the Ganga's path are to be

considered sacred land or punyabhumi. Not only the Ganga, but every particle it touches is a pilgrimage spot.

In present-day Uttar Pradesh lies Prayagaraj, the tirtha raja, considered the crest of such holy sites. In Prayagaraj, the Ganga, which is believed to be the personification of piousness and is referred to as punyadayini—the giver of punya, righteousness—meets two other rivers. It meets the Yamuna River, which is both a symbol of devotion and the Ganga's biggest tributary. It also meets the mythical river Saraswati, which symbolises knowledge. Here, at this triveni, the Kumbh Mela is considered most powerful.

According to the Matsya Purana (107.7), those who bathe in the bright waters of the Ganga where they meet the dark waters of the Yamuna during the month of Magh will not be reborn, even in thousands of years.

The Indologist Dr. G.C. Tripathi describes the most important part of the Kumbh as "the element of a cosmic force called amrit, or nectar." Stating that the dates of the Kumbh Mela are determined astrologically, he adds, "The phenomenon that the Sun is behind the Moon in this phase; its heat and energy results in the release of the nectar generated in the Moon. The belief is that taking a dip in the sacred waters during the Kumbh brings the blessings of the nectar."

The Kumbh Mela is, undoubtedly, the largest peaceful congregation of pilgrims on Earth—as acknowledged in documentations by the National Geographic, the BBC, and Harvard University. In 2017, the Mela was inscribed by UNESCO on the Representative List of the Intangible Cultural Heritage of Humanity, as an event that is attended by millions, irrespective of caste, creed, or gender; a culturally diverse festival. It is interesting to note that the Kumbh Mela is not only a religious gathering for cleansing one's sins and gaining spiritual merit, but also an occasion for holding religious assemblies at which doctrines and national matters are debated.

When UNESCO considered the Kumbh Mela's inclusion in this list, the Mela's contribution to 'cultural diversity and creativity, as well as tolerance and learning' was kept in view. This is best exemplified by how the Kumbh Mela embraces the old guru-shishya

parampara, peaceful discourse, the imparting and imbibing of Veda gyan, chanting of traditional Vedic hymns to purify the environment, demonstrations by yogis, performances of music and dance, and so on. The sale of hundreds of craft items, merchandise and trinkets, and street food, lends a festive air to the Mela, adding the element of a 'fair' to a religious and deeply devotional tirtha.

The Akhadas, the traditional monastic orders of ascetics, an important component of Sanatana Dharma, get precedence at the Kumbh. They display a balance between devotion and discipline, tranquility and physical strength, practice and instruction. Physical fitness, to them, is equally significant to spiritual strength. For holistic living, they see both as required, believing in the old adage:

शक्ति के कवच बिन भक्ति दुर्बल
भक्ति के अंतःकरण बिन शक्ति उन्मत्त

[Devotion, without the shield of strength, is feeble. But pure strength, without the conscience of devotion, is chaotic.]

The spiritual ecstasy they are enveloped in reflects the truth of eternal bliss (sat chit anand), which cannot be found in the material sphere. The Akhadas give paramount respect to all elements of the natural world, reminding the rest of the world that harmonious co-existence with nature has been an age-old notion as well, and is not simply a modern push toward environmental sustainability.

It is not only the metaphysical aspect of higher forces at work that entices people to attend, but a more immediate, unshakeable faith in the power of the Kumbh and the snan or holy bathing to wash away one's sins and renew oneself to the world. Thus, one hopes to achieve punya.

In the Ashtam Ashtak of the Rigveda, it is written that one who travels during the auspicious period may cleanse themselves of their earthly sins with good deeds, charity, and piety. The poet Kabir wrote of 'kumbh' as a metaphor for the body:

फूटा कुम्भ जल जलहिं समाना, यह तथ कथौ गियानी।

[The atm tatv, the human soul, is inherited in the pitcher, kumbh, of the body. When the body is broken, it is reunited with the parmatv tatv, in transcendent absolute truth.]

To Kabir, the Kumbh is a time to fill up one's pitcher-being with intellect and self-realisation.

The Poornakumbha itself, with its lotuses and water, is a symbol of not only auspicious plenty, but of the river goddess. The concept of river goddesses—nadi matrika—is as ancient as it is widespread. The idea of river as mother is mentioned in the Rigveda, which speaks of seven rivers and seven notes as Mata. A.L. Basham has expressed a similar idea held by people, stating, "In the flat plains, the land was cut by canals running from the great rivers and dotted with artificial reservoirs, which were made by and fed its smaller channels, which watered the fields. This water contained a great deal of silt, which helped the soil and the crops. This soil is known as nadi-matrika." A river can support life in an integral way, indeed, birthing it. Across millennia, countless civilisations have emerged to not only dwell but thrive on the banks of rivers. As borne out in literature—written and oral, global and local, classical and folk—rivers have been simplified and elevated in equal measure to goddesses and mothers; cultural identities in their own right.

Thus, feminine personifications of rivers are common in India. While each has her own unique iconography, a common element among river goddesses is in the water pot they carry. Just as the Kumbh is held on the confluence of rivers, the river goddesses are united by their kumbh.

Of the three rivers Ganga, Yamuna, and Saraswati, the Ganga is the most revered. Described as a river goddess as striking as the peaks of the Himalayas the river originates from, the Ganga is said to have the Makar, the legendary sea-creature, as her mount. In the Bhagwad Gita, Shree Krishna in verse 31 of chapter ten declares the Ganga as one of the vibhutis, glorious forms, of the Supreme:

पवनः पवतामस्मि
रामः शस्त्रभृतामहम्।
झषाणां मकरश्चास्मि
स्रोतसामास्मि जाहनवी।।

[Of purifiers I am the wind, of warriors I am Rama, of fishes I am the makar, of streams I am the Ganga.]

