

Namami Gange: An Opinion based framework and possible resolution

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Abstract

Despite accounting for only about 2.4% of the world's geographical area and 4% of the world's water resources, India supports approximately 18% of the world's human population. This puts an unprecedented strain on the land, pushing it beyond its carrying capacity and resulting in land degradation throughout the country. In terms of global averages, thus, not only is water a scarce resource, but land and consequently soil is even more so. This dual constraint poses enormous amount of difficulty in making the Namami Gange Program a real success. The extreme land and water constraints of the Ganga basin agriculture have speeded up the degradation of its agricultural lands, with eroded soils and nutrients running into the Ganga River network and seriously affecting the rivers and other ecosystems. Thus, there is an urgent need to devise and promote appropriate sustainable agricultural practices to protect the basin and its agricultural lands from any further damage. There is a need to find some long-term and better solutions to ensure the river's sustainability. In this review we have analyzed numerous public as well as experts' opinion on government policies, across both in and out of the political realm and proposed a comprehensive strategy based up on the actionable points excerpted out of the opinions.

Introductory background

The history of India is incomplete without the river Ganga, the cultural reverence of India is incomplete without Ganga. It would not be wrong to say that Ganga is the most alive river in the world, the biological and chemical properties make it unique from the other rivers.

“Tadevai Tatprakaren Bhavati Shrutermatam Dwirupam Chapi Gangavajagneyam Sa Jalrupini”

~Mahatmya Samyutam Nrunam Sevatam Bhakti Muktida Maryada Margvidhina Tatha Brahamapi Budhyatam”

In versus 5 to 6 of Siddhanta Muktavali, philosopher and reformer Vallabhacharya (1478-1530) and Vyasa describe three levels of perception about the river Ganga: first, as a stream of material water, second, as a stream of material water with some spiritual capability, and third, as a stream of water that is the manifestation of divine 'Ganga Maa.' Since, the times of East India Company, with the upper Ganga canal

constructed in 1855, our developmental approach have primarily been to treat Ganga as a stream of material water. Growing population and cities have led to discharge of pollution from industries and municipalities into the river.

The Himalayan Young Fold Mountains, the Gangetic Plain, and the Central Indian highlands make up the majority of the geographical area of the Ganga basin, which is divided into three broad topographic divisions of the Indian subcontinent. Upper Ganga plains, Middle Ganga plains, and Lower Ganga plains are the three main divisions of the Gangetic plains. Figure 1 below shares the flow diagram of the Ganga Basin.

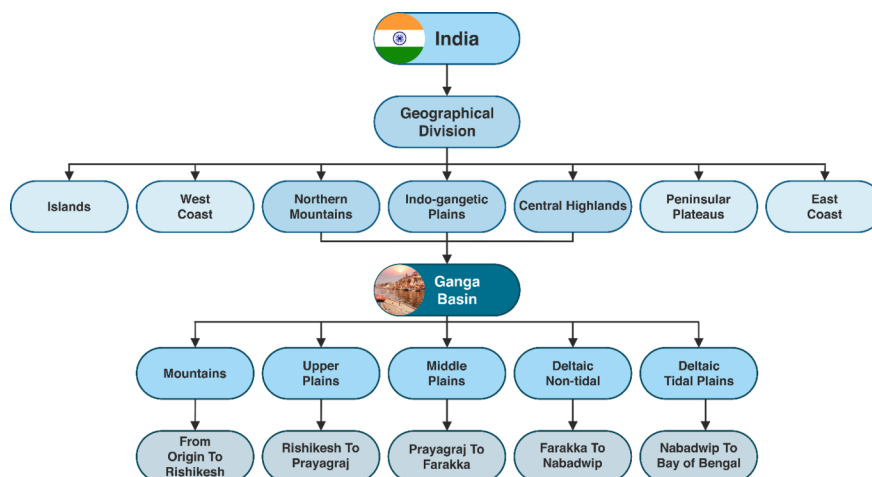


Figure 1 . Flow Diagram of the Ganga Basin

The Ganga Basin, one of the world's largest river basins, is home to a massive population, with the highest population density when compared to other river basins. With the average population density of 951 people per Sq. km across the states, Bihar holds the record of highest population density (1106 people per people Sq. km), followed by West Bengal (1028), Uttar Pradesh (821), and Uttarakhand (189) being the lowest of all, as shown in Figure 2 (Sati, 2021).



Figure 2 . Ganga basin states with different population density (Persons per Square Km)

A Shift Towards Integrated Basin Based Approach

In past 170 years the river Ganga has been seen as spiritual entity but is being treated like material water, which makes it a huge challenge to rejuvenate the river. From 1985 to 2015, programs like GAP I, GAP II were initiated whose efforts to clean up the pollution, did not succeed. The piece meal approach and lack of resources resulted in allocation of total Rs. 4000 crores for 30 years, which is very less given the size and complexity of the Ganga basin (Singh, A.K., 2022). To keep this majestic river alive or we should say, to keep the humanity alive a new approach towards Ganga River rejuvenation was required. Learning from the past, the ‘Namami Gange Programme’ has been designed differently, which does not look Ganga as separate river but treat the basin as a single system. The amalgamation of traditional knowledge of water management and new innovative technologies is one of the important approaches this programme offers towards the rejuvenation of Ganga River. Many initiatives and projects have been implemented in the past to rejuvenate the Ganga, and many more schemes and projects are currently being implemented under

the NMCG (NMCG, 2021). A timeline of different stages of Ganga Cleaning and rejuvenation is shown in Figure 3.

