

Ganges

The **Ganges** (/ˈɡændʒiːz/ *GAN-jeez*), also known as **Ganga** (Hindustani:[ˈɡəŋɡaː]), is a trans-boundary river of Asia which flows through the nations of India and Bangladesh. The 2,525 km (1,569 mi) river rises in the western Himalayas in the Indian state of Uttarakhand, and flows south and east through the Gangetic Plain of North India. After entering West Bengal, it divides into three rivers: The Hooghly River, or Adi Ganga, flows through several districts of West Bengal and into the Bay of Bengal near Sagar Island. The other, the Padma River, flows into and through Bangladesh, and also empties into the Bay of Bengal. The last is the Ajay River flows through Burdwan and Birbhum districts. The Ganges is the third largest river in the world by discharge.

The Ganges is one of the most sacred rivers to Hindus.^[4] It is also a lifeline to millions of Indians who live along its course and depend on it for their daily needs. It is worshipped in Hinduism as the goddess *Ganga*.^[5] It has also been important historically, with many former provincial or imperial capitals (such as ^[6] Kannauj, Kampilya, ^[6] Kara, Prayag or Allahabad, Kashi, Pataliputra or Patna, Hajipur, Munger, Bhagalpur, Murshidabad, Baharampur, Nabadwip, Saptagram, Kolkata and Dhaka) located on its banks.

The Ganges is highly polluted. Pollution threatens not only humans, but also more than 140 fish species, 90 amphibian species and the endangered Ganges river dolphin.^[7] The levels of fecal coliform bacteria from human waste in the waters of the river near Varanasi are more than 100 times the Indian government's official limit.^[7] The Ganga Action Plan, an environmental initiative to clean up the river, has been a major failure thus far,^{[a][b][8]} due to corruption, lack of technical expertise,^[c] poor environmental planning,^[d] and lack of support from religious authorities.^[e]

Contents

Course

Geology

Hydrology

History

Religious and cultural significance

- Embodiment of sacredness
- Avatarana* or Descent of the Ganges
- Redemption of the Dead
- The Purifying Ganges

The Ganges River (Ganga)



The Ganges in Varanasi

Country	 India Bangladesh
Tributaries	
 - left	Ramganga, Gomti, Ghaghara, Gandak, Kosi, Mahananda
 - right	Yamuna, Tamsa, Son, Punpun
Cities	Rishikesh, Haridwar, Kannauj, Kanpur, Fatehpur, Allahabad, Varanasi, Buxar, Patna, Munger, Farakka, Murshidabad, Plassey, Nabadwip, Kolkata, Pandaveswar
Source	Gangotri Glacier, Satopanth Glacier, Khatling Glacier, and waters from melted snow from such peaks as Nanda Devi, Trisul, Kedarnath, Nanda Kot, and Kamet.
 - location	Uttarakhand, India
 - elevation	3,892 m (12,769 ft)
 - coordinates	30°59′N 78°55′E﻿ / ﻿30°59′N 78°55′E﻿ / 30.983°N 78.917°E
Length	2,525 km (1,569 mi) ^[1]
Depth	17 m (56 ft)
Basin	1,080,000 km ² (416,990 sq mi) ^[2]
Discharge	for Farakka Barrage
 - average	16,648 m ³ /s (587,919 cu ft/s) ^[3]
 - max	70,000 m ³ /s (2,472,027 cu ft/s)
 - min	2,000 m ³ /s (70,629 cu ft/s)

Consort, Shakti, and Mother
Ganges in classical Indian iconography
Kumbh Mela

Irrigation

Canals
Dams and barrages

Economy

Tourism

Ecology and environment

Fish
Crocodilians and turtles
Ganges river dolphin
Effects of climate change

Pollution and environmental concerns

Water shortages
Mining

See also

Notes

References

Sources

Further reading

External links

Discharge elsewhere (average)

- Bay of Bengal 38,129 m³/s
(1,346,513 cu ft/s)^[3]



Map of the combined drainage basins of the Ganges (orange), Brahmaputra (violet), and Meghna (green)

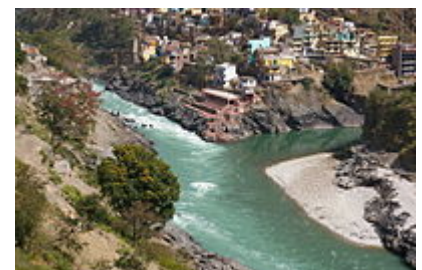
Course

The main stream of the Ganges begins at the confluence of the Bhagirathi and Alaknanda rivers in the town of Devprayag in the Garhwal division of the Indian state of Uttarakhand. The Bhagirathi is considered to be the source in Hindu culture and mythology, although the Alaknanda is longer, and, therefore, hydrologically the source stream.^{[9][10]} The headwaters of the Alakananda are formed by snowmelt from peaks such as Nanda Devi, Trisul, and Kamet. The Bhagirathi rises at the foot of Gangotri Glacier, at Gomukh, at an elevation of 3,892 m (12,769 ft), being mythologically referred to as, residing in the matted locks of Shiva, symbolically Tapovan, being a meadow of ethereal beauty at the feet of Mount Shivling, just 5 km (3.1 mi) away.^{[11][12]}



Bhagirathi River at Gangotri.

Although many small streams comprise the headwaters of the Ganges, the six longest and their five confluences are considered sacred. The six headstreams are the Alaknanda, Dhauliganga, Nandakini, Pindar, Mandakini, and Bhagirathi rivers. The five confluences, known as the Panch Prayag, are all along the Alaknanda. They are, in downstream order, Vishnuprayag where the Dhauliganga joins the Alaknanda; Nandprayag where the Nandakini joins; Karnaprayag where the Pindar joins, Rudraprayag where the Mandakini joins; and finally, Devprayag where the Bhagirathi joins the Alaknanda to form the Ganges River proper.^[9]



Devprayag, confluence of Alaknanda (right) and Bhagirathi (left) rivers, beginning of the Ganges proper.

After flowing 250 km (155.343 mi) ^[12] through its narrow Himalayan valley, the Ganges emerges from the mountains at Rishikesh, then debouches onto the Gangetic Plain at the pilgrimage town of Haridwar.^[9] At Haridwar, a dam diverts some of its waters into the Ganges Canal, which irrigates the Doab region of Uttar Pradesh, whereas the river, whose course has been roughly

southwest until this point, now begins to flow southeast through the plains of northern India.

The Ganges follows an 800 km (500 mi) arching course passing through the cities of Kannauj, Farukhabad, and Kanpur. Along the way it is joined by the Ramganga, which contributes an average annual flow of about 500 m³/s (18,000 cu ft/s).^[13] The Ganges joins the Yamuna at the Triveni Sangam at Allahabad, a holy confluence in Hinduism. At their confluence the Yamuna is larger than the Ganges, contributing about 2,950 m³/s (104,000 cu ft/s),^[13] or about 58.5% of the combined flow.^[14]

Now flowing east, the river meets the Tamsa River (also called *Tons*), which flows north from the Kaimur Range and contributes an average flow of about 190 m³/s (6,700 cu ft/s). After the Tamsa the Gomti River joins, flowing south from the Himalayas. The Gomti contributes an average annual flow of about 234 m³/s (8,300 cu ft/s). Then the Ghaghara River (Karnali River), also flowing south from the Himalayas of Nepal, joins. The Ghaghara (Karnali), with its average annual flow of about 2,990 m³/s (106,000 cu ft/s), is the largest tributary of the Ganges. After the Ghaghara (Karnali) confluence the Ganges is joined from the south by the Son River, contributing about 1,000 m³/s (35,000 cu ft/s). The Gandaki River, then the Kosi River, join from the north flowing from Nepal, contributing about 1,654 m³/s (58,400 cu ft/s) and 2,166 m³/s (76,500 cu ft/s), respectively. The Kosi is the third largest tributary of the Ganges, after the Ghaghara (Karnali) and Yamuna.^[13] The Koshi merge into the Ganges near Kursela in Bihar

Along the way between Allahabad and Malda, West Bengal, the Ganges passes the towns of Chunar, Mirzapur, Varanasi, Ghazipur, Patna, Hajipur, Chapra, Bhagalpur, Ballia, Buxar, Simaria, Sultanganj, and Saidpur. At Bhagalpur, the river begins to flow south-southeast and at Pakur, it begins its attrition with the branching away of its first tributary, the Bhāgirathi-Hooghly, which goes on to become the Hooghly River. Just before the border with Bangladesh the Farakka Barrage controls the flow of the Ganges, diverting some of the water into a feeder canal linked to the Hooghly for the purpose of keeping it relatively silt-free. The Hooghly River is formed by the confluence of the Bhagirathi River and Jalangi River at Nabadwip, and Hooghly has a number of tributaries of its own. The largest is the Damodar River, which is 541 km (336 mi) long, with a drainage basin of 25,820 km² (9,970 sq mi).^[15] The Hooghly River empties into the Bay of Bengal near Sagar Island.^[16] Between Malda and the Bay of Bengal, the Hooghly river passes the towns and cities of Murshidabad, Nabadwip, Kolkata and Howrah.

