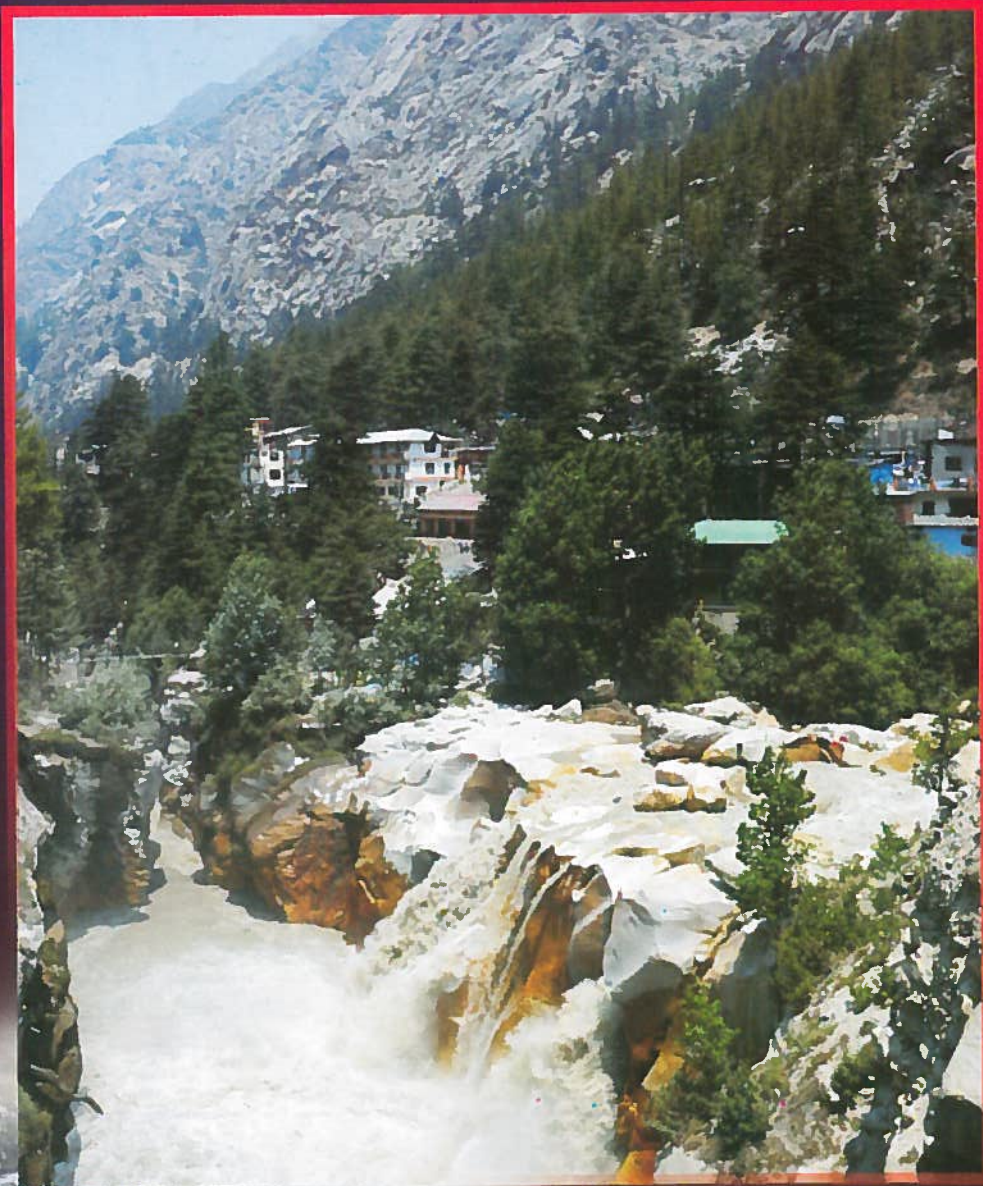


The Ganga-gallery

A gallery for public awareness, conservation
and restoration of the holy river.



Conceptualised by



**The National Academy of Sciences, India
(NASI)**

Designed & Developed by



National Council of Science Museums (NCSM)
Ministry of Culture, Government of India

GANGA GALLERY : AN INITIATIVE OF NASI

The river Ganges occupies an unique position in the cultural ethos of India. Legend says that the river has descended from Heaven to the earth as a result of the long and arduous prayers of King Bhagirath for the salvation of his deceased ancestors. From times immemorial, the Ganges has been India's river of faith, devotion and worship. But the holy river Ganges's existence is under threat, due to enormously increasing load of pollution year by year. Therefore, the Council of the Academy decided to establish a Ganga gallery. An Advisory Committee was set up under the Chairmanship of Prof. M.G.K. Menon with Dr. Manju Sharma as the Coordinator and experts like Dr. B.D. Tripathi, B.H.U. as member. The following are the well defined objectives in order to highlight the socio-scientific, religious, cultural and economic aspects of the holy river:

1. To develop a Ganga gallery using the scientific and technological tools with maps, large photographs and sculptures indicating different activities related to the holy river Ganges.
2. To create 'The Ganga Model' in a large hall indicating different pollution sources from Gaumukh to Ganga Sagar and its impact on the water quality with the help of relevant data and photographs. The model will also include the flow directions, water carrying capacity, sand deposition etc.
3. To establish a library with the literature on the origin; geological structure; geographical distribution; flow of water through different states; physico-chemical and biological properties; pollution sources & other degradational forces; biodiversity & endangered species; cultural, religious, economic, socio-scientific and ecological significance of the river Ganges.
4. To make audio visual presentation/light and sound program on the Ganges.
5. To institute fellowships and start lecture series on the Ganges in different states specially where those the river flows.
6. To prepare CDs and documentary films, arrange photography and essay competition on the Ganges and involve NGOs, Universities, Colleges, Schools, Electronic and Print Media etc. for public awareness and action programmes.
7. To create a website for wider publicity and disseminate the knowledge at global level about the Ganges.
8. To encourage researchers of various disciplines and develop indigenous technologies for the treatment and recycling of waste waters to solve the problems of the Ganga Water Pollution.
9. To develop trees, shrubs and grasses plantation strategy to control the impact of pollution, silt load and maintain the ecological integrity of the river ecosystem.
10. To organize seminar, symposia, workshop and training programmes time to time on the issues

**Financed by
MPLAD & Department of Science & Technology
Government of India**

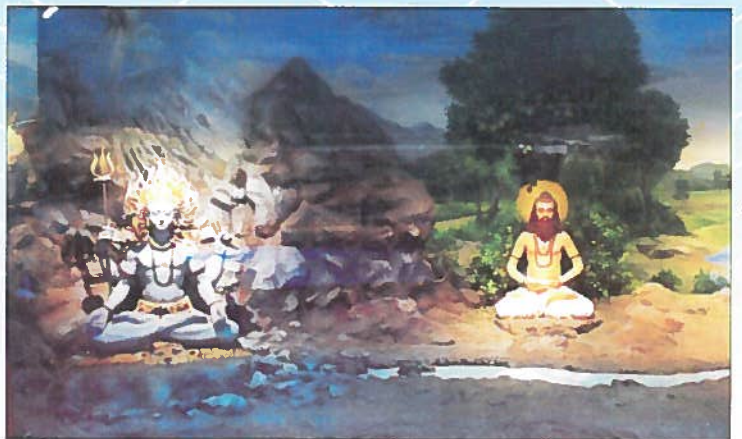
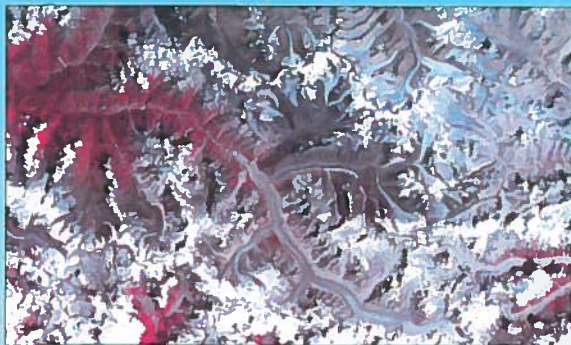
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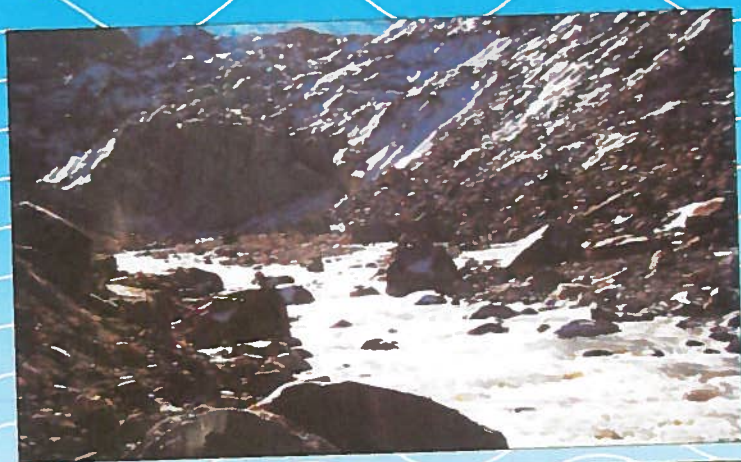
Ganga : The Heritage

No other river in the world is so closely identified with a country as the Ganga is with India. It is a life-line, a symbol of purity and virtue for millions of people living on its bank, representing their ethos, socio-scientific culture & identity in every forum, not just in India, but in the entire world.