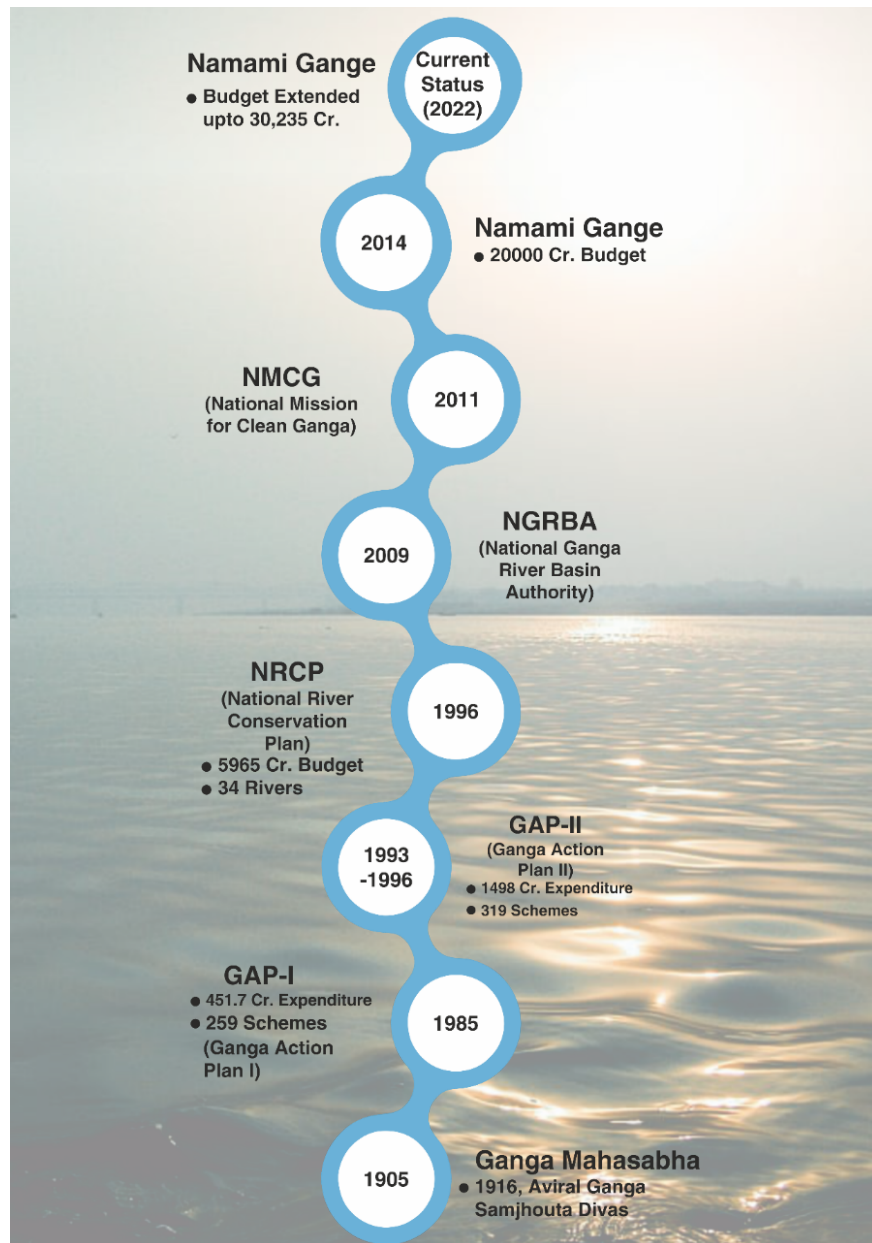


Figure 3 . Timeline of the Major Events to Clean Ganga

‘Namami Gange’, as the name suggests, the mission is bowing to the Ganga River and seeing it as more than simply water. Namami Gange Programme (NGP) is an integrated and multi-sectoral programme, and incorporates the Ganga notion as a stream of material water that is the manifestation of divine Ganga Maa. Recently, NGP has transitioned from a construction-only strategy to a construction-plus-performance approach by developing the HAM model in order to work toward the sustainability of the infrastructure projects built (Hybrid-Annuity-Model). The model also ensures the prompt completion of the plant’s construction because only a portion of the total allotted money is given to construction company during the

building phase, and any delay or ill-practice will result in potential liabilities. This strategy also enhances the plant monitoring and operations through the use of SCADA and other cutting-edge technologies. It refers to a paradigm shift in the sector as the performance is integrated into the model and the value of investment is assured. This methodology was also recently adopted by NITI Aayog for liquid/solid waste management. The Namami Ganga is a comprehensive Ganga rejuvenation strategy that includes Avartal, Nirmalta, ecological restoration, and connecting people to the river, and this approach has yielded results, with the completion of numerous key projects along the Ganga, leading to an improvement in the river's health (Singh, A.K., 2022).

The ultimate objective is to raise public awareness of the value of natural resources and advocate their sustainable usage. However, for this to happen or for the successful implementation of this project, public communication and engagement, as well as complete consideration of public opinion at all levels of governance, is required. Several opponents have publicly criticized the overall functioning of this programme or specific aspects of it, such as 'Arth Ganga,' 'Clean Ganga,' 'Jal Jeevan Mission,' 'Jal Shakti Abhiyan,' and so on. Furthermore, there are also couple of important learnings that have been presented in the form of case studies, pilot studies or as positive critique. This review article will help to the improvement of sustainable water governance by offering a detailed plan based on the underlying difficulties gathered from the opinions of several experts in this field, due to its distinctive method of studying public opinion on government policies.

Theme based public and expert opinions

The enunciation and progress of Namami Gange Programme

Global research and experiences show that the health of a country's river reflects the economic status of the enormous population that lives in the basin. The high prevalence of poverty and lack of economic prospects for Ganga's population, particularly farmers, is one of the major techno-social variables responsible for the river's current status. The Ganga's issue did not go overlooked by the PM Modi and he in his campaign in Varanasi in 2014, pledged to clean up the Ganga with his words "mujhe toh Maa Ganga ne bulaya hai" . He immediately started the NGP project after taking office, an integrated conservation effort with a budget of 20,000 crores to achieve the goals of effective pollution abatement, conservation, and regeneration of the Ganga. By 2022, the project hopes to have fully connected all 1,632 Gram Panchayats along the Ganga to a sanitation system. Moving forward in his 2019, in 73rd Independence Day speech, he emphasized the need of water conservation, saying that the center and states must collaborate to save water and supply it to every family. He stated that the government has set aside Rs 3.5 lakh crore for the project and that work on the Jal Jeevan Mission will be carried out with vigor in the coming years .

The competing roles of the river – power generation, irrigation, domestic water supply, fisheries, riverbed agriculture, result in a variety of services, which if sustainably managed, can contribute to sustainable economic development of the country. In this direction the PM again directed the NMCG to lead the development of an 'Arth Ganga' economic framework model for the Ganga Basin, integrating people's participation and financial development with Ganga rejuvenation, with a target of a 3% contribution to GDP from all concerted efforts made in this direction .

In between these two events, there was lot of criticism projected towards the NGP which caught the attention of then Minister of Water Resources, Nitin Gadkari, who expressed his deep displeasure over the 'slow progress' of projects and directed his officials to do quality work in a transparent, corruption free, and time-bound manner. He explained that they need to work on changing the general public perception that nothing is being done, and suggested solutions towards issues like loopholes and the delay in the process of DPRs preparations, finalization of tenders, and payments to contractors . Nitin Gadkari push seemed to work and helped in fast tracking of a lot of lingering projects which were eventually finalized after facing a lot of condemnation from the people across multiple sectors both in and out of political prism. In the same year, PM Modi met with the governments of Uttarakhand and Uttar Pradesh after regaining

power in both states' legislative assemblies' elections. Upon examining the status of work completed, he directed authorities to ensure public participation so that the NGP does not remain only a government initiative, as well as proper distribution of project-related information. . At this point, the BJP had friendly administrations in four of the five states along the major Ganga stem. However, there was a lot of political uproar after The Comptroller and Auditor General (CAG) of India issued a performance audit report to assess the availability and utilization of funds, planning and implementation of various schemes/projects, adequacy of human resources, and effectiveness of monitoring and evaluation mechanisms. The performance audit revealed underutilization of funds as around Rs. 2,500 crores were found unspent in the banks, and delays in the project approvals between 2014-15 and 2016-17 , besides several other shortcomings as apparent from a detailed report summary .