After entering Bangladesh, the main branch of the Ganges is known as the Padma. The Padma is joined by the Jamuna River, the largest distributary of the Brahmaputra. Further downstream, the Padma joins the Meghna River, the second largest distributary of the Brahmaputra, and takes on the Meghna's name as it enters the Meghna Estuary, which empties into the Bay of Bengal. Here it forms the 1,430 by 3,000 km (890 by 1,860 mi) Bengal Fan, the world's largest submarine fan,^[17] which alone accounts for 10–20% of the global burial of organic carbon.^[18]

The Ganges Delta, formed mainly by the large, sediment-laden flows of the Ganges and Brahmaputra rivers, is the world's largest delta, at about 59,000 km² (23,000 sq mi).^[19] It stretches 322 km (200 mi) along the Bay of Bengal.^[20]

Only the Amazon and Congo rivers have a greater average discharge than the combined flow of the Ganges, the Brahmaputra, and the Surma-Meghna river system.^[20] In full flood only the Amazon is larger.^[21]

Geology

The Indian subcontinent lies atop the Indian tectonic plate, a minor plate within the Indo-Australian Plate.^[22] Its defining geological processes commenced seventy-five million years ago, when, as a part of the southern supercontinent Gondwana, it began a northeastwards drift—lasting fifty million years—across the then unformed Indian Ocean.^[22] The subcontinent's subsequent collision with the Eurasian Plate and subduction under it, gave rise to the Himalayas, the planet's highest mountain ranges.^[22] In the



The Himalayan headwaters of the Ganges River in the Garhwal region of Uttarakhand, India. The headstreams and rivers are labelled in italics; the heights of the mountains, lakes, and towns are displayed in parentheses in metres.

former seabed immediately south of the emerging Himalayas, plate movement created a vast trough, which, having gradually been filled with sediment borne by the Indus and its tributaries and the Ganges and its tributaries,^[23] now forms the Indo-Gangetic Plain.^[24]

The Indo-Gangetic Plain is geologically known as a foredeep oforeland basin.^[25]

Hydrology

The hydrology of the Ganges River is very complicated, especially in the Ganges Delta region. One result is different ways to determine the river's length, its discharge, and the size of its drainage basin.

The name *Ganges* is used for the river between the confluence of the Bhagirathi and Alaknanda rivers, in the Himalayas, and the India-Bangladesh border, near the Farakka Barrage and the first bifurcation of the river. The length of the Ganges is frequently said to be slightly over 2,500 km (1,600 mi) long, about 2,505 km (1,557 mi),^[26] to 2,525 km (1,569 mi),^{[27][14]} or perhaps 2,550 km (1,580 mi).^[28] In these cases the river's source is usually assumed to be the source of the Bhagirathi River, Gangotri Glacier at Gomukh, and its mouth being the mouth of the Meghna River on the Bay of Bengal.^{[27][14][26][28]} Sometimes the source of the Ganges is considered to be at Haridwar, where its Himalayan headwater streams debouch onto the Gangetic Plain.^[29]

In some cases, the length of the Ganges is given for its Hooghly River distributary, which is longer than its main outlet via the Meghna River, resulting in a total length of about 2,620 km (1,630 mi), from the source of the Bhagirathi,^[19] or 2,135 km (1,327 mi), from Haridwar to the Hooghly's mouth.^[30] In other cases the length is said to be about 2,240 km (1,390 mi), from the source of the Bhagirathi to the Bangladesh border, where its name changes to *Padma*.^[31]

For similar reasons, sources differ over the size of the river's drainage basin. The basin covers parts of four countries, India, Nepal, China, and Bangladesh; eleven Indian states, Himachal Pradesh, Uttarakhand, Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Bihar, Jharkhand, Punjab, Haryana, Rajasthan, West Bengal, and the Union Territory of Delhi.^[32] The Ganges basin, including the delta but not the Brahmaputra or Meghna basins, is about 1,080,000 km² (420,000 sq mi), of which 861,000 km² (332,000 sq mi) are in India (about 80%), 140,000 km² (54,000 sq mi) in Nepal (13%), 46,000 km² (18,000 sq mi) in Bangladesh (4%), and 33,000 km² (13,000 sq mi) in China (3%).^[33] Sometimes the Ganges and Brahmaputra–Meghna drainage basins are combined for a total of about 1,600,000 km² (620,000 sq mi),^[21] or 1,621,000 km² (626,000 sq mi).^[20] The combined Ganges-Brahmaputra-Meghna basin (abbreviated GBM or GMB) drainage basin is spread across Bangladesh, Bhutan, India, Nepal, and China.^[34]

The Ganges basin ranges from the Himalaya and the Transhimalaya in the north, to the northern slopes of the Vindhya range in the south, from the eastern slopes of the Aravalli in the west to the Chota Nagpur plateau and the Sunderbans delta in the east. A significant portion of the discharge from the Ganges comes from the Himalayan mountain system. Within the Himalaya, the Ganges basin spreads almost 1,200 km from the Yamuna-Satluj divide along the Simla ridge forming the boundary with the Indus basin in the west to the Singalila Ridge along the Nepal-Sikkim border forming the boundary with the Brahmaputra basin in the east. This section of the Himalaya contains 9 of the 14 highest peaks in the world over 8,000m in height, including Mount Everest which is the high point of the Ganges



A 1908 map showing the course of the Ganges and its tributaries.



Catchment region of the Ganga

Major left-bank tributaries include Gomti (Gumti), Ghaghara (Gogra), Gandaki (Gandak), and Kosi (Kusi); major right-bank tributaries include Yamuna (Jumna), Son, Punpun and Damodar.



The river Ganges at Kolkata, with Howrah Bridge in the background

basin.^[35] The other peaks over 8,000m in the basin are Kangchenjunga,^[36] Lhotse,^[37] Makalu,^[38] Cho Oyu,^[39] Dhaulagiri,^[40] Manaslu,^[41] Annapurna^[42] and Shishapangma.^[43] The Himalayan portion of the basin includes the south-eastern portion of the state of Himachal Pradesh, the entire state of Uttarakhand, the entire country of Nepal and the extreme north-western portion of the state of West Bengal.