In the words and sentiments of Pandit Jawaharlal Nehru ;

"The Ganga, especially, is the river of India, beloved of her people, round which are intertwined her memories, her hopes and fears, her songs of triumph, her victories and her defeats. She has been a symbol of India's age-long culture and civilization, ever changing, ever flowing, and yet ever the same Ganga".





Ganga: The Myth & Legends

The river Ganga has held India's heart captive and drawn uncounted millions to her banks since the dawn of history. Certainly the legends associated with river Ganga, and the myth concerning its genesis prominently highlight the roles of the sacred water in our life - as the giver of life and remover of sin or curse.

The Origin of Ganga

The door or opening of the Ganges in the mountainous gorge at the foot of the Himalayas, Gangotri is the place from where the Ganges descends. Bhagirathi, one of the tributaries originates from the Gaumukh snout of Gangotri glacier, one of the longest glaciers of India, whereas the Alaknanda, the other main tributary emerges from the Bhagirathi Khark and Satopanth glaciers, east of Chaukhambha peaks. After flowing in opposite directions from their respective snouts they meet at Deoprayag and henceforth collectively known as the river Ganges.

In Search of Point Source

Prior to 10th century, some European geographers such as Ptolemy, Italian and Dutch cartographers tried to locate the source of the River Ganga on their maps. Jesuit missionaries traveled facing all odds to the lake Mansarovar in the early 17th century and brought back the legend that this was the source of Ganga. Chinese Cartographers were sent to Tibet and came back with the same story. In 1733, it received official stamp when published as a part of four volume description de l' Empire de la chine and later in James Rennels "Memoir of a Map of Hindustan" in 1783.

In 1808, East India Company sent Captain Webb to survey the Ganges from Hardwar to Gangotri (Gaumukh or the Cow's mouth). They gathered reliable information that the source of river is more remote than the place called Gangotri. James Ballie Fraser was the first European to actually reach Gangotri in 1815, followed by Captain J. A. Hodgson two years later, who continued his journey upto Gaumukh and officially discovered the source of Ganga.

Tributaries of Ganga

The Ganga river drains the young Himalayan fold mountains in the north, the stable northern part of the peninsular region in south and Gangetic alluvial plane in the centre. It has many tributaries, both in the Himalayan region before it enters the plains at Haridwar and further downstream before its confluence with the Bay of Bengal. The important tributaries and sub-tributaries are: Yamuna, Ramganga, Gomti, Ghaghara, Gandak, Kosi, Kali/ Sharda, Chambal, Sindh, Betwa, Ken, Tons, Sone, Punpun, Damodar & Kangsbat Haldi.

Hydrological Potential of River Ganges

Rainfall, subsurface flows and snow melt from glaciers are the main sources of water in river Ganga. More than 60 per cent of the water flowing into the Ganga basin comes from the Himalayan streams joining the Ganga from the north. The Peninsular streams combine to contribute only 40 percent of the water, despite the fact that the catchment area of the Peninsular streams extends well over 60 percent of the entire Ganga basin. Surface water resources of Ganga have been assessed at 525 billion cubic meter (BCM). Out of its 17 main existing tributaries Yamuna, Sone, Ghagra and Kosi contribute over half of the annual water yield of the Ganga. These tributaries meet the Ganga at Allahabad and further downstream. The river has a problem of low flows between the Haridwar - Allahabad stretch.

Stream & Flow Characteristics of River Ganges

Due to their high gradient and a tremendous velocity, Himalayan rivers including the Ganges have a strong erosive power. The geological fact that the Himalayan rivers run through poorly consolidated sedimentary rocks affected by folds and faults results in high rates of erosion and silt deposition. Landslide debris further adds to the silt load.

Based on stream characteristics, the entire 2,525 km course of the Ganga can be divided into the following major five sections: (i) mountainous, (ii) upper plain, (iii) middle plain, (iv) deltaic non-tidal and (v) deltaic tidal plain. The stream characteristics of the river Ganga, from its source to its outfall in the Bay of Bengal are as below:

Catchment area, annual yield of water and mean flow of tributaries of Ganga Basin
(* CWC Publication "Water Resources of India-2008")

Sr. No.	Sub-Basin	Mean Annual Yield (Billion Cubic Meter BCM)	Percentage Contribution (%)
1.	Ramganga	17.89	3.39
2.	Yamuna (excluding Chambal)	57.247	10.90
3.	Chambal	32.554	6.20
4.	Tons-Jamunna	10.609	2.02
5.	Gomti-Ghaghra	113.511	21.62
6.	Sone-East of Sone	44.144	8.41
7.	Gandak-Buhi Gandak	58.967	11.23
8.	Kosi-Mahananda	81.848	15.59
	Total (Tributaries)	416.663	79.36
9.	Ganga Main Stem	84.980	16.19
10.	Evaporation * (attributable to Ground Water)	23.380	4.45
	Total Ganga (Up to Indian Border)	525.023	100.00



Stream Characteristics along Different Sections of the Ganga

S. No.	Stretch	Section	Length (Km)	Av. Slope of Land	Mean Annual Rate of Flow (cum / second)
1	Source to Rishikesh	Mountainous	250	1 in 67	850
2	Rishikesh to Allahabad	Upper plain	770	1 in 4,100	850 - 1,700
3	Allahabad to Farakka	Middle plain	1005	1 in 13,800	4,000 - 10,200
4	Farakka to Nabadwip	Deltaic non-tidal plain	230	1 in 23,000	1,000 - 1,300
5	Nabadwip to outfall	Deltaic tidal plain	240	1 in 24,000	Variable due to the tides



Voyage of Ganga

Originating from the Gaumukh in the Himalayas, the river Ganga flows through the Sivalik hills and enters the plains at Haridwar. From Haridwar, it flows southwards, meandering over several hundred kilometers in the Indo-Gangetic plains in Uttar Pradesh, Bihar and West Bengal, ultimately to join the Bay of Bengal. Its path is about 2,525 km long and its basin is spread over about 8,61,404 square km area, draining about one fourth area of the country. The river system covers cool upland streams and warm water stretches, including deltaic habitats.

The Ganga: Mantra for Salvation

The water of river Ganges—"Gangajal", is considered to be sacred and having pristine properties in Hindu rituals and "Sanskaras". For example in the Mundan sanskara, the young child is shaven clean with Gangajal; because in the ancient time, the water was so pure that washing the head just after using the razor, was enough to wash out the germs.

The extraordinary self-purifying properties of Gangajal was because of:

- its high content of dissolved oxygen (DO).
- extraordinary high rate of re-aeration, long DO-retention abilities.
- the very fast assimilation of the putrefiable organic matter
- the presence of sulphur & radioactive traces
- the naturally occurring extracts of medicinal herbs
- the low temperature gradient at the origin
- the high flux density & flow
- the presence of beneficial algal and diatom population
- the abundance of predatory fauna; and over all & above
- the long duration of sunshine, along the Gangetic region, having its impact (electro-magnetic radiations) on microbial population.

But the pollution overload has maligned the purity of Gangajal.

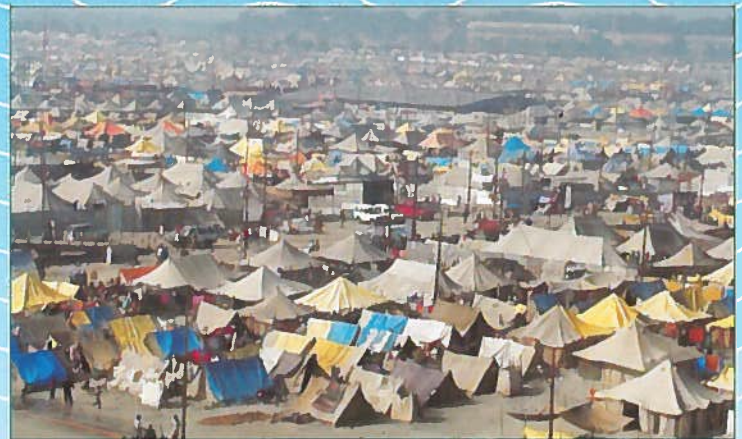
We all must try to restore it.