Union Home Minister, Sh. Amit Shah, during 'Ganga Aamantran Abhiyan,' ceremony, still stated that 'Namami Gange' improved water quality of Ganga" and that the project to clean Ganga, had been a success as government is planning to launch similar initiatives to clean other rivers in the country in coordination with people. He referred to the successful organization of Kumbh Mela (2019), and said that the people attending the ceremony were testimony to the NGP success . Further, Sh. Amitabh Kant, CEO of NITI Aayog also heaped praises on the government and said that 'With Its Multi-Sectoral Approach, Namami Gange Has Been Successful in Making Positive Impact' while talking at 5th India Water Impact Summit 2020. He also expressed that data and numbers are not sufficient, and only the passion can make the administration work a success. Taking inspiration from the Prime Minister's "vocal for local" campaign, he suggested that local water bodies should be managed by local people and should cater to local needs which will also generate local employment and reduce the cost of transporting water .

Livelihood Generation Opportunities

According to Indian literature, Ganga is everlasting and has thousands of years of history, with at least hundreds of years of documented writings about her. She not only provides ecological (biodiversity) and social values, but also economically sustains the people of India (livelihood). However, the non-judicial and irrational behavior of economic agents has jeopardized her resources.

A recent case study on the Ganga resources and the flow (ferry and tourist) and non-flow (riverbed farming) associated livelihood options drew our attention to the current situation. According to the report, the tragedy of the commons, state-provided subsidies, and myopic conduct within the community have reduced the sustainability of river resources, which will have a negative impact on the biological, physical, human, and management systems across the rivers. The article says that a comprehensive research of environmental assets is required to develop information on the socioeconomic advantages of river resources, and that an effective knowledge-based allocation of resources is urgently needed .

Uma Bharti, Former Madhya Pradesh Chief Minister and Ex-Union Water Resources Minister, during an event on 'Swachh Ganga Abhiyan', reciprocated the reports of experts and said that maintaining the Ganga's uninterrupted flow is critical as approximately 50 crore people rely on the Ganga for their livelihood and half of them would lose their resources if it dried up .

Shekhar Shah, DG, NCAER, while presenting the joint report of NCAER (New Delhi) and TCD (Chicago) stressed that there is an urgent need to regulate traditional river fishing methods by providing proper licensing services especially in Uttar Pradesh and West Bengal where the Ganga is used by fisher folk for drinking, fishing, and bathing. The report urges that the fisher communities should be recognized as part of the river ecology, and that their indigenous knowledge be synchronized with scientific findings in order to improve water monitoring and control strategies. Moreover, these communities should also be included in river development and alternative skilling programmes in order to expand their economic options, says the report .

Union Water Resources Minister, Sh. Gajendra Singh Shekhawat, also reputed the Ganga as foundation of India's economic activity, and at 'Ganga Utsav' event (2021) said that the 'NMCG has succeeded in bringing

Ganga closer to the people and turning it into a Jan Andolan. Hundreds of thousands of people are helping to clean the Ganga. Previously, work on cleaning the Ganga was done in silos, and efforts were not conducted with the same zeal as they should have been’.

DG, NMCG, Mr. G. Ashok Kumar in a conversation with a TheStatesman reporter, highlighted his vision of ‘Arth Ganga’ and discussed how economic activities around Ganga may be developed to make the “Clean Ganga” mission long-term self-sustaining. For this objective, he said, NMCG has established the concept of ‘Earth Ganga,’ which aims to develop socio-economic activities along the river’s banks in order to generate jobs. The first stage is to promote zero-based natural farming in the river basin area by reducing chemical use in agriculture. He made the argument that freshwater fisheries would bring income to those who live along river banks, and that they would care for the river since it would supply them with revenue. To assure a higher price for fish, we are considering establishing cold storage facilities in specific locations. Furthermore, he also said we focused on the promotion of tourism by developing ghats and beautifying them .

Agriculture, afforestation and water conservation

The Ganga basin accounts for around 29.5% of India’s total cultivable area. Irrigation covers about 68% (20.2 million hectares) of the basin’s net planted area (29.57 million ha), an increase of 43% from 1962-65 to 2003-06 . Water is the primary motive as well as the prime limitation for agriculture. Rainwater harvesting, less water-intensive crops, climate-smart agricultural methods, water-saving farming techniques, and organic farming may all benefit from increased awareness and information sharing. With significant anthropogenic strain on water resources, it is critical to focus on water conservation and the efficient and effective use of water resources. Consequently, organic agricultural inputs, an effective irrigation system, and the economic cash crops might be useful. Concerning this, it was decided in an official NMCG meeting that a corridor of 5 - 7 km along the banks of Ganga should be developed for organic farming. Further, farmers along Ganga River should be encouraged to take up sustainable agriculture practices including Zero Budget Farming, and that there is also need to minimize water loss from water distribution systems through adoption of measures such as lined irrigation canals, covered aqueducts, leak-proof pressure valves in drinking water distribution system .

Who is more eligible than Padma Shri and Padma Bhusan Dr. Anil P Joshi, who by profession and passion is a revered environmentalist, green activist, and the founder of Himalayan Environmental Studies and Conservation Organization, to comment on this topic? His work majorly includes developing sustainable technologies that are ecology inclusive economy for ecosystem development. Dr. Joshi says that ‘The genuine capital of a country is its natural resources’ and presented the concepts of GEP (gross environmental product) while contrasting this with the GDP (gross domestic product). He argues that GDP is too narrow a criterion for assessing a country’s total growth because it ignores the periodic state of soil, water, forest, and air. It should not be the only metric used to assess national progress, as the environment is rarely considered in it. He argues, we frequently forget that in agricultural nations like ours, where agriculture provides a living for more than 70% of the people, our subsistence pattern differs significantly from that of Western countries. He recognizes the paradox, that a nation’s needs economic growth while simultaneously ensuring its ecological needs; and he advised that a periodic examination of our ecological assets, such as forest cover, soil, and water bodies, be conducted for this to work. Gross Environmental Product (GEP), he believes is a concept that is inclusive of all of these .