The discharge of the Ganges also differs by source. Frequently, discharge is described for the mouth of the Meghna River, thus combining the Ganges with the Brahmaputra and Meghna. This results in a total average annual discharge of about 38,000 m³/s (1,300,000 cu ft/s),^[20] or 42,470 m³/s (1,500,000 cu ft/s).^[19] In other cases the average annual discharges of the Ganges, Brahmaputra, and Meghna are given separately, at about 16,650 m³/s (588,000 cu ft/s) for the Ganges, about 19,820 m³/s (700,000 cu ft/s) for the Brahmaputra, and about 5,100 m³/s (180,000 cu ft/s) for the Meghna.^[27]

The maximum peak discharge of the Ganges, as recorded at Hardinge Bridge in Bangladesh, exceeded 70,000 m³/s (2,500,000 cu ft/s).^[44] The minimum recorded at the same place was about 180 m³/s (6,400 cu ft/s), in 1997!^[45]

The hydrologic cycle in the Ganges basin is governed by the Southwest Monsoon. About 84% of the total rainfall occurs in the monsoon from June to September. Consequently, streamflow in the Ganges is highly seasonal. The average dry season to monsoon discharge ratio is about 1:6, as measured at Hardinge Bridge. This strong seasonal variation underlies many problems of land and water resource development in the region.^[31] The seasonality of flow is so acute it can cause both drought and floods. Bangladesh, in particular, frequently experiences drought during the dry season and regularly suffers extreme floods during the monsoon.^[45]

In the Ganges Delta many large rivers come together, both merging and bifurcating in a complicated network of channels. The two largest rivers, the Ganges and Brahmaputra, both split into distributary channels, the largest of which merge with other large rivers before themselves joining. This current channel pattern was not always the case. Over time the rivers in Ganges Delta have changed course, sometimes altering the network of channels in significant ways.

Before the late 12th century the Bhagirathi-Hooghly distributary was the main channel of the Ganges and the Padma was only a minor spill-channel. The main flow of the river reached the sea not via the modern Hooghly River but rather by the Adi Ganga. Between the 12th and 16th centuries the Bhagirathi-Hooghly and Padma channels were more or less equally significant. After the 16th century the Padma grew to become the main channel of the Ganges.^[16] It is thought that the Bhagirathi-Hooghly became increasingly choked with silt, causing the main flow of the Ganges to shift to the southeast and the Padma River. By the end of the 18th century the Padma had become the main distributary of the Ganges.^[19] One result of this shift to the Padma was that the Ganges joined the Meghna and Brahmaputra rivers before emptying into the Bay of Bengal, together instead of separately. The present confluence of the Ganges and Meghna formed about 150 years ago.^[46]

Also near the end of the 18th century, the course of the lower Brahmaputra changed dramatically, altering its relationship with the Ganges. In 1787 there was a great flood on the Teesta River, which at the time was a tributary of the Ganges-Padma River. The flood of 1787 caused the Teesta to undergo a sudden change course (an avulsion), shifting east to join the Brahmaputra and causing the Brahmaputra to shift its course south, cutting a new channel. This new main channel of the Brahmaputra is called the Jamuna River. It flows south to join the Ganges-Padma. Since ancient times the main flow of the Brahmaputra was more easterly, passing by the city



Lower Ganges in Lakshmipur Bangladesh



The Mahatma Gandhi Setubridge over the Ganges connecting the cities of Patna and Hajipur



Hardinge Bridge, Bangladesh, crosses the Ganges-Padma River. It is one of the key sites for measuring streamflow and discharge on the lower Ganges.

of Mymensingh and joining the Meghna River. Today this channel is a small distributary but retains the name Brahmaputra, sometimes Old Brahmaputra.^[47] The site of the old Brahmaputra-Meghna confluence, in the locality of Langalbandh, is still considered sacred by Hindus. Near the confluence is a major early historic site called Wari-Bateshwar.^[16]

History

The Late Harappan period, about 1900–1300 BCE, saw the spread of Harappan settlement eastward from the Indus River basin to the Ganges-Yamuna doab, although none crossed the Ganges to settle its eastern bank. The disintegration of the Harappan civilisation, in the early 2nd millennium BC, marks the point when the centre of Indian civilisation shifted from the Indus basin to the Ganges basin.^[48] There may be links between the Late Harappan settlement of the Ganges basin and the archaeological culture known as "Cemetery H", the Indo-Aryan people and the Vedic period.

This river is the longest in India.^[49] During the early Vedic Age of the Rigveda, the Indus and the Sarasvati River were the major sacred rivers, not the Ganges. But the later three Vedas gave much more importance to the Ganges.^[f] The Gangetic Plain became the centre of successive powerful states, from the Maurya Empire to the Mughal Empire.^{[9][50]}

The first European traveller to mention the Ganges was Megasthenes (ca. 350–290 BCE). He did so several times in his work Indica: "India, again, possesses many rivers both large and navigable, which, having their sources in the mountains which stretch along the northern frontier, traverse the level country, and not a few of these, after uniting with each other, fall into the river called the Ganges. Now this river, which at its source is 30 stadia broad, flows from north to south, and empties its waters into the ocean forming the eastern boundary of the Gangaridai, a nation which possesses a vast force of the largest-sized elephants." (Diodorus II.37)^[51] In the rainy season of 1809, the lower channel of the Bhagirathi, leading to Kolkata, had been entirely shut; but in the following year it opened again, and was nearly of the same size with the upper channel; both however suffered a considerable diminution, owing probably to the new communication opened below the Jalanggi on the upper channel.

In 1951 a water sharing dispute arose between India and East Pakistan (now Bangladesh), after India declared its intention to build the Farakka Barrage. The original purpose of the barrage, which was completed in 1975, was to divert up to 1,100 m³/s (39,000 cu ft/s) of water from the Ganges to the Bhagirathi-Hooghly distributary in order to restore navigability at the Port of Kolkata. It was assumed that during the worst dry season the Ganges flow would be around 1,400 to 1,600 m³/s (49,000 to 57,000 cu ft/s), thus leaving 280 to 420 m³/s (9,900 to 14,800 cu ft/s) for the then East Pakistan.^[52] East Pakistan objected and a protracted dispute ensued. In 1996 a 30-year treaty was signed with Bangladesh. The terms of the agreement are complicated, but in essence they state that if the Ganges flow at Farakka was less than 2,000 m³/s (71,000 cu ft/s) then India and Bangladesh would each receive 50% of the water, with each receiving at least 1,000 m³/s (35,000 cu ft/s) for alternating ten-day periods. However, within a year the flow at Farakka fell to levels far below the historic average, making it impossible to implement the guaranteed sharing of water. In March 1997, flow of the Ganges in Bangladesh dropped to its lowest ever, 180 m³/s (6,400 cu ft/s). Dry season flows returned to normal levels in the years following, but efforts were made to address the problem. One plan is for another barrage to be built in Bangladesh at Pangsha, west of Dhaka. This barrage would help Bangladesh better utilise its share of the waters of the Ganges.^[g]



The birth of Ganges

Religious and cultural significance

Embodiment of sacredness

The Ganges is a sacred river to Hindus along every fragment of its length. All along its course, Hindus bathe in its waters,^[53] paying homage to their ancestors and to their gods by cupping the water in their hands, lifting it and letting it fall back into the river; they offer flowers and rose petals and float shallow clay dishes filled with oil and lit with wicks (diyas).^[53] On the journey back home from the Ganges, they carry small quantities of river water with them for use in rituals (Ganga jal, literally water of the Ganges).^[54]

The Ganges is the embodiment of all sacred waters in Hindu mythology.^[55] Local rivers are said to be *like* the Ganges, and are sometimes called the local Ganges (Ganga).^[55] The Kaveri river of Karnataka and Tamil Nadu in Southern India is called the Ganges of the South; the Godavari, is the Ganges that was led by the sage Gautama to flow through Central India.^[55] The Ganges is invoked whenever water is used in Hindu ritual, and is therefore present in all sacred waters.^[55] In spite of this, nothing is more stirring for a Hindu than a dip in the actual river, which is thought to remit sins, especially at one of the famous tirthas such as Gangotri, Haridwar, Prayag, or Varanasi.^[55] The symbolic and religious importance of the Ganges is one of the few things that Hindu India, even its skeptics, are agreed upon.^[56] Jawaharlal Nehru, a religious iconoclast himself, asked for a handful of his ashes to be thrown into the Ganges.^[56] "The Ganga," he wrote in his will, "is the river of India, beloved of her people, round which are intertwined her racial 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."^[56]



Chromolithograph, "Indian woman floating lamps on the Ganges," by William Simpson, 1867.