The Traditional Galore along the River Course

The people used to worship Ganga due to its purity; hence the river featured prominently in Indian classics and folklore -- from Vedas to Anthropocene. The Ganga basin was so fertile, that the people living around depended for their livelihood by cultivating a variety of food grains; and with every harvest they used to offer their share just to pay regards to Ganges on whom they were dependent for their livelihood. Gradually these became the mark of their rituals taking shape in many celebrations, puja, purva and festivals. The main festivals are: Kumbh Mela, Sawan Mela, Magha Mela, Kartik Poornima, Ganga Dusshera, Chhath Puja and Ganga Sagar Mela.

The nearby cities along the river Ganga grew into trade centres as navigation along the Ganga was the main source of transportation in ancient India, giving rise to association and fusion of different trades and culture. The outcome in terms of celebrated products and traditions are: Varanasi, Paan & Thandai, Madhubani Art & Murshidabad Painting, Shehnai, Akharas & Ganga Arti.

The fusion of trade, culture and complexes made the priesthood holy and famous occupation; which flourished several other religious practices, making it the part of our great tradition. Ganga Arti is a special ritual performed at many places on the banks of Ganga on special occasions in which thousands of people participate to worship the mother Ganga, their lifeline. tury performers reads like an honour roll of Indian artists: Kanthe Maharaj, Rasoolan Bai, Siddheshwari Devi, Girija Devi, Bade Ramdas, Kishen Maharaj, Samta Prasad, Gopi Krishna, Ravi Shankar, Bismillah Khan and many others.





Ganga and Tourism

The ethnic importance of Ganga and its socio-economic viabilities have made it possible to develop the tourism industry across the length & breadth of the river. Religious tourism, river & heritage cruising, long distance cruises featuring wildlife & wilderness giving access to a number of national parks, cultural & historical tourism, white water rafting, Ganga rallies, floating restaurants are some of the activities that are performed in and around the river Ganga.

Navigation in Ganges & the National Waterway

In ancient times the Ganges and some of its tributaries, especially in the east, were important transportation routes.

- According to the ancient Greek historian Megasthenes, the Ganges and its main tributaries were being navigated in the 4th century BC.
- In the 14th century, inland-river navigation in the Ganges basin was still flourishing.
- By the 19th century, irrigation-cum-navigation canals formed the main arteries of the water-transport system.
- The advent of paddle steamers revolutionized inland transport, stimulating the growth of indigo production in Bihar and Bengal.
- Regular steamer services ran from Kolkata up the Ganges to Allahabad and far beyond, as well as to Agra on the Yamuna and up the Brahmaputra River.

Considering the advantages of Inland waterways such as energy & fuel efficiency, high single unit carrying capacity, environment friendliness (low noise and air pollution), suitability for movement of bulk cargos like coal, cement, flyash, food grains & fertilizers and low capital intensity, the 1620 km stretch of the Ganges between Allahabad & Haldia has been declared as National Waterway I.

Gangetic Ecosystem

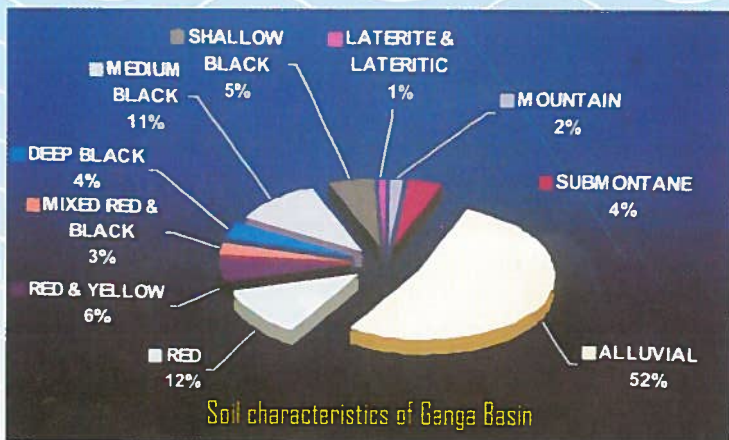
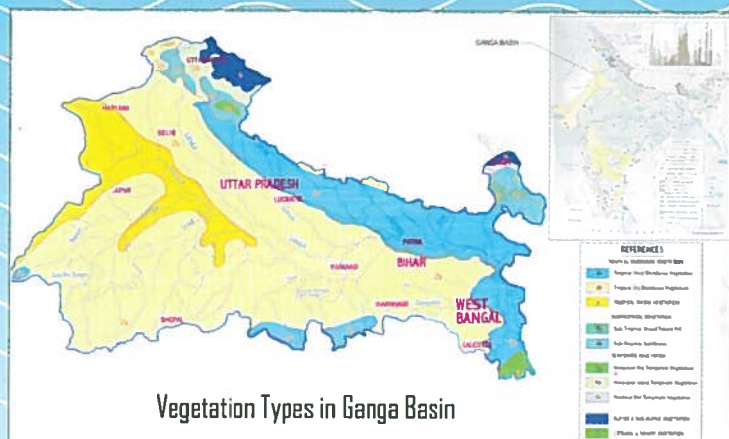
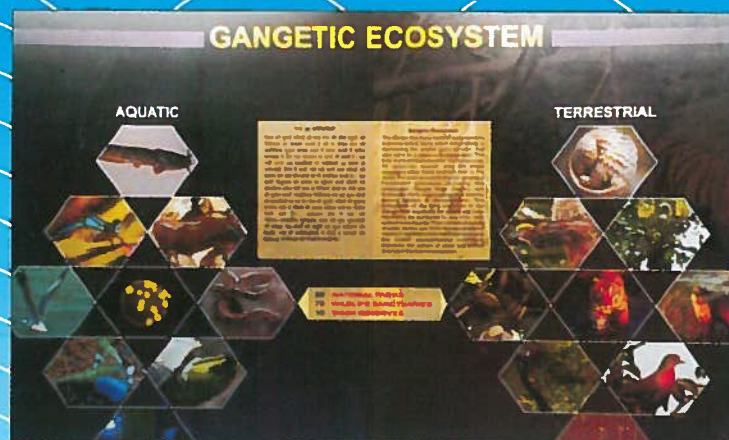
The Ganges, like many rivers of world sustains a diverse flora & fauna, which not only help in maintaining the pristine purity of water, but also serve as a resource for humankind. The river sustains over 140 fish species, 90 amphibian species, and five areas supporting birds found nowhere else in the world. The basin is home for the five species of freshwater cetaceans including the endangered Ganges River Dolphin, rare freshwater shark, *Glyptothorax gangeticus* besides several species of microorganisms. The composition of the living organisms in the river Ganges is possibly the richest and most fascinating as compared to any other lotic system in our country. Physio-chemical quality of water, benthic soil, micro-faunal population, nature of vegetation in the catchment area and the overall environmental conditions determine the pattern of plant and animal diversity in the riverine ecosystem.

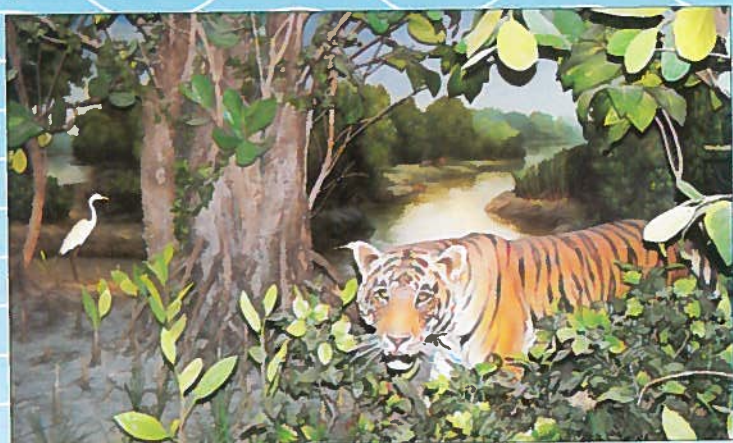
Climate in Ganga Basin

The annual average rainfall in the basin varies between 39 cm to 200 cm, with an average of 110 cm. 80% of the rainfall occurs during the monsoon months (June to October). There is a large temporal variation in the precipitation, which results in wide fluctuations in the river flow characteristic. On an average, each square km of the Ganga basin receives 01 million cubic meters (MCM) of water as rainfall. 30% is lost as evaporation, 20% seeps to subsurface and remaining 50% is available as surface run off. Annual flooding is characteristic of all rivers. The flood plain is usually 0.5 to 2km wide and is flooded every year.

Soil characteristics of Ganga Basin

Ten classes of Soils developed under different lithological, climatic & pedogenetic conditions are found in the Gangetic Basin. Gangetic plain provides huge receptacle into which thousands of meters of thick layers of sediments have been deposited to form a wide valley plain. Some soils highly susceptible to erosion. These soils are sensitive to change & prone to rapid degradation and pollution. Signs of salinity (Haryana), alkalinity (Western UP), calcareousness (North Bihar) & acidity (W. Bengal) due to overuse, long occupation, excessive irrigation water and toxic agrochemicals.