Ex-Director, NMCG, Sh. Rajiv Ranjan Mishra also believes that a boost to organic farming is required, as he presented his case, saying that the rapid urbanization, removal of top soil (for brick laying, etc.), increasing population (75 million per year globally), conversion of prime crop land to urban use (3 million ha.), deforestation of alluvial regions, and alarming rates of water abstraction for Agri-purposes in the Ganga basin area have all been causing damage to aquatic flora and fauna. Mr. Mishra said that the NMCG is working closely with the Ministry of Agriculture and Farming welfare to promote organic farming and improve farming techniques in order to alleviate these detrimental effects. He also recommended micro-irrigation techniques and flood irrigation instruction as ways to successfully reduce soil erosion in basin states

The Chairman of consumer goods giant Patanjali Ayurved, Sh. Acharya Balkrishna, says ‘We can only rescue Ganga, her holiness, and the flow if we plant more trees while leaving the present ones alone and avoid polluting her with dangerous chemicals (insecticides and pesticides)’. Speaking at a ceremony ‘Clean Ganga - Rural Participation’ (2016), Acharya Je stated that ‘during older days one could readily see soil along the banks of the Ganga, but now that is all gone and all that is left is sand, which is also a matter of illicit mining these days. This has happened as a result of soil erosion caused by large-scale deforestation in the recent decades. As a solution, we may limit the use of pesticides for at least 1-2 kilometers along both sides of the Ganga’. He further talked of the shared responsibilities and says that these things must be worked out as a moral duty and as our commitments, since we are the part of the problem itself .

The banks of the Ganga are home to a diverse array of flower species. Climate, altitude, and Ganga water all contribute to the variety, which gives nutrients and conserves water by preventing soil erosion along the Ganga’s banks. Floral variety abounds from the Ganga’s headwaters to Rishikesh (Upper Ganga basin). From October to March, the source region is snow-covered for approximately six months, and during that period, numerous medicinal plants thrive there, hence the region is also known as alpine meadows. Below the alpine meadows (2200–2800 m), dense coniferous woodlands with a diverse range of species grow. The most prevalent species are deodar, spruce, cedar, and fir. Mixed-oak woodlands border coniferous forests (1800–2200 m). Pine woods may be found between 1100 and 1800 meters above sea level. Monsoon deciduous woods thrive below 1100 m (Shivalik hills) (Sati, 2020). Figure 4 depicts the Ganga Basin regions as per the biodiversity and some dominant vegetation found in this area.

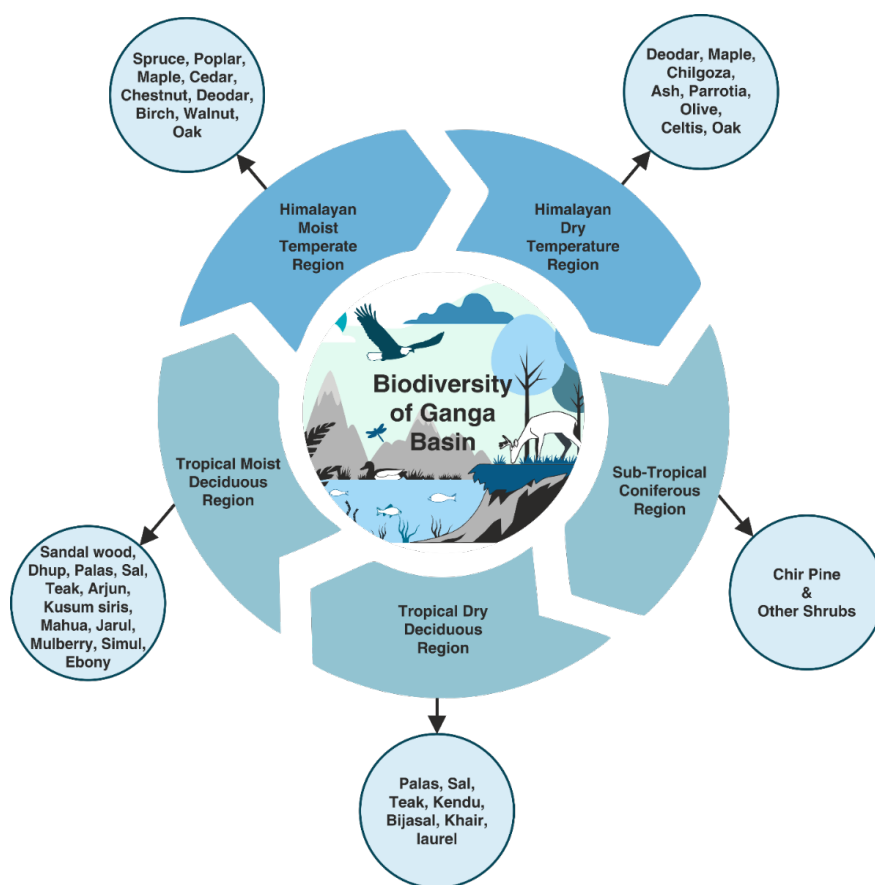


Figure 4 . Ganga Basin Regions as per the biodiversity (Source: Sanghi, 2013)

The Ganga basin, which is split into ten agricultural zones based on meteorological and soil factors is ideal for canal building. It is also helped by an abundant supply of water (Sati, 2021). The basin is one of the most highly irrigated areas on the planet. There are locations with the highest agricultural productivity which play a significant role in meeting the nation's food needs. While some places are well-known for specific crop production, some crops are also exported out of the nation (Figure 5). Rice, wheat, potatoes, sugarcane, oil seed crops, and lentils are some of the key crops, and they are also water-intensive crops that need extensive irrigation. Though, there has been a discernible change in the river's hydrology and water quality throughout time.

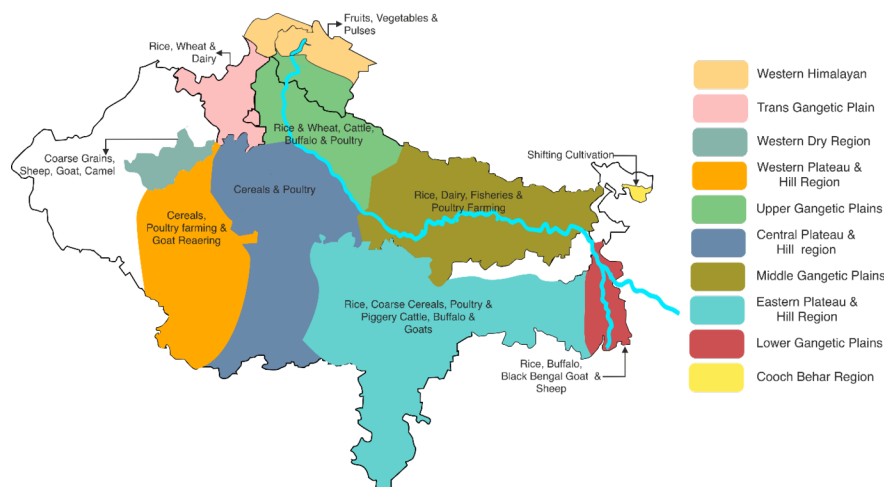


Figure 5 . Ganga Basin Regions and the Key Agricultural Products (Source: Sati, 2021)

The NGP has achieved various milestones so far, including assisting in the release of Kanpur from the harmful effects of the Sisamau drain after a 128-year gap, which was infamous for the filth it was contributing to the Ganga. According to reports, approximately 140 MLD of waste has been stopped from flowing into the Holy Ganga. 97 towns within a 5-kilometer stretch of the Ganga have been identified to make necessary interventions, and several user-friendly mobile-based applications, such as the Green Ganga App and the Bhuvan Ganga App, have been launched for the sake of convenience . The Green Ganga App is used for geo-tagging seedlings and delineating plantation borders as part of Namami Gange's continuous afforestation initiatives, whilst the Bhuvan Ganga App is utilized by the public to collect and submit information on different pollution sources that influence Ganga water quality.