Avatarana or Descent of the Ganges

In late May or early June every year, Hindus celebrate the *avatarana* or descent of the Ganges from heaven to earth.^[57] The day of the celebration, *Ganga Dashahara*, the *dashami* (tenth day) of the waxing moon of the Hindu calendar month Jyestha, brings throngs of bathers to the banks of the river.^[57] A soak in the Ganges on this day is said to rid the bather of ten sins (dasha = Sanskrit "ten"; hara = to destroy) or alternatively, ten lifetimes of sins.^[57] Those who cannot journey to the river, however, can achieve the same results by bathing in any nearby body of water, which, for the true believer, in the Hindu tradition, takes on all the attributes of the Ganges.^[57]

The *avatarana* is an old theme in Hinduism with a number of different versions of the story.^[57] In the Vedic version, Indra, the Lord of Svarga (Heaven) slays the celestial serpent, Vritra, releasing the celestial liquid, the soma, or the nectar of the gods which then plunges to the earth and waters it with sustenance.^[57]

In the Vaishnava version of the myth, Indra has been replaced by his former helper Vishnu.^[57] The heavenly waters are now a river called *Vishnupadi* (*padi*: Skt. "from the foot of").^[57] As he completes his celebrated three strides—of earth, sky, and heaven—Vishnu as Vamana stubs his toe on the vault of heaven, punches open a hole, and releases the *Vishnupadi*, which until now had been circling around the cosmic egg within.^[58] Flowing out of the vault, she plummets down to Indra's heaven, where she is received by Dhruva, the once steadfast worshipper of Vishnu, now fixed in the sky as the polestar.^[58] Next, she streams across the sky forming the Milky Way and arrives on the moon.^[58] She then flows down earthwards to Brahma's realm, a divine lotus atop Mount Meru, whose petals form the earthly continents.^[58] There, the divine waters break up, with one stream, the Alaknanda, flowing down one petal into Bharatvarsha (India) as the Ganges.^[58]



Descent of Ganga – painting by Raja Ravi Varma

It is Shiva, however, among the major deities of the Hindu pantheon, who appears in the most widely known version of the *avatarana* story.^[59] Told and retold in the Ramayana, the Mahabharata and several Puranas, the story begins with a sage, Kapila, whose intense meditation has been disturbed by the sixty thousand sons of King Sagara. Livid at being disturbed, Kapila sears them with his angry gaze, reduces them to ashes, and dispatches them to the netherworld. Only the waters of the Ganges, then in heaven, can bring the

dead sons their salvation. A descendant of these sons, King Bhagiratha, anxious to restore his ancestors, undertakes rigorous penance and is eventually granted the prize of Ganga's descent from heaven. However, since her turbulent force would also shatter the earth, Bhagiratha persuades Shiva in his abode on Mount Kailash to receive Ganga in the coils of his tangled hair and break her fall. Ganga descends, is tamed in Shiva's locks, and arrives in the Himalayas. She is then led by the waiting Bhagiratha down into the plains at Haridwar, across the plains first to the confluence with the Yamuna at Prayag and then to Varanasi, and eventually to Ganga Sagar, where she meets the ocean, sinks to the netherworld, and saves the sons of Sagara.^[59] In honour of Bhagirath's pivotal role in the *avatarana*, the source stream of the Ganges in the Himalayas is named Bhagirathi, (Sanskrit, "of Bhagiratha").^[59]

Redemption of the Dead

Since Ganga had descended from heaven to earth, she is also the vehicle of *ascent*, from earth to heaven.^[60] As the *Triloka-patha-gamini* (Skt. *triloka*= "three worlds", *patha* = "road", *gamini* = "one who travels") of the Hindu tradition, she flows in heaven, earth, and the netherworld, and, consequently, is a "tirtha," or crossing point of all beings, the living as well as the dead.^[60] It is for this reason that the story of the *avatarana* is told at Shraddha ceremonies for the deceased in Hinduism, and Ganges water is used in Vedic rituals after death.^[60] Among all hymns devoted to the Ganges, there are none more popular than the ones expressing the worshipers wish to breathe his last surrounded by her waters.^[60] The *Gangashtakam* expresses this longing fervently!^[60]

O Mother! ... Necklace adorning the worlds!
Banner rising to heaven!
I ask that I may leave of this body on your banks,
Drinking your water, rolling in your waves,
Remembering your name, bestowing my gaze upon you.^[61]

No place along her banks is more longed for at the moment of death by Hindus than Varanasi, the Great Cremation Ground, or Mahashmshana.^[60] Those who are lucky enough to die in Varanasi, are cremated on the banks of the Ganges, and are granted instant salvation.^[62] If the death has occurred elsewhere, salvation can be achieved by immersing the ashes in the Ganges.^[62] If the ashes have been immersed in another body of water, a relative can still gain salvation for the deceased by journeying to the Ganges, if possible during the lunar "fortnight of the ancestors" in the Hindu calendar month of Ashwin (September or October), and performing the *Shraddha* rites.^[62]

Hindus also perform pinda pradana, a rite for the dead, in which balls of rice and sesame seed are offered to the Ganges while the names of the deceased relatives are recited.^[63] Every sesame seed in every ball thus offered, according to one story, assures a thousand years of heavenly salvation for the each relative.^[63] Indeed, the Ganges is so important in the rituals after death that the *Mahabharata*, in one of its popular *slokas*, says, "If only (one) bone of a (deceased) person should touch the water of the Ganges, that person shall dwell honoured in heaven."^[64] As if to illustrate this truism, the *Kashi Khanda* (Varanasi Chapter) of the Skanda Purana recounts the remarkable story of *Vahika*, a profligate and unrepentant sinner, who is killed by a tiger in the forest. His soul arrives before Yama, the Lord of Death, to be judged for the hereafter. Having no compensating virtue, Vahika's soul is at once dispatched to hell. While this is happening, his body on earth, however, is being picked at by vultures, one of whom flies away with a foot bone. Another bird comes after the vulture, and in fighting him off, the vulture accidentally drops the bone into the Ganges below. Blessed by this happenstance, Vahika, on his way to hell, is rescued by a celestial chariot which takes him instead to heaven.^[65]



Preparations for cremations on the banks of the Ganges in Varanasi, 1903. The dead are being bathed, wrapped in cloth and covered with wood. The photograph has caption, "Who dies in the waters of the Ganges obtains heaven."

The Purifying Ganges

Hindus consider the waters of the Ganges to be both pure and purifying.^[66] Nothing reclaims order from disorder more than the waters of the Ganges.^[67] Moving water, as in a river, is considered purifying in Hindu culture because it is thought to both absorb impurities and take them away.^[67] The swiftly moving Ganges, especially in its upper reaches, where a bather has to grasp an anchored chain in order to not be carried away, is considered especially purifying.^[67] What the Ganges removes, however, is not necessarily physical dirt, but symbolic dirt; it wipes away the sins of the bather, not just of the present, but of a lifetime.^[67]



Devotees taking holy bath during festival of *Ganga Dashara* at Har-ki-Pauri, Haridwar

A popular paean to the Ganges is the *Ganga Lahiri* composed by a seventeenth century poet Jagannatha who, legend has it, was turned out of his Hindu Brahmin caste for carrying on an affair with a Muslim woman. Having attempted futilely to be rehabilitated within the Hindu fold, the poet finally appeals to Ganga, the hope of the hopeless, and the comforter of last resort. Along with his beloved, Jagannatha sits at the top of the flight of steps leading to the water at the famous *Panchganga Ghat* in Varanasi. As he recites each verse of the poem, the water of the Ganges rises up one step, until in the end it envelops the lovers and carry them away.^[67] "I come to you as a child to his mother," begins the *Ganga Lahiri*.^[68]

I come as an orphan to you, moist with love.
I come without refuge to you, giver of sacred rest.
I come a fallen man to you, uplifter of all.
I come undone by disease to you, the perfect physician.
I come, my heart dry with thirst, to you, ocean of sweet wine.
Do with me whatever you will!^[68]