Gangetic Dolphins

The Ganges river dolphin (*Platanista gangetica gangetica*), known as 'Susu' is distributed along the Ganges, Brahmaputra, Karnaphuli-Sangu and Meghna River systems and their tributaries, from the foot hills of the Himalaya to the limits of the tidal zone in India, Bangladesh, Nepal, and Bhutan. It has been declared as the National Aquatic animal of India and an endangered freshwater cetacean species. The species is morphologically and taxonomically distinctive, and being the only blind cetacean, is dependent on echolocation for locomotion, sensory perception and feeding. The subspecies is positioned at the apex of food chain in the freshwater ecosystem and plays a vital role in maintaining its ecological balance, but its status has become a matter of grave concern over the past few decades and its population has declined considerably.

Vikramshila Gangetic Dolphin Sanctuary (VGDS), highly productive 65-km stretch of the lower Ganges river between Sultanganj and Kahalgaon in Bihar, is the only protected area specifically created for the gangetic dolphins in India.

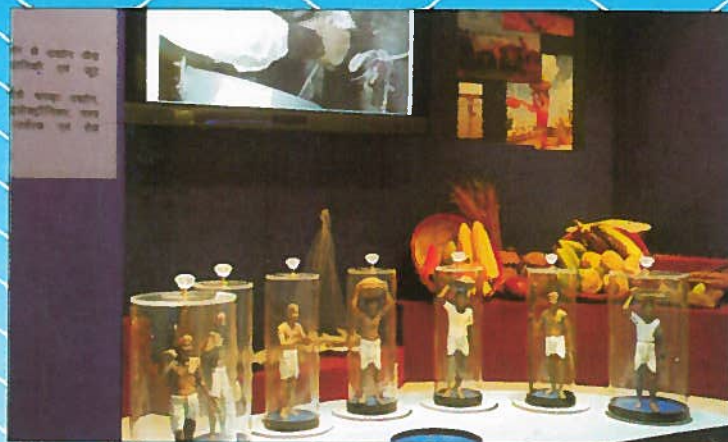
Sunderbans: The Biosphere reserve

The forest diversity along the Gangetic terrain is an attribute to the river Ganges; the major among these is the Sunderbans, a pristine mangrove swamps lying at the southern fringe of West Bengal, embedded with 102 islands amidst the emerald estuarine waters of the tributaries of the Ganges and the Bay of Bengal, the kingdom of the famous Royal Bengal Tigers and one of the largest deltaic regions in the world.

Considering the importance of Sunderbans Bio-geographic Region, the National Park Area of the Sunderbans Tiger Reserve has been included in the list of World Natural Heritage sites in 1985. The Sunderbans, including the protected area of Sunderbans Tiger Reserve has been declared as BIOSPHERE RESERVE.

The Ganga: Source of Livelihood

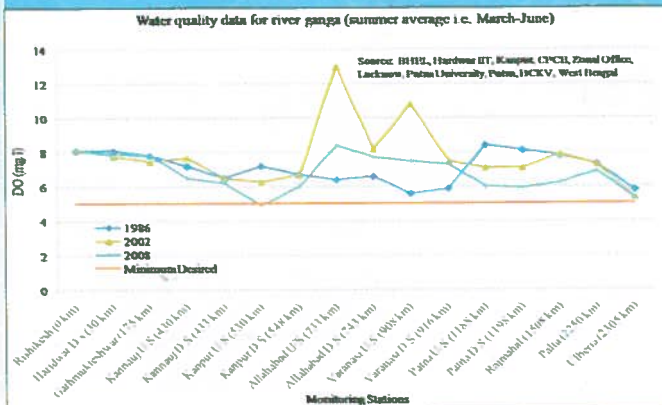
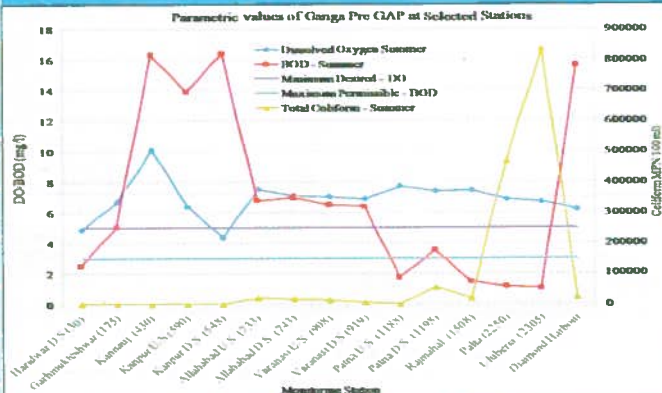
More than 450 million people living in its basin are directly or indirectly dependent upon the Ganga. The Ganges and its tributaries are conventionally and dynamically the source of livelihood for the people involved in the following occupation/trades/tradition: Agriculture, Power generation, Fisheries, Navigation, Transport & Tourism, Poultry & Live-stock Farming, Pottery, Sand-mining, Art & Craft, Several Small and medium scale Industries, such as, apiculture, silviculture and jute etc. Large scale industries, such as leather industries, pharmaceuticals, electronics, textile, paper, tanneries, fertilizer and oil refineries and Priest hood, magicians and snake charmers.



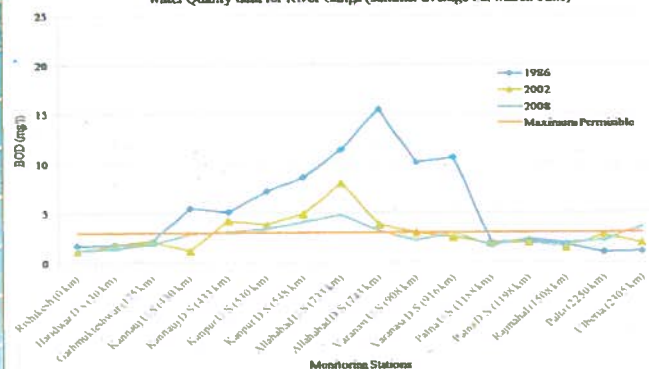
Water Properties & its Monitoring

Water is an elixir of life. Its physico chemical and biological properties such as Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), pH, temperature, acidity, alkalinity, turbidity, hardness and coliform count are used to evaluate the quality of water for its use in various sectors i.e. domestic, commercial, agricultural and industrial.

The present scenario of Gangajal has been depicted with following charts:



Water Quality data for River Ganga (summer average i.e. March-June)



Zoning and Water Quality Classification of the Ganga

S. No.	Zone	Length (km)	Ambient Water quality class	Designated Best Use	Critical parameter
1.	Source Rishikesh	to 250	B	A	Total Coliform
2.	Rishikesh Kannauj	to 420	C	B	Total Coliform and BOD
3.	Kannauj to d/s Varanasi (Trighat)	730	B	A	Total Coliform
4.	Trighat Kalyani	to 950	C	B	Total Coliform
5.	Kalyani to Diamond Harbour	100	D	B	Total Coliform

(Source: CPCB)

Status of Ambient Water Quality Along Different Zones of the Ganga

Monitoring Stations	Total Coliform	DO Status	BOD Status	Over all water quality
Uttarakhand				
Rishikesh	C	B	B	B
Haridwar	C	C	D	C
UP				
Garhmukteswar	C	C	D	C
Kannauj	D	B	D	C
Kanpur u/s	D	C	D	D
Kanpur d/s	D	D	D	D
Allahabad u/s	D	A	D	D
Allahabad d/s	D	A	D	D
Mirzapur	D	A	D	D
Varanasi u/s	D	A	D	D
Varanasi d/s	D	A	D	D
Bihar				
Buxar	D	A	B	C
Patna u/s	D	A	C	C
Patna d/s	D	A	B	C
Munger	D	B	C	C
Bhagalpur	D	A	B	C
Rajmahal	D	A	B	C
West Bengal				
Farakka	D	A	A	C
Nabadwip	D	A	A	C
Kalyani	D	B	D	D
Patna	D	A	B	D
Uluberia	D	B	D	D
Diamond Harbour	D	A	D	D