The fundamental goal of the planned forestry interventions is to contribute to the holistic protection of the Ganga River, including enhancing the flow of the river (Aviralta) through a multi-pronged strategy across the Ganga riverscape. Since 2016-17, the project "Forestry Interventions for Ganga" has been executed by the State Forest Departments of Uttarakhand, Uttar Pradesh, Bihar, Jharkhand, and West Bengal in accordance with the FRI DPR, with NMCG providing financial assistance to the relevant State Forest Departments .

As per Mr. Raman K. Tyagi, Director, NEER Foundation, apart from Ganga rejuvenation, we should also focus on Ganga's tributaries and also on Yamuna (and the tributaries). Mr. Tyagi says that there is a perception among people, especially urban world that small rain-fed rivers can't be revitalized, which is not true. The results of successful efforts made on the Ganga's major tributary River Kali and Neem and while of Yamuna's, the Hindon River have given us energy, enthusiasm and courage, but a concerted and systematic effort is needed. He then suggested a 'Meri Nadi, Meri Pehal' initiative where he quoted ten 'Mool Mantra' for rejuvenating the rivers. These are, 'Knowledge of River; Mapping of Main River body; Rejuvenation of river resources; Solid-Liquid waste management; Cleaning of River bed; Public Awareness; Intensive Afforestation; Lake conservation; and Chemical free Agri practices .

NITI Aayog has recently declared ‘Jakhni’ village in Banda district of Bundelkhand as the Model ‘Jal Gram’, because, here the villagers have made the village green by planting trees along the ridges of the fields. Under the leadership of Uma Shankar Pandey, a social-worker from Jakhani, and hero of this initiative, almost 10-15 years ago few awake persons of the village formed the ‘Sarvodaya Adarsh Jalgram Swaraj Abhiyan Samiti’. The samiti started to make people aware of conserving water. Neither any grant was taken from government in the course of this collective endeavor for water-conservation, nor utilized new machine-run technique—rather peasants, youths, unemployed-persons of the village themselves picked-up the spade, offered their time, provided selfless labor under shramdan, constructed ridges, prevented the water of village from being drained out, vitalized the water of village, emerged their village as the first Jalgram of country .

Furthermore, Secretary of Jaladhikar Foundation (Delhi), Mr. G. K. Agrawal, who is very active regarding the water conservation aspects of NGP, has been discussing the issue of water with different people of the society for quite a time now, advocates free water for everyone as he believes water is a natural commodity and no one should have rights to commercialize it, no matter what their obligations are. He believes that we all are equally responsible for ensuring clean water for everybody. He also says that the government expects the people to follow the constitution but the government itself is disobeying the constitution of nature. Instead of providing free water for living beings, the government is promoting its indiscriminate commercialization. The issue according to him is of mismanagement and unjustified allocation of water resources, especially among urban communities. He then concludes by praising the government’s Jal Jeevan Mission (Har Ghar Jal) initiative in this regard, but notes that more effort is needed to ensure the water quality, price, and distribution status scenarios .

Arth Ganga, Brand Ganga and Ganga tourism

To energize socio-economic development along the banks of the Ganges, a concept of ‘Arth ganga’ was visualized under “Namami Gange” mission which is now being pushed as a sub component of Jal Marg Vikas Project (JMVP). During the inaugural meeting of the NGC in Kanpur on 14th Dec, 2019, Prime Minister Modi conceptualized the “Arth Ganga” in order to revitalize economic activities along the Ganga River bank . Project’s major objective was to channelize economic activity along the Ganga River’s banks in order to support India’s inclusive growth and provide enormous job opportunities. Project is currently being implemented by Ministry of Shipping of the Government of India in coordination with Ministry of water resources (via NMCG).

PM Modi, in this meeting also instructed the governments of the five gangetic states to focus on increasing religious and adventure tourism on the river in order to create sustainable coinage for cleaning the Ganga. He believes that the focus should change from Namami Gange to Arth ganga, which will support the sustainable development paradigm through economic activity. He went on to say that a digital dashboard should be built up to collect data on water quality from villages and urban bodies, and that it should be monitored by the Niti Aayog .

Speaking at the sixth India Water Impact Summit, current Union Water Resources Minister, Sh. G. S. Shekhawat, urged for collaboration among diverse activities being performed throughout the world to address increasing water concerns, and stated that information gained from the Ganga will be shared with the rest of the world. He then stressed the terms ‘Arth Ganga’ and ‘Gyan Ganga,’ saying that in order for Ganga to have a worldwide appeal, it must be branded, and that eventually, Ganga tourism, Ganga Medicine, Ganga Products, and so on will demarcate the Ganga River .

In a case study, based on the E-Flows Related Livelihood in the Ganga River, Mr. Panta (IIT, Kanpur) focuses on the interaction between river resources and livelihood, with the backdrop of river resource exploitation generating an imbalance in flow-related livelihood, ultimately leading to the extinction of river resources. For the first time, a study recommended that the river’s Maximum Sustainable Yield (MSY) be kept in a desirable state in order to increase environmental flows (e-flows) and encourage livelihood opportunities such as tourism and pilgrimage in the states like Uttarakhand (Haridwar-Rishikesh) and Uttar

Pradesh (Kachhla Ghat-Bithoor) .

Ms. Gupta, in The Print news article, regarding ‘Arth Ganga’ writes that the government now plans to make Ganga a focus of economic activities by establishing floating flower and fruit markets similar to those seen in Srinagar’s Dal Lake, as well as ferry service to transfer commuters to various areas inside towns. This project envisions the construction of small community jetties to convey farmers selling flowers, vegetables, milk products, and pottery to lively markets in the four states along the Ganga’s banks. In addition, the government has proposed launching boat services connecting various sites throughout the city, including tourism attractions. It was first presented by the PM as a concept of sustainable development model centered on economic activities and livelihood generating from the river .