Consort, Shakti, and Mother

Ganga is a consort to all three major male deities of Hinduism.^[69] As Brahma's partner she always travels with him in the form of water in his kamandalu (water-pot).^[69] She is also Vishnu's consort.^[69] Not only does she emanate from his foot as *Vishnupadi* in the *avatarana* story, but is also, with Sarasvati and Lakshmi, one of his co-wives.^[69] In one popular story, envious of being outdone by each other, the co-wives begin to quarrel. While Lakshmi attempts to mediate the quarrel, Ganga and Sarasvati, heap misfortune on each other. They curse each other to become rivers, and to carry within them, by washing, the sins of their human worshippers. Soon their husband, Vishnu, arrives and decides to calm the situation by separating the goddesses. He orders Sarasvati to become the wife of Brahma, Ganga to become the wife of Shiva, and Lakshmi, as the blameless conciliator, to remain as his own wife. Ganga and Sarasvati, however, are so distraught at this dispensation, and wail so loudly, that Vishnu is forced to take back his words. Consequently, in their lives as rivers they are still thought to be with him.^[70]

It is Shiva's relationship with Ganga, that is the best-known in Ganges mythology.^[71] Her descent, the *avatarana* is not a one time event, but a continuously occurring one in which she is forever falling from heaven into his locks and being forever tamed.^[71] Shiva, is depicted in Hindu iconography as *Gangadhara*, the "Bearer of the Ganga," with Ganga, shown as spout of water, rising from his hair.^[71] The Shiva-Ganga relationship is both perpetual and intimate.^[71] Shiva is sometimes called *Uma-Ganga-Patiswara* ("Husband and Lord of Uma (Parvati) and Ganga"), and Ganga often arouses the jealousy of Shiva's better known consort Parvati.^[71]

Ganga is the *shakti* or the moving, restless, rolling energy in the form of which the otherwise recluse and unapproachable Shiva appears on earth.^[69] As water, this moving energy can be felt, tasted, and absorbed.^[69] The war-god Skanda addresses the sage Agastya in the *Kashi Khand* of the *Skanda Purana* in these words:^[69]

One should not be amazed ... that this Ganges is really Power, for is she not the Supreme Shakti of the Eternal Shiva, taken in the form of water?
This Ganges, filled with the sweet wine of compassion, was sent out for

the salvation of the world by Shiva, the Lord of the Lords.

Good people should not think this Triple-Pathed River to be like the thousand other earthly rivers, filled with water^[69]

The Ganges is also the mother, the *Ganga Mata* (*mata*="mother") of Hindu worship and culture, accepting all and forgiving all.^[68] Unlike other goddesses, she has no destructive or fearsome aspect, destructive though she might be as a river in nature.^[68] She is also a mother to other gods.^[72] She accepts Shiva's incandescent seed from the fire-god Agni, which is too hot for this world, and cools it in her waters.^[72] This union produces Skanda, or Kartikeya, the god of war.^[72] In the *Mahabharata*, she is the wife of Shantanu, and the mother of heroic warrior-patriarch, Bhishma.^[72] When Bhishma is mortally wounded in battle, Ganga comes out of the water in human form and weeps uncontrollably over his body^[72]

The Ganges is the distilled lifeblood of the Hindu tradition, of its divinities, holy books, and enlightenment.^[69] As such, her worship does not require the usual rites of invocation (*avahana*) at the beginning and dismissal (*visarjana*) at the end, required in the worship of other gods.^[69] Her divinity is immediate and everlasting.^[69]



Shiva, as *Gangadhara*, bearing the Descent of the Ganges, as the goddess Parvati, the sage Bhagiratha, and the bull Nandi look on (circa 1740).

Ganges in classical Indian iconography



Photograph (1875) of goddess Ganga (Gupta Period, 5th or 6th century CE) from Besnagar, Madhya Pradesh, now in Museum of Fine Arts, Boston.



Goddess Ganga with left hand resting on a dwarf attendant's head from the Rameshwar Temple, Ellora Caves, Maharashtra. Date of Sculpture, 6th century



The goddess Ganga stands on her mount, the *makara*, with a *kumbha*, a full pot of water, in her hand, while an attendant holds a parasol over her. Terracotta, Ahichatra, Uttar Pradesh, Gupta, 5th century, now in National Museum, New Delhi



The goddess Ganga (right) in tribhanga pose with retinue. Pratihara, 10th century, now in National Museum, New Delhi

Early in ancient Indian culture, the river Ganges was associated with fecundity, its redeeming waters and its rich silt providing sustenance to all who lived along its banks.^[73] A counterpoise to the dazzling heat of the Indian summer, the Ganges came to be imbued with magical qualities and to be revered in anthropomorphic form.^[74] By the 5th century CE, an elaborate mythology surrounded the Ganges, now a goddess in her own right, and a symbol for all rivers of India.^[75] Hindu temples all over India had statues and reliefs of the goddess carved at their entrances, symbolically washing the sins of arriving worshippers and guarding the

gods within.^[76] As protector of the sanctum sanctorum, the goddess soon came to be depicted with several characteristic accessories: the makara (a crocodile-like undersea monster, often shown with an elephant-like trunk), the kumbha (an overfull vase), various overhead parasol-like coverings, and a gradually increasing retinue of humans.^[77]

Central to the goddess's visual identification is the makara, which is also her vahana, or mount. An ancient symbol in India, it pre-dates all appearances of the goddess Ganga in art.^[77] The makara has a dual symbolism. On the one hand, it represents the life-affirming waters and plants of its environment; on the other, it represents fear, both fear of the unknown it elicits by lurking in those waters and real fear it instills by appearing in sight.^[77] The earliest extant unambiguous pairing of the makara with Ganga is at Udayagiri Caves in Central India (circa 400 CE). Here, in Cave V, flanking the main figure of Vishnu shown in his boar incarnation, two river goddesses, Ganga and Yamuna appear atop their respective mounts, makara and kurma (a turtle or tortoise).^[77]

The makara is often accompanied by a gana, a small boy or child, near its mouth, as, for example, shown in the Gupta period relief from Besnagar, Central India, in the left-most frame above.^[78] The gana represents both posterity and development (udbhava).^[78] The pairing of the fearsome, life-destroying makara with the youthful, life-affirming gana speaks to two aspects of the Ganges herself. Although she has provided sustenance to millions, she has also brought hardship, injury, and death by causing major floods along her banks.^[79] The goddess Ganga is also accompanied by a dwarf attendant, who carries a cosmetic bag, and on whom she sometimes leans, as if for support.^[76] (See, for example, frames 1, 2, and 4 above.)

The purna kumbha or full pot of water is the second most discernible element of the Ganga iconography.^[80] Appearing first also in the relief in Udayagiri Caves (5th century), it gradually appeared more frequently as the theme of the goddess matured.^[80] By the seventh century it had become an established feature, as seen, for example, the Dashavatara temple, Deogarh, Uttar Pradesh (seventh century), the Trimurti temple, Badoli, Chittorgarh, Rajasthan, and at the Lakshmaneshwar temple, Kharod, Bilaspur, Chhattisgarh.^[80] (ninth or tenth century), and seen very clearly in frame 3 above and less clearly in the remaining frames. Worshipped even today, the full pot is emblematic of the formless Brahman, as well as of woman, of the womb, and of birth.^[81] Furthermore, The river goddesses Ganga and Saraswati were both born from Brahma's pot, containing the celestial waters.^[81]

In her earliest depictions at temple entrances, the goddess Ganga appeared standing beneath the overhanging branch of a tree, as seen as well in the Udayagiri caves.^[82] However, soon the tree cover had evolved into a chatra or parasol held by an attendant, for example, in the seventh-century Dasavatara temple at Deogarh.^[82] (The parasol can be clearly seen in frame 3 above; its stem can be seen in frame 4, but the rest has broken off.) The cover undergoes another transformation in the temple at Kharod, Bilaspur (ninth or tenth century), where the parasol is lotus-shaped^[82] and yet another at the Trimurti temple at Badoli where the parasol has been replaced entirely by a lotus.^[82]

As the iconography evolved, sculptors in the central India especially were producing animated scenes of the goddess, replete with an entourage and suggestive of a queen en route to a river to bathe.^[83] A relief similar to the depiction in frame 4 above, is described in Pal 1997, p. 43 as follows:

A typical relief of about the ninth century that once stood at the entrance of a temple, the river goddess Ganga is shown as a voluptuously endowed lady with a retinue. Following the iconographic prescription, she stands gracefully on her composite makara mount and holds a water pot. The dwarf attendant carries her cosmetic bag, and a ... female holds the stem of a giant lotus leaf that serves as her mistress's parasol. The fourth figure is a male guardian. Often in such reliefs the makara's tail is extended with great flourish into a scrolling design symbolizing both vegetation and water.^[76]

Kumbh Mela

Kumbh Mela is a mass Hindu pilgrimage in which Hindus gather at the Ganges River. The normal Kumbh Mela is celebrated every 3 years, the *Ardh* (half) Kumbh is celebrated every six years at Haridwar and Prayag,^[84] the *Purna* (complete) Kumbh takes place every twelve years^[85] at four places (Prayag (Allahabad), Haridwar, Ujjain, and Nashik). The *Maha* (great) Kumbh Mela which comes after 12 'Purna Kumbh Melas', or 144 years, is held at Prayag (Allahabad).^[85]

The major event of the festival is ritual bathing at the banks of the river. Other activities include religious discussions, devotional singing, mass feeding of holy men and women and the poor, and religious assemblies where doctrines are debated and standardized. Kumbh Mela is the most sacred of all the pilgrimages.^{[86][87]} Thousands of holy men and women attend, and the auspiciousness of the festival is in part attributable to this. The sadhus are seen clad in saffron sheets with ashes and powder dabbed on their skin per the requirements of ancient traditions. Some, called naga sanyasis, may not wear any clothes.^[88]

Irrigation

The Ganges and its all tributaries, especially the Yamuna, have been used for irrigation since ancient times.^[89] Dams and canals were common in gangetic plain by fourth century BCE.^[90] The Ganges-Brahmaputra-Meghna basin has a huge hydroelectric potential, on the order of 200,000 to 250,000 megawatts, nearly half of which could be easily harnessed. As of 1999, India tapped about 12% of the hydroelectric potential of the Ganges and just 1% of the vast potential of the Brahmaputra.^[91]

Canals

Megasthenes, a Greek ethnographer who visited India during third century BCE when Mauryans ruled India described the existence of canals in the gangetic plain. Kautilya (also known as Chanakya), an advisor to Chandragupta Maurya the founder of Maurya Empire, included the destruction of dams and levees as a strategy during war.^[90] Firuz Shah Tughlaq had many canals built, the longest of which, 240 km (150 mi), was built in 1356 on the Yamuna River. Now known as the Western Yamuna Canal, it has fallen into disrepair and been restored several times. The Mughal emperor Shah Jahan built an irrigation canal on the Yamuna River in the early 17th century. It fell into disuse until 1830, when it was reopened as the Eastern Yamuna Canal, under British control. The reopened canal became a model for the Upper Ganges Canal and all following canal projects.^[89]

The first British canal in India—with no Indian antecedents—was the Ganges Canal built between 1842 and 1854.^[92] Contemplated first by Col. John Russell Colvin in 1836, it did not at first elicit much enthusiasm from its eventual architect Sir Proby Thomas Cautley, who balked at idea of cutting a canal through extensive low-lying land in order to reach the drier upland destination. However, after the Agra famine of 1837–38, during which the East India Company's administration spent Rs. 2,300,000 on famine relief, the idea of a canal became more attractive to the Company's budget-conscious Court of Directors. In 1839, the Governor General of India Lord Auckland, with the Court's assent, granted funds to Cautley for a full survey of the swath of land that underlay and fringed the projected course of the canal. The Court of Directors, moreover, considerably enlarged the scope of the projected canal, which, in consequence of the severity and geographical extent of the famine, they now deemed to be the entire Doab region.^[93]

The enthusiasm, however, proved to be short lived. Auckland's successor as Governor General, Lord Ellenborough, appeared less receptive to large-scale public works, and for the duration of his tenure, withheld major funds for the project. Only in 1844, when a new Governor-General, Lord Hardinge, was appointed, did official enthusiasm and funds return to the Ganges canal project. Although the intervening impasse had seemingly affected Cautley's health and required him to return to Britain in 1845 for recuperation, his European sojourn gave him an opportunity to study contemporary hydraulic works in the United Kingdom and Italy. By the time of his return to India even more supportive men were at the helm, both in the North-Western Provinces, with James Thomason as Lt. Governor, and in British India with Lord Dalhousie as Governor-General. Canal construction, under Cautley's supervision, now went into full swing. A 560 km (350 mi) long canal, with another 480 km (300 mi) of branch lines, eventually stretched between the headworks in Hardwar, splitting into two branches below Aligarh, and its two confluences with the Yamuna



A procession of Akharas marching over a makeshift bridge over the Ganges River Kumbh Mela at Allahabad, 2001.



Head works of the Ganges canal in Haridwar (1860). photograph by Samuel Bourne.

(Jumna in map) mainstem in Etawah and the Ganges in Kanpur (Cawnpore in map). The Ganges Canal, which required a total capital outlay of £2.15 million, was officially opened in 1854 by Lord Dalhousie.^[94] According to historian Ian Stone:

It was the largest canal ever attempted in the world, five times greater in its length than all the main irrigation lines of Lombardy and Egypt put together, and longer by a third than even the largest USA navigation canal, the Pennsylvania Canal

Dams and barrages

A major barrage at Farakka was opened on 21 April 1975,^[95] It is located close to the point where the main flow of the river enters Bangladesh, and the tributary Hooghly (also known as Bhagirathi) continues in West Bengal past Kolkata. This barrage, which feeds the Hooghly branch of the river by a 42 km (26 mi) long feeder canal, and its water flow management has been a long-lingering source of dispute with Bangladesh.^[96] Indo-Bangladesh Ganges Water Treaty signed in December 1996 addressed some of the water sharing issues between India and Bangladesh.^[95]

Tehri Dam was constructed on Bhagirathi River, tributary of the Ganges. It is located 1.5 km downstream of Ganesh Prayag, the place where Bhilangana meets Bhagirathi. Bhagirathi is called Ganges after Devprayag.^[97] Construction of the dam in an earthquake prone area^[98] was controversial!^[99]

Bansagar Dam was built on the Son River, a tributary of the Ganges for both irrigation and hydroelectric power generation.^[100]

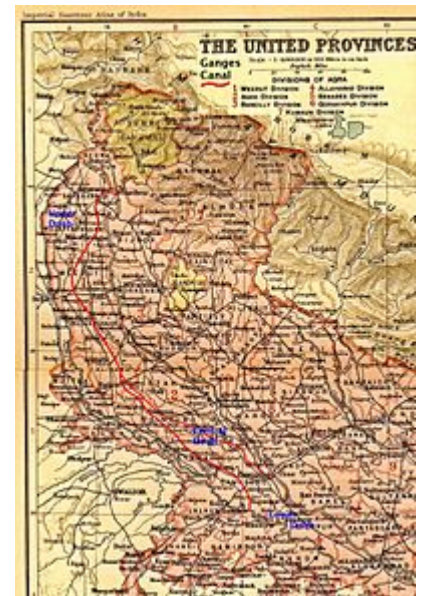
Economy

The Ganges Basin with its fertile soil is instrumental to the agricultural economies of India and Bangladesh. The Ganges and its tributaries provide a perennial source of irrigation to a large area. Chief crops cultivated in the area include rice, sugarcane, lentils, oil seeds, potatoes, and wheat. Along the banks of the river, the presence of swamps and lakes provide a rich growing area for crops such as legumes, chillies, mustard, sesame, sugarcane, and jute. There are also many fishing opportunities along the river, though it remains highly polluted. Also the major industrial towns of Unnao, Kanpur, situated on the banks of the river with the predominance of tanning industries add to the pollution.^[101]

Tourism

Tourism is another related activity. Three towns holy to Hinduism—Haridwar, Prayag (Allahabad), and Varanasi—attract thousands of pilgrims to its waters to take a dip in the Ganges, which is believed to cleanse oneself of sins and help attain salvation. The rapids of the Ganges also are popular for river rafting, attracting adventure seekers in the summer months. Also, several cities such as Kanpur, Kolkata and Patna have developed riverfront walkways along the banks to attract tourists.^{[102][103][104][105]}

Ecology and environment



The Ganges Canal highlighted in red stretching between its headworks off the Ganges River in Hardwar and its confluences with the Jumna River in Etawah and with the Ganges in Cawnpore (now Kanpur).