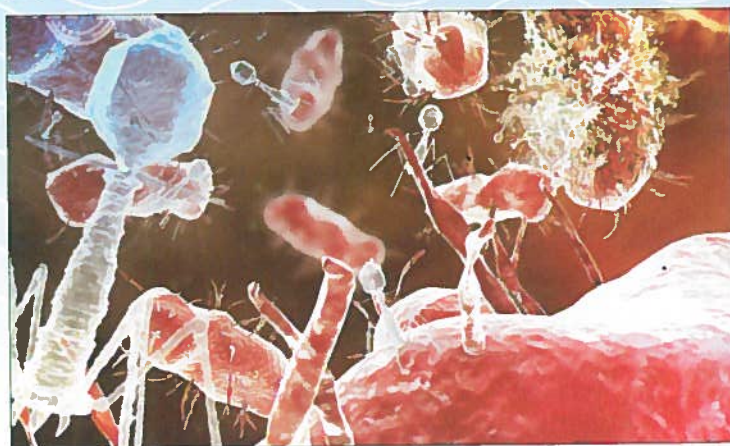
u/s :- upstream d/s :- downstream

Gangajal: Past & Present

- The water of river Ganga is regarded as the most purifier of human body and soul.
- The river water has its unique and extraordinary ability to retain the oxygen.
- In Himalayan region flowing from different quality of rocks, a number of chemical substances get dissolved into the Ganga water.
- During runoff from its catchment area water contain lot of alkaloid and other chemical substances as an extract of the medicinal plants growing in this region luxuriantly.
- Ganges water does not putrefy, even after long periods of storage.
- The Mughal emperor Akbar's preference for 'the water of immortality' from Ganga for drinking and cooking is described at length in the Ain-i-Akbari by Abul Fazl.
- Md. bin Tughluq in the year after 1327, carried the Gangajal for forty days journey for his own personal use, when he established the new capital of Delhi Sultanate in Daulatabad.
- British Physician, C.E. Nelson observed that Gangajal taken from Hooghly - one of its dirtiest mouths - by ships returning to England remained fresh & sweet throughout the voyage.
- It is also reported that Bdellovibrio bacteria is found in Ganga water which kills all those bacterial species who are responsible for decomposing the organic matters present into the water.
- Ernest Hankin, a British bacteriologist, reported in 1896 on the presence of marked antibacterial activity against Vibrio cholera and D'Herelle called it "bacteriophage". Thus in a way the world owes the discovery of bacteriophages to the Ganges water.
- In 1896, the British physician E Hanbury Hankin, reported in the French journal Annales de l'Institut Pasteur that cholera microbes died within three hours in Ganga water.



- A French scientist, Monsieur Herelle, was amazed to find, that only a few feet below the dead bodies floating in the Ganga who had died of dysentery and cholera, where one would expect million of germs, there were no germs at all.
- The great Indian leader Pt. Madan Mohan Malaviya Ji had deep reverence for the holy life line of India- the river Ganga. In order to maintain the natural flow of Ganga, he opposed the ambitious plan of the British Government in 1916 i.e. diversion of Ganga from Har ki Paudi to a canal in Bhimnagar.



Degradation of river Ganga Ecosystem

The Ganga is like a carotid artery that supplies the oxygenated blood to the main upper part of the body. The watershed of the river Ganga spreads over eleven States of India, namely Uttaranchal, Uttar Pradesh, Bihar, Jharkhand, West Bengal, Himachal Pradesh, Rajasthan, Haryana, Madhya Pradesh, Chhatisgarh and Delhi covering 26.2 percent area of India's total geographical area. However, during past a few decades water of the river Ganga has started losing its efficacy due to discharge of huge quantity of untreated city sewage and toxic industrial influents. The important sources of degradation and pollution of river Ganga are as follows:

- Discharge of city sewage and industrial effluents.
- Cremation of dead bodies.
- Agricultural runoff.
- Solid & bio-medical waste disposal.
- Animal bathing.
- Washing of clothes.
- Disposal of temple waste materials.
- Extraction of huge quantity of Ganga water through lift canals.
- Deforestation in water shade and the places of origin of the river.
- Construction of dams in Himalayan region and major constructions in the catchments area.

Sewage Treatment Plant

Wastewater

Any water that has been adversely affected in quality by anthropogenic influence is called wastewater. It comprises liquid waste discharged from domestic, commercial, industrial and agricultural sectors.

Wastewater Treatment Technologies

- Transformation of undesirable substances to a desirable form and extraction of toxicants from the waste water is called waste water treatment technology.
- Eco-friendly and cost effective technologies are adapted as the best technology for environmental management.

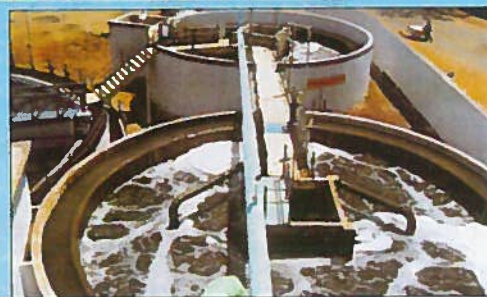
Sewage

Sewage is the wastewater that is contaminated with feces or urine.

Sewage treatment Technologies

Following treatment technologies are successfully demonstrated and utilized for the treatment of wastewater in India.

- Waste Stabilization Pond Systems (WSPS)
- Duckweed Pond System (DPS)
- Facultative Aerated Lagoon (FAL)
- Trickling Filter (TF)
- Activated Sludge Process (ASP)
- BIOFOR Technology (Biological Filtration and Oxygenated Reactor)
- High Rate Activated Sludge Biofor-F Technology
- Fluidized Aerated Bed (FAB)
- Submerged Aeration Fixed Film (SAFF) Technology
- Rotating Biological Rope Contactor(RBRC) process
- Cyclic Activated Sludge Process (CASP)
- Upflow Anaerobic Sludge Blanket (UASB) Process
- Down Hanging Sponge Bio tower (DHSB) process



Climate change & Indo Gangetic basin (IGB)

The Indo-Gangetic plain (IGP) is an environmentally sensitive, socially significant and economically strategic domain of India where landscape, hydrology, food production and fertility are threatened by climate change and anthropogenic pressure. The major impact is -

- Change in seasonal distribution of total flows
- Drying up of Aquifers
- Dam safety under threat
- Fluctuation in precipitation and its intensity leads to flood or draught
- Submergence of land
- Threat of Glacial Lake Outburst Flood (GLOF's)
- Potential increase in sedimentation
- Increase aridity
- Soil salinization, Desertification and Eutrophication
- Impact on Ecosystem: Terrestrial & Aquatic
- Soil Erosion leading to increase in Carbon load
- Water logging
- Hard rock exposure
- Degradation of hydro-biological conditions leading to rise in communicable diseases
- Increase in floods and drought leading to endemic and further pandemics
- Large scale displacement of population

Ganga: Threats to its existence

There are enormous threats to the integrity of the world's great river basins. The SIX primary threats faced by the ten most endangered river basins are: i. Over-extraction, ii. Dams & infrastructure, iii. Invasive species, iv. Climate change, v. Over fishing, and vi. Pollution.

Especially in terms of Ganga, the following are worth mentioning-

- Water withdrawal poses a serious threat to Ganges.
- Barrages control all of the tributaries to the Ganges and divert roughly 60% of river flow & large-scale irrigation.
- Over extraction for agriculture in the Ganges has caused the reduction in surface water resources.
- Lowering water levels indirectly lead to deficiencies in soil organic content, reduction in agricultural productivity, poor water quality, water contamination etc.



Human Impact

Ganga: Our Sink

The river Ganga and its basin have been treated by people as a huge reservoir and a logical place for the quiet disposal of the tremendous volume of waste on its banks for past several decades. Dumping of plastic bags, plastic containers, mineral water bottles, cans, rubbers & plastics, partly dissolved faeces, soaps and detergents, medical waste and several other articles in the river has defaced the Ganga. The Human impact may rob the pristine river, its glory and sacredness. A collective action from all the stakeholders, the people & the state is needed to bring Ganga to its original glory.

Sustainable Development of River Ganga Ecosystem

Sustainable development of any ecosystem consists with its four pillars i.e. Environmental development, Economic development, Cultural development and Socio political development. Sustainable Development of River Ganga needs Holistic Ecological Approach based on self regulatory mechanism to maintain the homeostasis. This may be achieved with the following:

- Suitability and economic viability of the new Sewage Treatment Plants be ensured before their establishment.
- For economic saving old and existing STPs be upgraded/modified in light of their past drawbacks and recent advances in Wastewater Treatment Technologies.
- Land use patterns, fertility level of land and upstream/downstream locations for new STPs be examined so that no STP be constructed on highly fertile lands.
- Probabilities of Community Treatment Plants and recycling of the wastewater be explored for economically feasible solutions.
- Accurate quantity and quality of waste water (e.g. sewage, industrial effluents and laboratory chemicals etc.) generated at Varanasi, Allahabad and Kanpur be assessed for long term environmental planning.
- Small scale & cottage industries (including motor workshops & garbage disposal) located in vicinity of the cities be identified and suitable treatment plants be suggested.

- Proper quantification and quality examination of solid wastes generated in each zone of the city be assessed for their recycling and other utilizations.
- Electric crematorium on respective cremation grounds, incineration plants for cattle's and separate washing ghats at downstream be established.
- Unauthorized constructions near the banks and its catchment areas be stopped immediately to maintain the natural flow.
- Local Technical Expert Committees be formed to monitor and assess the working of ongoing projects.
- Involvement of Ganga users in various projects be ensured.
- Non consumptive activities (e.g. fishery, aquaculture, navigation etc.) of Ganga water be encouraged.
- Higher dilution zones of the river Ganga be examined and preferred as disposal sites.
- Mass awareness programs through documentaries, Nukkad natak, literature and public lectures be organized at school level.
- Development and adoption of micro level irrigational techniques be adopted to save the huge loss of Ganga water through flood irrigation practices.
- Rain Water Harvesting, its storage, multiple uses at micro community level and Ground Water Recharging practices be encouraged to maintain the ground water status and save the Ganga water.
- Green belt of resilient and ecologically adaptable plant species on both banks of river be developed. This will act as kidney in filtering the non point pollutants and also check the soil erosion.