Current DG, NMCG, Mr. G. Ashok, while talking about Arth Ganga, at 7th Smart Cities India Expo where NMCG had also set up a booth on the theme ‘Arth Ganga for Smart Cities,’ said that the objective of ‘Arth Ganga’ is primarily to connect people and Ganga through the bridge of commerce. He also discussed the six pillars, which include monetizing sludge (by supplying farmers with natural manure), monetizing cleaned water, establishing ghats and other infrastructure, generating markets/tourism, institution building, and capacity building. Other topics discussed at the event included the need to strengthen people-river connections, promote circular water economy, adopt sustainable agriculture practices, conserve and protect riverine ecosystems and biodiversity, localized climate change mitigation solutions, and revitalize natural and cultural heritage .

The minister of State for Shipping, Sh. Mandaviya, while speaking at a press conference, emphasized that inland waterways is one of the most significant pillars of the “Arth-Ganga” project, which would result in inclusive growth and play a vital role in the creation of massive job possibilities along the National Waterways stretch. Many initiatives, such as the development of tiny jetties by the Ministry of Shipping, have been carried out for the benefit of local communities, particularly farmers, traders, and the general public, along the 1400km stretch of National Waterway-1 from Banaras to Haldia. Farmers will earn a higher return on their produce since transportation of goods will be easier and less expensive as a result of this. It will increase the ‘Ease of Doing Business’ and the ‘Ease of Living’ .

Soil health and Industrial waste management, wetland monitoring and conservation

Modern agricultural practices are major contributors to soil degradation and fertility loss, water pollution, and natural resource depletion in the river system. While these are global issues, the extreme land and water constraints of the Ganga basin’s agriculture have accelerated the degradation of its agricultural lands, with eroded soils and nutrients running into the Ganga River network and seriously affecting the rivers and other ecosystems. As a result, there is an urgent need to develop and promote appropriate sustainable agricultural practices to prevent further damage to the basin and its agricultural lands. Soil Erosion, Soil Nutrient Availability, Soil Biodiversity, and Water Usage are the primary concerns and for this reason environmentally sustainable agriculture should be promoted in the basin area.

Pollutants such as industrial waste, sewage, toxic chemicals, solid waste, dead bodies disposal, pollutants from cremation grounds, temple wastes, and the plastic usage, are all contributing towards deterioration of the Ganga basin eco-system (Figure 6). Due to rapid urbanization, Ganga collects an average of over 6 billion liters per day of untreated sewage into her from the cities, towns, and villages along her banks. Every day, hundreds of factories and tanneries discharge an additional 260 million liters of untreated industrial wastewater. Pollution is caused by the application of six million tons of chemical fertilizer and 9,000 tons of pesticides to agricultural fields in the basin .

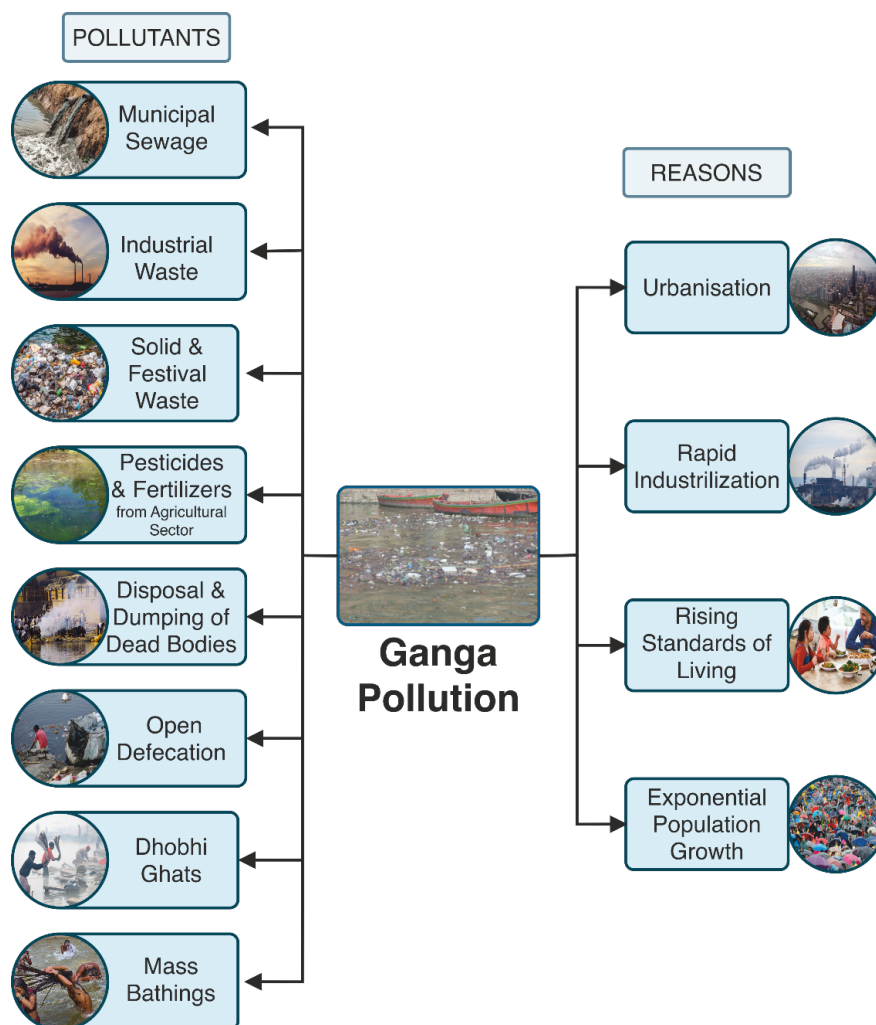


Figure 6 . Pollutants of the Ganga River

Given the high costs of land inundation, human displacement, ecological damage, and the operation, transportation, and evaporation losses of large in-stream reservoirs, any plan to rejuvenate the Ganga must emphasize distributed water storage in the basin's groundwater, lakes, tanks, and ponds, as well as the promotion of wetlands and forests.

The revered soil scientist Dr. Rattan Lal, an Indian-American, won the 2020 World Food Prize for inventing and mainstreaming a soil-centric approach to increase food production that restores and conserves natural resources while mitigating climate change. Over the course of his five-decade career, he has promoted innovative soil-saving techniques that have benefited the livelihoods of over 500 million smallholder farmers, improved the food and nutritional security of over two billion people, and saved hundreds of millions of hectares of natural tropical ecosystems. Dr. Lal contends that soil health is a dynamic notion that evolves with each generation, and that we must adapt our techniques to meet the changing needs. While commenting on the notification on E-flow for Ganga which recognizes the right of river to perform her ecological tasks, he indicated that in a similar sense, we need to reflect on the right of soil for protection against flood in order to mitigate soil erosion and improve soil health.