A girl selling plastic containers for carrying Ganges water, Haridwar.

Human development, mostly agriculture, has replaced nearly all of the original natural vegetation of the Ganges basin. More than 95% of the upper Gangetic Plain has been degraded or converted to agriculture or urban areas. Only one large block of relatively intact habitat remains, running along the Himalayan foothills and including Rajaji National Park, Jim Corbett National Park, and Dudhwa National Park.^[106] As recently as the 16th and 17th centuries the upper Gangetic Plain harboured impressive populations of wild Asian elephants (*Elephas maximus*), Bengal tigers (*Panthera t. tigris*), Indian rhinoceros (*Rhinoceros unicornis*), gaurs (*Bos gaurus*), barasinghas (*Rucervus duvaucelii*), sloth bears (*Melursus ursinus*) and Indian lions (*Panthera leo persica*).^[106] In the 21st century there are few large wild animals, mostly deer, wild boars, wildcats, and small numbers of Indian wolves, golden jackals, and red and Bengal foxes. Bengal tigers survive only in the Sundarbans area of the Ganges Delta.^[9] The Sundarbans freshwater swamp ecoregion, however, is nearly extinct.^[107] Threatened mammals in the upper Gangetic Plain include the tigerelephant, sloth bear, and four-horned antelope (*Tetracerus quadricornis*).^[106]



Ganges from Space

Many types of birds are found throughout the basin, such as myna, Psittacula parakeets, crows, kites, partridges, and fowls. Ducks and snipes migrate across the Himalayas during the winter, attracted in large numbers to wetland areas.^[9] There are no endemic birds in the upper Gangetic Plain. The great Indian bustard (*Ardeotis nigriceps*) and lesser florican (*Sypheotides indicus*) are considered globally threatened.^[106]

The natural forest of the upper Gangetic Plain has been so thoroughly eliminated it is difficult to assign a natural vegetation type with certainty. There are a few small patches of forest left, and they suggest that much of the upper plains may have supported a tropical moist deciduous forest with sal (*Shorea robusta*) as a climax species.^[106]



Lesser florican (*Sypheotides indicus*)

A similar situation is found in the lower Gangetic Plain, which includes the lower Brahmaputra River. The lower plains contain more open forests, which tend to be dominated by Bombax ceiba in association with Albizia procera, Duabanga grandiflora, and Sterculia vilosa. There are early seral forest communities that would eventually become dominated by the climax species sal (*Shorea robusta*), if forest succession was allowed to proceed. In most places forests fail to reach climax conditions due to human causes.^[108] The forests of the lower Gangetic Plain, despite thousands of years of human settlement, remained largely intact until the early 20th century. Today only about 3% of the ecoregion is under natural forest and only one large block, south of Varanasi, remains. There are over forty protected areas in the ecoregion, but over half of these are less than 100 square kilometres (39 sq mi).^[108] The fauna of the lower Gangetic Plain is similar to the upper plains, with the addition of a number of other species such as the smooth-coated otter (*Lutrogale perspicillata*) and the large Indian civet (*Viverra zibetha*).^[108]

Fish

It has been estimated that about 350 fish species live in the entire Ganges drainage, including several endemics.^[109] In a major 2007–2009 study of fish in the Ganges basin (including the river itself and its tributaries, but excluding the Brahmaputra and Meghna basins), a total of 143 fish species were recorded, including 10 non-native introduced species.^[110] The most diverse orders are Cypriniformes (barbs and allies), Siluriformes (catfish) and Perciformes (perciform fish), each comprising about 50%, 23% and 14% of the total fish species in the drainage.^[110]

There are distinct differences between the different sections of the river basin, but Cyprinidae is the most diverse throughout. In the upper section (roughly equalling the basin parts in Uttarakhand) more than 50 species have been recorded and Cyprinidae alone accounts for almost 80% those, followed by Balitoridae (about 15.6%) and Sisoridae (about 12.2%).^[110] Sections of the Ganges basin at altitudes above 2,400–3,000 m (7,900–9,800 ft) above sea level are generally without fish. Typical genera approaching this

altitude are Schizothorax, Tor, Barilius, Nemacheilus and Glyptothorax.^[110] About 100 species have been recorded from the middle section of the basin (roughly equalling the sections in Uttar Pradesh and parts of Bihar) and more than 55% of these are in family Cyprinidae, followed by Schilbeidae (about 10.6%) and Clupeidae (about 8.6%).^[110] The lower section (roughly equalling the basin in parts of Bihar and West Bengal) includes major floodplains and is home to almost 100 species. About 46% of these are in the family Cyprinidae, followed by Schilbeidae (about 11.4%) and Bagridae (about 9%).^[110]

The Ganges basin supports major fisheries, but these have declined in recent decades. In the Allahabad region in the middle section of the basin, catches of carp fell from 424.91 metric tons in 1961–1968 to 38.58 metric tons in 2001–2006, and catches of catfish fell from 201.35 metric tons in 1961–1968 to 40.56 metric tons in 2001–2006.^[110] In the Patna region in the lower section of the basin, catches of carp fell from 383.2 metric tons to 118, and catfish from 373.8 metric tons to 194.48.^[110] Some of the fish commonly caught in fisheries include catla (*Catla catla*), golden mahseer (*Tor putitora*), tor mahseer (*Tor tor*), rohu (*Labeo rohita*), walking catfish (*Clarias batrachus*), pangas catfish (*Pangasius pangasius*), goonch catfish (*Bagarius*), snakeheads (*Channa*), bronze featherback (*Notopterus notopterus*) and milkfish (*Chanos chanos*).^{[9][110]}

The Ganges basin is home to about 30 fish species that are listed as threatened with the primary issues being overfishing (sometimes illegal), pollution, water abstraction, siltation and invasive species.^[110] Among the threatened species is the critically endangered Ganges shark (*Glyphis gangeticus*).^[111] Several fish species migrate between different sections of the river, but these movements may be prevented by the building of dams.^[110]

Crocodylians and turtles

The main sections of the Ganges River are home to the gharial (*Gavialis gangeticus*) and mugger crocodile (*Crocodylus palustris*), and the delta is home to the saltwater crocodile (*C. porosus*). Among the numerous aquatic and semi-aquatic turtles in the Ganges basin are the northern river terrapin (*Batagur baska*; only in the lowermost section of the basin), three-striped roofed turtle (*B. dhongoka*), red-crowned roofed turtle (*B. kachuga*), black pond turtle (*Geoclemys hamiltonii*), Brahminy river turtle (*Hardella thurjii*), Indian black turtle (*Melanochelys trijuga*), Indian eyed turtle (*Morenia petersi*), brown roofed turtle (*Pangshura smithii*), Indian roofed turtle (*Pangshura tecta*), Indian tent turtle (*Pangshura tentoria*), Indian flapshell turtle (*Lissemys punctata*), Indian narrow-headed softshell turtle (*Chitra indica*), Indian softshell turtle (*Nilssonia gangetica*), Indian peacock softshell turtle (*N. hurum*) and Cantor's giant softshell turtle (*Pelochelys cantorii*; only in the lowermost section of Ganges basin).^[113] Most of these are seriously threatened.^[113]

Ganges river dolphin

The river's most famed fauna is the freshwater dolphin *Platanista gangetica gangetica*, the Ganges river dolphin.^[106] recently declared India's national aquatic animal.^[114]

This dolphin used to exist in large schools near to urban centres in both the Ganges and Brahmaputra rivers, but is now seriously threatened by pollution and dam construction. Their numbers have now dwindled to a quarter of their numbers of fifteen years before, and they have become extinct in the Ganges' main tributaries.^[e] A recent survey by the World Wildlife Fund found only 3,000 left in the water catchment of both river systems.^[115]



The catla (*Catla catla*) is one of the Indian carp species that support major fisheries in the Ganges



The threatened gharial (*Gavialis gangeticus*) is a large fish-eating crocodylian that is harmless to humans^[112]



The Gangetic dolphin in a sketch by Whympers and P. Smit, 1894.