The sanctity of the sangam, the confluence of the Ganga with the Yamuna, is such that the act of bathing in such waters can be more spiritually effective than the attainment of supreme knowledge itself—for it is through a bath in the two rivers merged is one assured liberation from the bonds of birth, death, and rebirth.

Though unseen, the river Saraswati too is part of this tri-confluence. Believed by historians to have existed between 5000 and 3000 C.E, the Saraswati disappeared physically, through possible combinations of tectonic shifts and major catastrophic events in the region. The river Saraswati is mentioned in the Rigveda as being between the Yamuna in the east and the Sutlej in the west. Later Vedic texts like the Jaiminiya Brahmanas and Tandya, as well as the Mahabharata, mention that the Saraswati dried to nonexistence in a desert. The local lore in Prayagaraj is that the Saraswati flows under the city in a deep well known as Saraswati Koop.

Numerous stories on the origins of the Ganga exist as well. One of the most popular of such stories is from Vishwamitra's Ramayan Bal Kand, wherein the cursed souls of King Bhagirath's ancestors were liberated by the touch of the Ganga's holy water.

One would be hard-pressed to find a ritual that does not involve the use of water. The water that accompanies one for worship is purified first, typically by the 'Jala-Suddhi' mantra. With this water, rivers are invited into the water to purify it. The Ganga is oft involved in these rituals, including the shodash sanskara, which is given in Sanatana Dharma. For those who live on the banks of the Ganga, there is little example of ritual which does not involve the Ganga in some way or the other. The last rites of a person, anyodaya karma, are pivotal on the Ganga, since the river is believed to have to power to elevate all who touch it, living or dead, up to heavenly realms.

The Kumbh Mela has a worldwide reputation as a 'mega-event'—not only for the sheer number of attendants, but also for a wide display of cultural traits of the Indian subcontinent. A large number of pilgrims and visitors arrive to see the sadhus, or renunciants, who come to take the ritual bath in the holy waters. The number of pilgrims especially swells to millions when the

Naga sadhus and Juna and Dasnamai Akhada ascetics come for their ritual bathing. Per custom, they enjoy some degree of privilege, such as exclusive access to the sangam on auspicious days marked for shahi snan. As they arrive to the sangam in a colorful and grand procession, it is a memorable spectacle to witness. On this occasion other sadhus are seen in full grandeur; their procession march includes elephants and horses, which are ornamented. The leaders of various sects are borne in heavily adorned palanquins, and this royal procession culminates with the sadhus joyfully bathing in the Ganga. This event, called shahi snan, is famed, and one of the biggest draws for people to attend Kumbh, not only as a spectacle, but to get darshan, or sacred sight, of the ascetics.

The Kumbh Mela is open to anyone who would have an interest in attending. There are no conditions for visitors; the principle of inclusivity can be seen in how public activities like ritual bathing, discourses by prominent religious leaders, cultural performances and langar or community meals are open to all. In Kumbh 2019, the Kinnar Akhada of transgender ascetics was allowed to participate in the peshwai or procession for the first time. During this event the Kinnar Akhada later merged their akhada with the Juna Akhada.

There are constants in the rituals, beliefs, and customs that comprise the backbone of the Kumbh. When bathing in the sangam, it is seen as auspicious to donate, whatever one can afford, to the needy. The devout also undertake parikrama—the ritual of moving clockwise around the object of devotion—of Prayag. There is a beautiful ritual called the suhag pitari, wherein the rivers are offered the same objects and accessories that would be typically considered gifts for a married lady. There is also the kumbh kalash dan, an act of charity where fresh food and produce, money, matches and incense are donated. Another custom, specific to the Kumbh Mela, is in how people offer idols of Brihaspati—the wisdom-giver, synonymous with Jupiter.

According to the Mahabharata's narration, Prayag is the most revered place of worship in the entire universe. It is believed that, by Lord Brahma's declaration, all sins are immediately eradicated upon entrance to Prayag. The city is considered dear to Lord Vishnu too.

The Prayaga Mahatamya mentions three eternal guardians of the sacred pilgrimage of Prayag, which correspond with the triforce of major deities in Hinduism. Vishnu is represented by the four limbed idol veni-madhava, Brahma is represented by the shalmali or the silk-cotton tree, and Shiva is represented by the banyan-fig tree.

Despite lesser textual support to claims of the Kumbh's historicity, there is no doubt that it holds the promise of deep meaning and joy to millions, both nationally and globally. It is believed by the most faithful that Kumbh Parv has been in existence since ananta kal—'eternal time'. It is believed that in the universe, it will be there till the end of time, too. One could say that to calculate the meant age of the Kumbh, one would need to calculate the age of time itself. But then again, in the words of the great mathematician Aryabhatta,

कालोऽयमनाध्यंतः

[Kal, Time, has no beginning or end at all. Aryabhatiya Granth, 499 CE]

People across the country, the globe, are drawn in faith to attend the Mela. The Kumbh provides an uncommon opportunity to escape from the strains of a literal, materialistic world, and experience a refinement of existence down to the unification of the soul with earth and its waters, with mass consciousness, and with the eternal. Despite its color and festivities, the heart of the Kumbh is this minimalistic refinement, the purifying, spiritual cleanse. One may consider that here, the essence of dharma is presented in its purest form—not by pushing to fulfill worldly needs, but by keeping them to the minimum; by rejoicing in the sensation of overflowing spirituality instead.

The Kumbh Mela is truly an awe-inspiring and remarkable confluence—in sacred time—of holy rivers and an enormous mass of humanity connected with deep religious beliefs and impeachable devotion. There is no other congregation that can match this collective set of circumstances.

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