Wetland conservation, according to Mr. Ranjan (Ex-DG, NMCG), is an important component in river

rejuvenation. Wetlands are separate ecosystems that are permanently or seasonally inundated by water. Floodplains and surrounding wetlands are especially important because they can directly contribute to improved river flows. The ‘Namami Gange’ mission has collaborated with a number of partners, including WWF, WII, and state wetland authorities, to produce a good inventory, ground verification, integrated management plans (IMP), and their implementation for conservation and protection. A special Namami Gange project is ongoing in Uttar Pradesh, creating IMPs of 226 wetlands within 10 kms of the Ganga spanning over 1,000km length as a one-of-a-kind endeavor to scale up wetland conservation to river and basin level .

Dr. Tripathi, reproaches the existing administration, to which he says that, in spite of forming a separate ministry, and after investing a large sum, only a little has been done, and the results are far from satisfactory. The results of Ganga cleaning are not exactly reflecting what is being claimed, and the flow of ganga is still tipping, reducing her diluting capacity, he elaborates. There are dead zones leading from industrial waste dumps that may be up to 2 kilometers long. Every year, about 700 tons of ash from the burning of around 33,000 dead corpses are thrown into the river, along with the remnants of those deceased bodies. These are some of the things he describes as impeding efforts to clean Ganga .

Pilot Projects and studies

According to the article, the Indian government initiated a pilot afforestation project along the Ganga’s banks in 2015. According to the NMCG website, this refers to a project financed by NMCG that the state forest departments of Uttarakhand, Uttar Pradesh, Bihar, Jharkhand, and West Bengal have been undertaking since 2016. The entire amount allotted was Rs 2,293 crore. However, after five years, many people consider that this endeavor is a colossal failure. Some experts have even commented that planting new trees can reduce the streamflow 70% of the time, particularly during the dry season. As per this report, Mr. Krishnaswamy stated that providing a mix of trees, grasses, and shrubs in “suitable densities” and species composition, consistent with the river’s flow regime and the area’s temperature, will be critical to ensuring that tree-planting itself does not drain water .

For the first time, the mission received and began implementing a scientific plan for afforestation along the full length of the Ganga produced by the Forest Research Institute. This design addresses natural, urban, and agricultural riverscapes. Using it as a model, the MoEF&CC is presently applying a similar technique to 13 additional rivers around the country . However, the DG, NMCG recently informed the empowered task force (ETF) that repeated efforts have been made in the past for allocation of funds from Central CAMPA for scaling up afforestation activities under the NGP, which have not resulted in any specific results, and as a result, the comprehensive DPR developed by FRI, Dehradun has not been fully implemented. Participating in the discussions, Hon’ble Minister for Jal Shakti (MoWR) emphasized the importance of conducting a Third Part Appraisal of the Afforestation Project under the NGP to assess the impact of such large-scale intervention and going beyond simply reporting on the number of hectares and number of plants planted in the region. To which DG, NMCG responded that IIFM, Bhopal has been engaged for this sole purpose .

In light of the expired deadline of the NGP which was initially supposed to be in March 2019, was again extended to 2020 by then minister Sh. Nitin Gadkari, one report cites a study conducted by the Sankat Mochan Foundation (SMF), a Varanasi-based NGO, which revealed a significant increase in coliform bacteria and biochemical oxygen demand (BOD) over these years. SMF has developed its own laboratory to analyze Ganga water samples on a regular basis. According to these statistics, the coliform level increased from 5.2 crores in 2016 to 14.4 crores in 2019. Similarly, between January 2016 and February 2019, BOD levels increased from 46.8-54mg/l to 66-78mg/l. During the period, however, there was a minor improvement in sewage flow into the Ganga .

Nonetheless, despite all of the criticism and skepticism, there are a number of excellent developments related to the NGP’s basic aim of river rejuvenation. One such pilot case study is from Uttarakhand, where Mothugad, a rain-fed river in the Chamoli district, began to dry up over time, forcing the district administration

to begin work on renewing Mothugad River in particular and cleaning rivers in general as part of the Namami Gange Project. Ms. Swati (District DM) applauded the region's degree of public collaboration and social awareness, noting that they were able to create an Anthem for the River in their native Gadwali language. She claimed that the effort had a direct and indirect impact on 80,000 people. In terms of the project's implementation, according to NMCG, harvesting structures were built and plantation was carried out with the support of locals, all while utilizing already available money from MNREGA and CAMPA, making it cost-effective. GIS mapping and tracking for all actions were intended for transparency, and the project was reported to be extremely scalable and practical with the deployment of geo-tagging and drone surveillance .

Another success story is of establishment of Bio Gas (CNG) Generation plant from 18 MLD Jagjeetpur STP at Haridwar. It started with Uttarakhand Jal Sansthan (UJS) recommendation for generating biogas (Bio CNG) by mandating relevant improvements in the digester and building an Upgrade to the plant in PPP (Public-Private partnership) mode on a revenue sharing basis to address the problem of sludge disposal created at the STP plant. The NMCG supplied funds for the STP's foundation upgrades, while the DST provided Rs. 431 lakhs in funding through its Technology Development Board for the processing unit's technology installation. This project was said to help a number of government projects, including Namami Gange, Atmnirbhar Bharat, Swadeshi, Swachta, and others .

In a study published in 2021, Mr. Singh, collected data from field visits, household surveys, and focus group discussions (FGDs) on the ancient practice of flood recession farming (FRF). FRF refers to farmers using moisture and nutrient rich soil of the floodplains for growing crops after water levels recede and harvest them before flooding in the river. The study concludes that true potentials of FRF can only be assessed through comprehensive research about its different aspects and mainstreaming this practice in policy-making for sustainable food production .

Yet, in another very interesting and recent study, Mr. Dey who is currently a research affiliate with Nature Conservation Foundation, presented a new challenge which has hurdled as a side-effect of the push to the water ways economic model (Arth Ganga). He says that "The Ganga, as we know, already experiences an immense load in terms of motorized vessel traffic,". The most obvious fear is that any increase in vessel traffic could result in more harm than good to the Gangetic Dolphins. Not only will the number of vessels traversing the river rise, but they will largely be on a regular schedule, resulting in a more chronic noise environment than a vessel that passes by only once. Study concludes that maintaining the ecological flows (E-Flows), downscaling of vessel traffic, and propeller modifications to reduce cavitation noise, could help mitigate noise impacts on Ganga River dolphins .

Emphasis based actions list quarried from the opinions

A great number of positive, negative, and neutral comments on different areas of the 'Namami Gange Programme' were logged and thoroughly reviewed in an unbiased way, providing numerous actionable points that are addressed individually in the following sections of this review. Based on these comments, a bulleted list of tasks was extracted and duplicated below in order to weave a framework-based solution to the project's core challenges.