Key points for River basin Development

- A long-term vision for the river basin, agreed by all the major stakeholders.
- Integration of policies, decisions and costs across sectoral interests through poverty reduction strategies.
- Strategic decision-making at the river basin scale, which guides actions at sub-basin or local levels.
- Effective timing and opportunities within a strategic framework.
- Active participation of all relevant stakeholders.
- Adequate investment by governments, private sectors and civil societies.
- A solid foundation of knowledge of the river basin and natural & socio-economic forces that influence it.

Initial steps taken for the conservation of River Ganga Ecosystem

Looking into shortcomings of the GAP it was felt necessary that a new holistic approach based on river basin as the unit of planning and institutional redesign may be adopted. Accordingly, the Government of India has given Ganga the status of a National River and has constituted the National Ganga River Basin Authority (NGRBA) on 20th February 2009 under Section 3(3) of the Environment (Protection) Act, 1986. The NGRBA is a planning, financing, monitoring and coordinating body of the centre and the states.

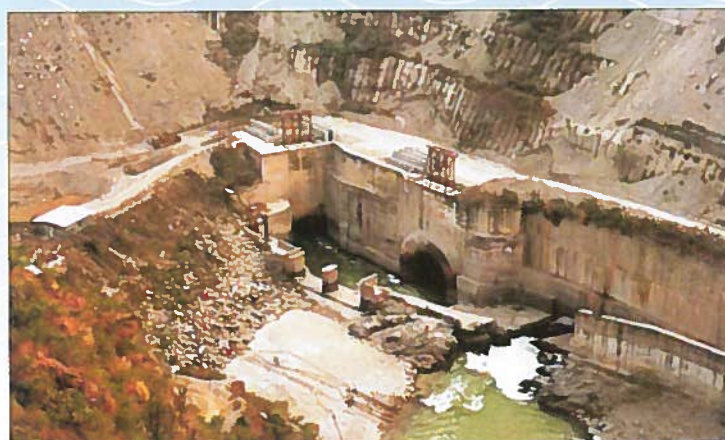
Objective of the NGRBA

The objective of the NGRBA is to ensure effective abatement of pollution and conservation of the river Ganga by adopting a river basin approach for comprehensive planning and management.

Function and Power of NGRBA

The Authority has both regulatory and developmental functions. The Authority will take measures for effective abatement of pollution and conservation of the river Ganga in keeping with sustainable development needs. These include:

- Development of a river basin management plan;
- Regulation of activities aimed at prevention, control and abatement of pollution in Ganga to maintain its water quality, and to take measures relevant to river ecology and management in the Ganga basin states;
- Maintenance of minimum ecological flows in the river Ganga;
- Measures necessary for planning, financing and execution of programmes for abatement of pollution in the river Ganga including augmentation of sewerage infrastructure, catchment area treatment, protection of flood plains, creating public awareness;
- Collection, analysis and dissemination of information relating to environmental pollution in the river Ganga;
- Investigations and research regarding problems of environmental pollution and conservation of the river Ganga;
- Promotion of water conservation practices including recycling and reuse, rain water harvesting, and decentralized sewage treatment systems;
- Monitoring and review of the implementation of various programmes or activities taken up for prevention, control and abatement of pollution in the river Ganga;
- Issue directions under section 5 of the Environment (Protection) Act, 1986 for the purpose of exercising and performing these functions and for achievement of its objectives.



Ganga and Dams

The Ganga along with its tributaries, sub-tributaries and distributaries provide a massive network of irrigation channels and are a major source of hydroelectric production. Dams, barrage and hydro-power stations are constructed on Ganga river system for irrigation and drainage, flood control and land reclamation, river management, integrated agriculture development, watershed management, hydropower, rural electrification, ground water exploration, minor irrigation, water supply and sanitation (rural and Urban). There are several water resources and hydroelectricity generation projects situated in the Ganga basin. Tehri Dam, the eighth largest dam of the world has been built on Bhagirathi for hydropower generation resulting in regulated additional water during the dry months. While the barrage Farakka on Ganga, the longest barrage in the world, regulates the flow of the river, diverting some of the water into a feeder canal linking Hooghly to keep it relatively silt-free.

Relevance of Dams

- The dams are built across a stream, river or estuary to retain water for Flood Control, Irrigation, Drinking and Industrial use, Hydro Power Production, Inland Navigation and Recreation.
- The advent of hydropower technology changed the shape of old dams from small to big & huge dams.
- The construction of large dams heavily alter the natural flow of the river; as a consequence it affects virtually every aspect of a river ecosystem, including water quality, sediment transport and deposition, fish migrations, riparian and floodplain habitat affecting the organisms that rely on such habitat.
- Now, it is must to reassess whether the Big Dams are necessary?



Ganga : Our National Pride

The pristine river has been an inseparable part of our life from eons. Not only socially, ecologically too the Ganga plays a very significant role in making the Ganga basin one of the most fertile regions for the agriculture in the world. Besides, it contributes in economic wealth generation too, through pilgrimage and festivities.

The River has, thus been declared as the National River and it is the duty of all of us to conserve and protect her. Otherwise the loss will be irreparable to the collective psyche & consciousness of the people as a whole, presently & future generations.

Dont's

- ♦ Dispose the polythene and puja Samagri in the river
- ♦ Destroy the river bank habitat of animals
- ♦ Cattle bath
- ♦ Mass bathing
- ♦ Dispose of domestic and industrial waste directly in the river
- ♦ Block the flowing water
- ♦ Cutting and destruction of forests
- ♦ Use the excess chemical pesticides & fertilizer
- ♦ Disposal of carcasses in the river
- ♦ Washing of clothes

Do's

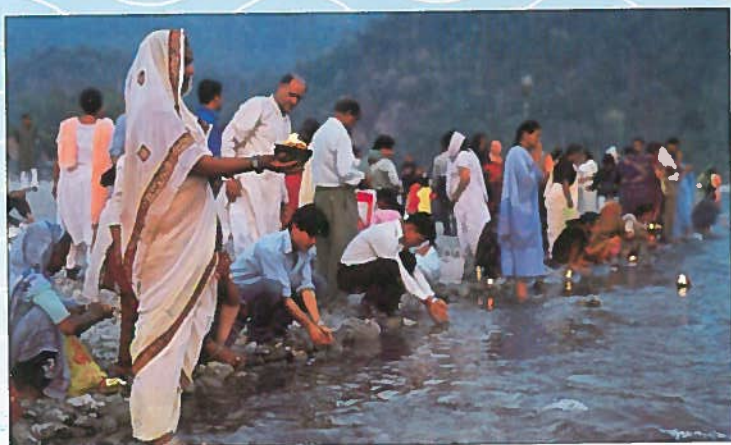
- ♦ Mass Awareness and education
- ♦ Plant trees
- ♦ Maintain the natural & continuous flow of river
- ♦ Stop killing of native animals of river like Dolphins, Crocodile, fishes etc.
- ♦ Restore the river bank
- ♦ Use the Bio-pesticides and Bio-fertilizers
- ♦ Adopt Organic Farming
- ♦ Protect longitudinal and lateral connectivity
- ♦ Provide adequate space for various river functions
- ♦ Maintain the ecological identity of the river



गंगा निर्मल मंत्र

गंगा पुण्यजलां प्राप्य त्रयोदश विवर्जयेत् ।
शौचमाचमनं सेकं निर्माल्यं मलघर्षणम् ।
ग्रात्रसंवाहनं क्रीडां प्रतिग्रहमथोरतिम् ।
अन्यतीर्थरतिंचैवः अन्यतीर्थं प्रशंसनम् ।
वस्त्रत्यागमथाघातं सन्तारंच विशेषतः ॥

ब्रह्मानन्दपुराण (800 ई0)



Thirteen actions prohibited in holy River Ganga

- Defecation
- Ablutions
- Discharge of wastewater
- Throwing of used floral offerings
- Rubbing of filth
- Body shampooing
- Frolicking
- Acceptance of donations
- Obscenity
- Offering of inappropriate praises or even hymns in a incorrect way
- Discarding of garments
- Beating and
- Swimming across, in particular

Ganga Pledge

From times immemorial rishis and saints and commoners alike every morning have gone about their morning chores including bathing, drinking, religious rituals, washing and verily every conceivable function of life in the river Ganges or Ganga. But now they increasingly shun her. Revering Ganga like a mother deity, succeeding generations have called upon her to make one's day blissful by providing fresh and life giving water.

The river Ganges has also a unique ecosystem that has positive impacts not just within banks but spread over the whole Indo Gangetic basin. Sadly we have not taken care of her and have contributed to destroy her pristine nature. She is now facing the challenge to provide adequate soil, water and energy for the growing population, urbanization, industrialization and agriculture in the basin.