- Conservation of water and connecting every household to the tapped water supply and a sanitation system.
- Connect Ganga Panchayats, villages, taluks, towns, etc. along the Ganga River to economic model of 'Arth Ganga'.
- Ganga centric economic activities to create livelihood opportunities.
- Concern of sustainability of the projects regarding Ganga cleansing.
- Reducing chemical use around Ganga banks, promoting sustainable and safe farming practices like Organic and Natural farming.
- Promoting business activities, like freshwater fisheries, and eco-tourism along Ganga River.

- Licensing, Branding, Certification, and Training activities related to Ganga or Ganga products.
- Periodic monitoring and control strategies using GIS mapping, Geo-tagging and Geo-fencing technologies.
- Herbal gardens, and tree plantation drives in a transparent and sustainable manner.
- Assessment of model pilot projects for their scalability.
- Focus on Himalayan River conservation programs.
- Promotion of field surveys, household visits, and group discussions to collect data on Traditional farming methods, especially flood recession farming (FRF), and micro-irrigation techniques.
- Soil health monitoring using advance surveillance mechanism to curb soil erosion and support good farming practices.
- The Dolphin Conservation Program may be jeopardised by 'Arth Ganga' initiatives because dolphins may be harmed as a result of noise from jetties and ferries or other economic activities.
- Urban water management, and revitalization of rain-fed rivers, especially the major tributaries of Ganga, supported by the mapping of whole river body, creating awareness, rejuvenation of wetlands, and other practices.
- STP generated sludge management, using the concept of 'sludge to compost' and 'Bio CNG' derived entirely from urban sewage sludge.

Based on these deliberations, we have proposed a solution to the vexing challenge of rejuvenating and cleaning the Ganga.

Way forward: A conclusive remark

Namami Gange, the cleaning and rejuvenation plan of the Ganga basin established a striking new magnitude of progression for the nation's prosperity by ensuring a clean and increased flow of water in river Ganga. Several other core issues are currently being considered to fulfil the overall aim of rejuvenation. It is believed that the future of Ganga is the future of India, whether it is culturally, economically or in terms of water resource availability. It is important to not treat the majestic and unique river just as the source of water, but a passage to our history, culture and civilization. With several first-time initiatives, NGP is potentially most comprehensive framework for River Rejuvenation. In conjunction with the main objectives, sludge management and agriculture activities in the basin area seem to be the refined focus of this project as per detailed analysis of public comments and opinions.

Farmers are among the most important water managers because they use roughly 70% of the freshwater water withdrawn globally to support agriculture. Helping farmers will thus help creates possibilities for reducing waste water and curb the water pollution levels (Sharma & Shekhar, 2021). Sludge management on the other hand is also a core issue, with increase in number of STPs and the current scale of wastewater treatment. This is a problem faced not just by India but on a global level.

There were numerous challenges that needed to be addressed one by one. We have concluded our review with the bulleted observations about the technology-based interventions we have offered across the identified issues, which are provided below.

Agricultural interventions : The constant flow of water, clean water, geological protection, and aquatic biodiversity conservation are without a doubt the primary components that sustain the Ganga River in a novel manner. However, there are certain crucial initiatives that may be performed to improve the Ganga's sustainability. Our goal is to investigate the scope of ecohydrological and technology options for Ganga rejuvenation based up on four primary components: rural (farmer), urban, Ganga Dhara (watershed area), and Ganga Dhara (flood plains). Part of the answer is to promote natural, organic agriculture and related industries such as horticulture, floriculture, fishing, and animal husbandry. The following are the main agricultural reforms we have proposed regarding this:

- Adoption of Organic Farming.

- Adoption of Natural Farming (zero-budget, no-tillage, crop diversification, and permanent organic soil cover).
- A digital Farmer's registration inventory in accordance with e-governance initiative.
- Cadastral mapping, complete with geo-referencing, geo-tagging, and geo-fencing which should be linked to the above digital inventory for a smooth functioning.
- Farmer Training programmes to generate Soil health related awareness for a judicious and optimized usage of chemical fertilizers (in case the farmer is not yet ready to move for organic or natural farming).
- For upliftment of farmers, developing an accessible market platform for the agribusinesses.

A complete and integrated (traditional + digital technical) strategy that promotes organic and natural farming and leads to sustainable agriculture and food security in India is essential for the holistic development of the Ganga basin's agricultural sector.

Sludge management interventions : Because of the massive growth in urban population and continual changes in living circumstances, which have resulted in significant water usage and subsequent discharge of wasted water into surface watercourses, sewage sludge treatment has now become a serious problem. One aspect is the use of sludge in agriculture due to its high quantity of organic components and plant macronutrients such as N, P, and K. However, because there are several imperative problems, such as the existence of undesired components like phenolics, heavy metals, polycyclic aromatic compounds, and so on, which are possible threats to the environment, a prudent approach is required. Considering the many sludge' management and disposal methods accessible to us, India, as an agrarian-based growing economy, must decide what is best for her. Landfilling is one alternative with advantages such as being a substantial producer of greenhouse gases; however, there is a faster technique of converting it into organic fertilizer that is both green and sustainable. We need to look at private companies who are working in this area and can efficiently manage heavy metals out of sludge while producing high-quality agricultural goods.

Biodiversity Conservation, Sustainable Forestry, and livelihood generation interventions : Apart from luring tourists, the protected areas throughout the Ganga Basin give opportunities for biodiversity parks. The Ganga River contains a diverse aquatic population. Wildlife Institute of India (WII) has designated as many as six high biodiversity zones, and there are over 5 lakh wetlands reportedly spread over the five Ganga River states. Wetlands not only maintain a high level of biological diversity, but also provides a diverse range of ecosystem goods and services, such as irrigation, residential water supply, freshwater fisheries, and recreational water. Based on our observations of current developments under the 'Arth Ganga' project, we propose the following actionable ideas:

- Geotagging of Trees during Afforestation Programme.
- Timely Review of Eco-sustainable model of Arth Ganga.
- Community led conservation programmes.
- Wetland tourism promotion.
- Biodiversity based eco-tourism.
- Promotion of water sports.
- Skill based training programmes and promotion of local artisans and creating international trade opportunities.

Among the multi-sectoral interventions, the specific challenges being faced by Agriculture and Sludge management sectors are of huge scale and needs immediate attention. Such challenges need not just a piece meal approach but an overall integrated technology-based framework presented as a solution which can address the monitoring and marketing aspects while covering all other concerning aspects. It has to be dealt on grass route level while using the modern approaches. This multi-facet approach must include provision for farmer's connect to businesses, their acceptability towards organic and natural farming, warehousing solutions for pre- and post-harvest management, promoting safe farming practices, monitoring the activities on a dashboard level with pin-point accuracy, region-based tree plantation and monitoring mechanism. Such a technology can help to reduce risk, stimulate innovation and help the farmers dealing with the effects of climate change.

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