Do we want our life giving Mother Ganges to choke on our wastes and die? Or do we care enough to give her life again?

Today, let us pledge to do our best to put life back into our mother river - the Ganges.

USE BASED CLASSIFICATION OF SURFACE WATERS IN INDIA

Designated Best-Use	Class of water	Criteria
Drinking water source without conventional treatment but after disinfection	A	1. Total Coliforms Organism MPN/100 ml shall be 50 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 6 mg/l or more 4. Biochemical Oxygen Demand 5 days 20 °C 2 mg/l or less
Outdoor bathing (organised)	B	1. Total Coliforms Organism MPN/100 ml shall be 500 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 5 mg/l or more 4. Biochemical Oxygen Demand 5 days 20 °C 3 mg/l or less
Drinking water source after conventional treatment and disinfection	C	1. Total Coliforms Organism MPN/100 ml shall be 5000 or less 2. pH between 6 and 9 3. Dissolved Oxygen 4 mg/l or more 4. Biochemical Oxygen Demand 5 days 20 °C 3 mg/l or less
Propagation of wild life and fisheries	D	1. pH between 6.5 and 8.5 2. Dissolved Oxygen 4 mg/l or more 3. Free Ammonia (as N) 1.2 mg/l or less
Irrigation, industrial cooling, controlled waste disposal	E	1. pH between 6.0 and 8.5 2. Electrical Conductivity at 25 °C micro mhos/cm maximum 2250 3. Sodium absorption ratio maximum 26 4. Boron maximum 2 mg/l



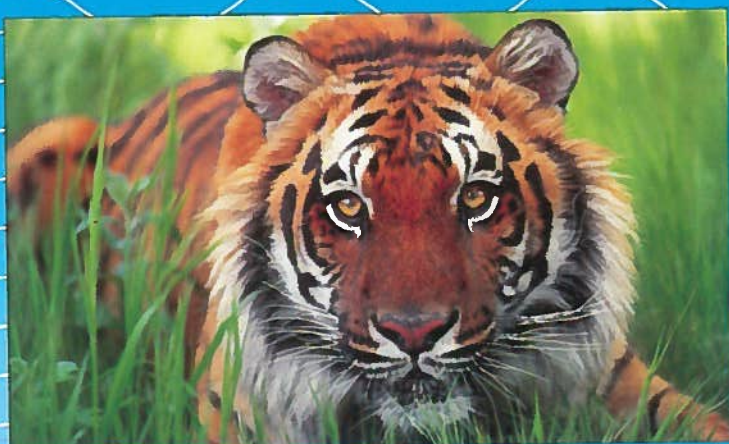
Primary water quality criteria for bathing water (water used for organized outdoor bathing)

Criteria	Rationale
Faecal Coliform : 500 (desirable) MPN/100ml : 2500 (maximum permissible)	To ensure low sewage contamination, faecal coliform and faecal streptococci are considered as they reflect the bacterial pathogenicity.
Faecal Streptococci : 100 (desirable) MPN/100ml : 500 (maximum permissible)	The desirable and permissible limits are suggested to allow for fluctuation in environmental conditions such as seasonal changes, changes in flow conditions, and so on.
pH : between 6.5 and 8.5	The range provides protection of the skin and delicate organs like eyes, nose, ears, and so on, which are directly exposed during outdoor bathing.
Dissolved oxygen : 5 mg/l or more	The minimum dissolved oxygen concentration of 5 mg/l ensures reasonable freedom from oxygen consuming organic pollution immediately U/s which is necessary for preventing production of anaerobic gases (obnoxious gases) from sediments.
Biochemical oxygen : 3 mg/l or less Demand 3 day, 27 °C	The biochemical oxygen demand of 3 mg/l or less of the water ensures reasonable freedom from oxygen demanding pollutants and prevent production of obnoxious gases.

List of parameters – River Ganga water quality monitoring programme

Core parameters (9)	Field observations (7)
pH	Weather
Temperature	Depth of main stream/depth of water table
Conductivity	Colour and intensity
Dissolved Oxygen	Odour
Bio-chemical Oxygen Demand	Visible effluent discharge
Nitrate – N	Human activities around station
Nitrite – N	Station detail
Faecal Coliform	Trace Metals (9)
Total Coliform	Arsenic, µg/L
General Parameters (19)	Cadmium, µg/L
Turbidity, NTU	Copper, µg/L
Phenolphthalein Alkalinity, as CaCO ₃	Lead, µg/L
Total Alkalinity, as CaCO ₃	Chromium (Total), µg/L
Chlorides, mg/L	Nickel, µg/L
Chemical Oxygen Demand, mg/L	Zinc, µg/L
Total Kjeldahl – N, as N mg/L	Mercury, µg/L
Ammonia – N, as N mg/L	Iron (Total), µg/L
Hardness, as CaCO ₃	Pesticides (15)
Calcium, as CaCO ₃	Alpha BHC
Sulphate, mg/L	Beta BHC
Sodium, mg/L	Gamma BHC (Lindane)
Total dissolved solids, mg/L	O P DDT
Total fixed dissolved solids, mg/L	P P DDT
Total suspended Solid, mg/L	Alpha Endosulphan
Phosphate	Beta Endosulphan
Boron, mg/L	Aldrin
Magnesium, as CaCO ₃	Dieldrin
Potassium, mg/L	Carbaryl (carbamate)
Fluoride, mg/L	2-4 D
Bio-monitoring (3)	Malathion
Saprobity index	Methyl parathion
Diversity index	Antilophos
P/R Ratio	Chloropyrifos





Biosphere Reserves located within the Ganga Basin

The Ganga basin has two Biosphere reserves, namely the Nanda Devi Biosphere and the Sundarbans National Park, which are also a part of the World Network of Biosphere reserves. Besides this, 29 National Parks, 75 Wild Life Sanctuaries and 10 Tiger Reserves of India are located within the Ganga Basin.

The Sunderbans biosphere reserve is located in the North & South 24-Parganas district of West Bengal along the Ganges and spread over 9630 Sq. Kms. The Nanda Devi reserve is located in Pithoragarh district of Uttarakhand adjacent to Ramganga river, a tributary of Ganges and is spread over 5860.69 kms.

Tiger Reserves Located within the Ganga Basin

Name	State	Location (District)	Adjacent Tributary*	Adjacent Settlement*	Core Area (SqKm)
Valmiki	Bihar	West Champaran	Koshi	Narkatiaganj Bagha	880.76
Bandhavgarh	Madhya Pradesh	Shahdol and Jabalpur	Johilla and Son	Katni	716.90
Kanha	Madhya Pradesh	Mandla	Narmada	Bahar	940.00
Panna	Madhya Pradesh	Ken	Panna and Chhatarpur	Son	576.63
Ranthambhore	Rajasthan	Sawai Madhopur and Karauli	Chambal	Sawai Madhopur	1113.36
Seriska	Rajasthan	Alwar	Chambal	Alwar	68.11
Dudhwa-Katerniaghat	Uttar Pradesh	Lakhimpur-Kheri	Ganga, Sarda	Dhangadhi	648.00
Corbett	Uttarakhand	Nainital and Pauri Garhwal	Yamuna	Yamunanagar	821.99
Buxa	West Bengal	Jalpaiguri	Torsa, Brahmaputra	Alipurduar	760.00
Sunderbans	West Bengal	North and South 24-Parganas	Ganga	Haldia	1699.92
Ganga Basin Total		10 Reserves		8838.18	

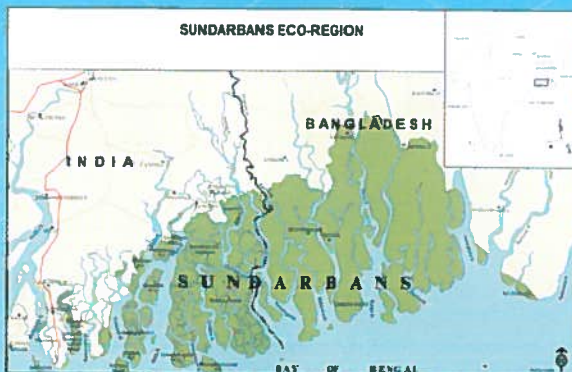
Source: Project Tiger Task Force Reports (2004, 2010), Project Tiger Website

Mangrove forests and the Sunderbans

Mangrove forests consist of salt-tolerant plant species and occur along the inter-tidal zones of rivers and seas. The plants form narrow strips or extensive patches in the estuarine habitats and/or river deltas of tropical and sub-tropical climates. Due to the fact that mangroves must survive the tidal fluctuations and storms surges associated with the harsh environment between land and sea, they display distinctive morphological and physiological adaptations that make them at once one of the more resilient and more unique ecosystems on the planet. These extensive adaptations allow for mangrove forests to become perhaps the most productive and diverse kind of wetland area in the world. However, mangroves provide more than just a habitat for a diverse array of species and wildlife; their ecosystem also serves as a plentiful source of firewood, timber, fodder, fruits, medicines, etc. for neighboring human settlements while providing a critical buffer zone against cyclones, sea-level rise and other natural threats.

Mangroves are classified by the density of their canopy cover. The categories are: **very dense** (canopy cover of more than 70%), **moderately dense** (canopy cover of between 40-70%), and **open** (canopy cover between 10-40%).

Among the states within Ganga basin, only West Bengal has mangrove forests cover, due to the fact that part of the Sunderbans mangrove forest falls within its boundaries. All told, the Sunderbans is 10,000 km², however only 40% falls in India, with the rest residing in Bangladesh. Like most mangroves, the Sunderbans consist of a number of small, forested islands floating amidst tidal streams. It is also home to a number of rare fauna, most notably, the Bengal Tiger.

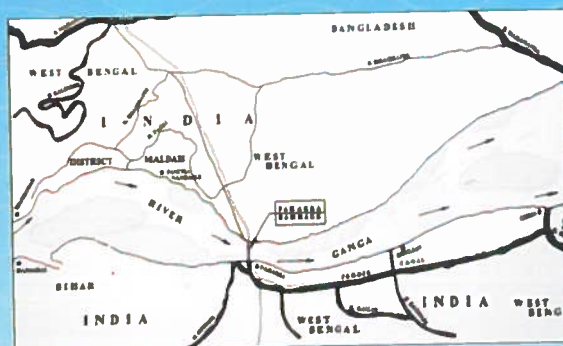


Length of Ganga

Near Jangipur in Murshidabad district of West Bengal, the Ganga branches off into two channels. The main river flows south-east as the Ganga-Padma into Bangladesh and another one flows southwards as the Bhagirathi through West Bengal. In fact the river has made a natural division of the two countries, India on the right bank and Bangladesh on left bank for about 50 kms.

Place to place	Ganga-Bhagirathi-Hooghly course (Km)	Place to place	Ganga-Padma-Meghna course (Km)	Remarks
1	2	3	4	5
Gangotri (Source) to Rishikesh	345	Gangotri (Source) to Rishikesh	345	• Direction of Ganga-Bhagirathi-Hooghly course changes from north-south to south-east to south.
Rishikesh to Farakka	1,760	Rishikesh to Farakka	1,760	
Farakka to Ahiran (Mouth of Bhagirathi)	45	Farakka to Jalangi Bazar (India-Bangladesh Border)	105	
Ahiran to Nabadwip (confluence of Jalangi river)	185	Jalangi Bazar to Goalanda Bhat (confluence of Brahmaputra)	220	
Nabadwip to Calcutta (Rabindra Setu)	210	Goalanda Bhat to Meghna outfall	100	• Direction of Ganga-Padma-Meghna course changes from north-south to south-east
Calcutta to outfall to sea near Sagar Island	100	Meghna outfall to Cox Bazar (sea face)	120	
Total	2,645		2,650	

(Source: Ganga- Water Use in the Indian Subcontinent by Dr. P. K. Parua, Springer Publication)

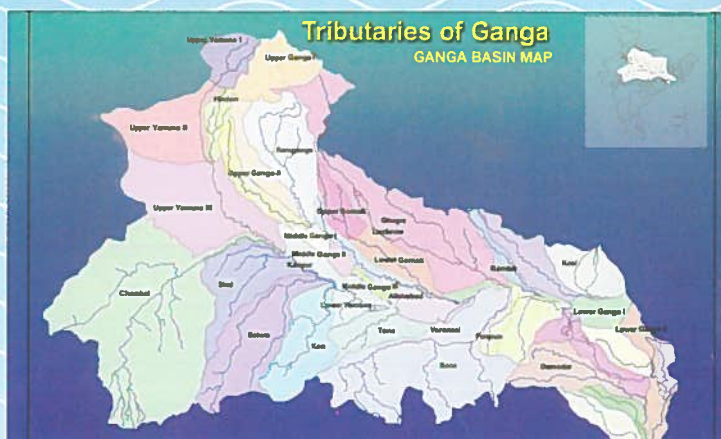
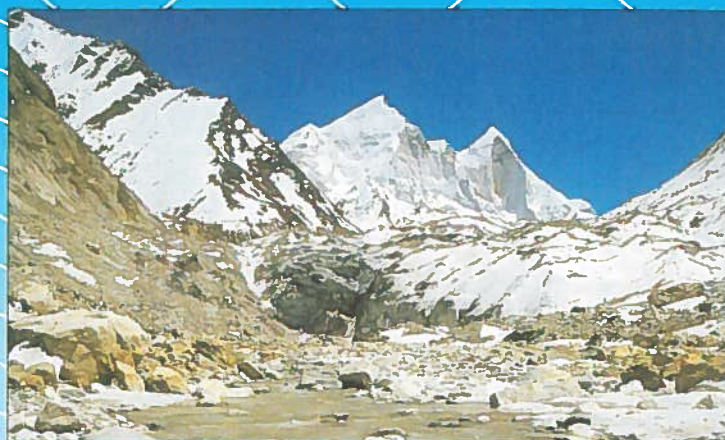


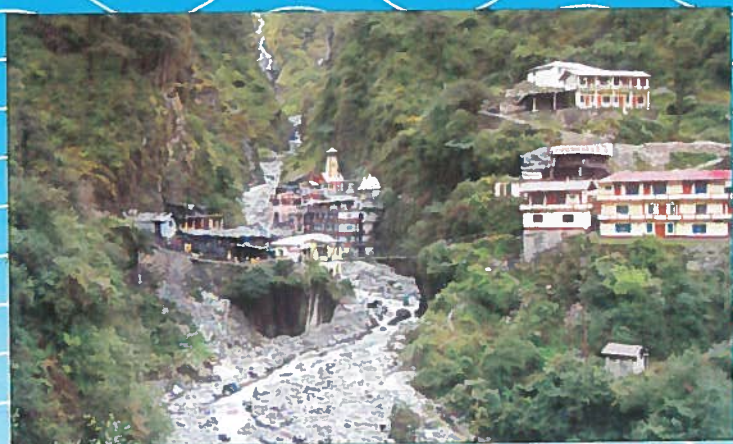
Salient Features of River Ganga

Total Length	: 2,525 km
Length in UP & Uttarakhand	: 1,450 km
Boundary bet. UP & Bihar	: 110 km
Length in Bihar	: 445 km
Length in West Bengal	: 520 km
Geographical area of India	: 3.28 million sq.km
Reported Area-River Basins	: 3.05 million sq.km
Catchment Area of Basin	: 8,61,404 sq.km (26.4%)
Average Annual Discharge	: 4,93,400 million cu. meter
East Longitude of Basin area	: 73°30' and 89°
North Lat. of Basin Area	: 22°30' and 31°30'
Surface Water Resource	: 525 billion cubic meter
Potential	
States of India in the Indo-Gangetic Basin	: 11
Average Population Density	: Over 550 persons/sq.km.

Drainage Area of River Ganga Basin

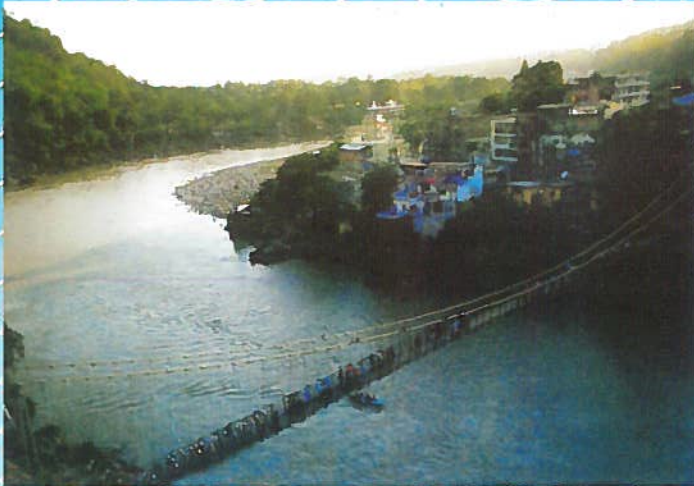
State	Drainage area (Sq. Km.)
Uttarakhand and Uttar Pradesh	294,364
Madhya Pradesh and Chhattisgarh	198,962
Bihar and Jharkhand	143,961
Rajasthan	112,490
West Bengal	71,485
Haryana	34,341
Himachal Pradesh	4,317
Delhi	1,484
Total	861,404





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- Dr. L.M.S. Palni, Director, G.B. Pant Inst. Of Himalayan Env. & Dev., Almora, Uttarakhand
- Web site of Central Pollution Control Board, New Delhi
- Website of Ministry of Env. & Forests, GOI
- National Remote Sensing Services, Deptt. Of Space, GOI
- WWF India
- Luc Marcheux
- www.google.co.in
- www.gangapedia.com
- www.youtube.com
- www.nicholasduke.com
- BBC
- & several scientists and wellwishers of river Ganga



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