The Ganges river dolphin is one of only five true freshwater dolphins in the world. The other four are the baiji (*Lipotes vexillifer*) of the Yangtze River in China, now likely extinct; the Indus river dolphin of the Indus River in Pakistan; the Amazon river dolphin of the Amazon River in South America; and the Araguaian river dolphin (not considered a separate species until 2014^[116]) of the Araguaia–Tocantins basin in Brazil. There are several marine dolphins whose ranges include some freshwater habitats, but these five are the only dolphins who live only in freshwater rivers and lakes.^[108]

Effects of climate change

The Tibetan Plateau contains the world's third-largest store of ice. Qin Dahe, the former head of the China Meteorological Administration, said that the recent fast pace of melting and warmer temperatures will be good for agriculture and tourism in the short term; but issued a strong warning:

Temperatures are rising four times faster than elsewhere in China, and the Tibetan glaciers are retreating at a higher speed than in any other part of the world.... In the short term, this will cause lakes to expand and bring floods and mudflows... In the long run, the glaciers are vital lifelines for Asian rivers, including the Indus and the Ganges. Once they vanish, water supplies in those regions will be in peril.^[117]

In 2007, the Intergovernmental Panel on Climate Change (IPCC), in its Fourth Report, stated that the Himalayan glaciers which feed the river, were at risk of melting by 2035.^[118] The IPCC has now withdrawn that prediction, as the original source admitted that it was speculative and the cited source was not a peer reviewed finding.^[h] In its statement, the IPCC stands by its general findings relating to the Himalayan glaciers being at risk from global warming (with consequent risks to water flow into the Gangetic basin). Many studies have suggested that the climate change will affect the water resources in the Ganges river basin including increased summer (monsoon) flow and peak runoff could result in an increased risk of flooding.^[119]

Pollution and environmental concerns

The Ganges suffers from extreme pollution levels caused by the 400 million people who live close to the river.^{[120][121]} Sewage from many cities along the river's course, industrial waste and religious offerings wrapped in non-degradable plastics add large amounts of pollutants to the river as it flows through densely populated areas.^{[8][122][123]} The problem is exacerbated by the fact that many poorer people rely on the river on a daily basis for bathing, washing, and cooking.^[122] The World Bank estimates that the health costs of water pollution in India equal three percent of India's GDP.^[j] It has also been suggested that eighty percent of all illnesses in India and one-third of deaths can be attributed to waterborne diseases.^[e]

Varanasi, a city of one million people that many pilgrims visit to take a "holy dip" in the Ganges, releases around 200 million litres of untreated human sewage into the river each day, leading to large concentrations of faecal coliform bacteria.^[122] According to official standards, water safe for bathing should not contain more than 500 faecal coliforms per 100ml, yet upstream of Varanasi's ghats the river water already contains 120 times as much, 60,000 faecal coliform bacteria per 100 ml.^{[124][125]}

After the cremation of the deceased at Varanasi's ghats the bones and ashes are thrown into the Ganges. However, in the past thousands of uncremated bodies were thrown into the Ganges during cholera epidemics, spreading the disease. Even today holy men, pregnant women, people with leprosy/chicken pox, people who had been bitten by snakes, people who had committed suicide, the poor, and children under 5 are not cremated at the ghats but are floated free to decompose in the waters. In addition, those who cannot afford the large amount of wood needed to incinerate the entire body leave behind a lot of half burned body parts.^{[126][127]}



People bathing and washing clothes in the Ganges in Varanasi.

After passing through Varanasi, and receiving 32 streams of raw sewage from the city, the concentration of fecal coliforms in the river's waters rises from 60,000 to 1.5 million,^{[124][125]} with observed peak values of 100 million per 100 ml.^[122] Drinking and bathing in its waters therefore carries a high risk of infection.^[122]

Between 1985 and 2000, Rs. 10 billion, around US\$226 million, or less than 4 cents per person per year,^[128] were spent on the Ganga Action Plan,^[8] an environmental initiative that was "the largest single attempt to clean up a polluted river anywhere in the world."^[d] The Ganga Action Plan has been described variously as a "failure",^{[129][l][k]} a "major failure",^{[a][b][i]}

According to one study^[129]

The Ganga Action Plan, which was taken on priority and with much enthusiasm, was delayed for two years. The expenditure was almost doubled. But the result was not very appreciable. Much expenditure was done over the political propaganda. The concerning governments and the related agencies were not very prompt to make it a success. The public of the areas was not taken into consideration. The releasing of urban and industrial wastes in the river was not controlled fully. The flowing of dirty water through drains and sewers were not adequately diverted. The continuing customs of burning dead bodies, throwing carcasses, washing of dirty clothes by washermen, and immersion of idols and cattle wallowing were not checked. Very little provision of public latrines was made and the open defecation of lakhs of people continued along the riverside. All these made the Action Plan a failure.

The failure of the Ganga Action Plan, has also been variously attributed to "environmental planning without proper understanding of the human–environment interactions,"^[d] Indian "traditions and beliefs,"^[l] "corruption and a lack of technical knowledge"^[c] and "lack of support from religious authorities."^[e]

In December 2009 the World Bank agreed to loan India US\$1 billion over the next five years to help save the river.^[130] According to 2010 Planning Commission estimates, an investment of almost Rs. 70 billion (Rs. 70 billion, approximately US\$1.5 billion) is needed to clean up the river.^[8]

In November 2008, the Ganges, alone among India's rivers, was declared a "National River", facilitating the formation of a National Ganga River Basin Authority that would have greater powers to plan, implement and monitor measures aimed at protecting the river.^[131]

In July 2014, the Government of India announced an integrated Ganges-development project titled *Namami Ganga* and allocated ₹2,037 crore for this purpose.^[132]

In March 2017 the High Court of Uttarakhand declared the Ganges River a legal "person", in a move that according to one newspaper, "could help in efforts to clean the pollution-choked rivers."^[133] As of 6 April 2017, the ruling has been commented on in Indian newspapers to be hard to enforce,^[134] that experts do not anticipate immediate benefits,^[134] that the ruling is "hardly game changing,"^[135] that experts believe "any follow-up action is unlikely,"^[136] and that the "judgment is deficient to the extent it acted without hearing others (in states outside Uttarakhand) who have stakes in the matter."^[137]

The incidence of water-borne and enteric diseases—such as gastrointestinal disease, cholera, dysentery, hepatitis A and typhoid—among people who use the river's waters for bathing, washing dishes and brushing teeth is high, at an estimated 66% per year.^[122]

Recent studies by Indian Council of Medical Research (ICMR) say that the river is so full of killer pollutants that those living along its banks in Uttar Pradesh, Bihar and Bengal are more prone to cancer than anywhere else in the country. Conducted by the National Cancer Registry Programme under the ICMR, the study throws up shocking findings indicating that the river is thick with heavy metals and lethal chemicals that cause cancer. According to Deputy Director General of NCRP A. Nandkumar, the incidence of cancer was highest in the country in areas drained by the Ganges and stated that the problem would be studied deeply and with the findings presented in a report to the health ministry.^[138]

Water shortages

Along with ever-increasing pollution, water shortages are getting noticeably worse. Some sections of the river are already completely dry. Around Varanasi, the river once had an average depth of 60 metres (200 ft), but in some places, it is now only 10 metres (33 ft).^[139]

To cope with its chronic water shortages, India employs electric groundwater pumps, diesel-powered tankers, and coal-fed power plants. If the country increasingly relies on these energy-intensive short-term fixes, the whole planet's climate will bear the consequences. India is under enormous pressure to develop its economic potential while also protecting its environment—something few, if any, countries have accomplished. What India does with its water will be a test of whether that combination is possible.^[140]

Mining

Illegal mining in the Ganges river bed for stones and sand for construction work has been a long problem in Haridwar district, Uttarakhand, where it touches the plains for the first time. This is despite the fact that quarrying has been banned in Kumbh Mela area zone covering 140 km² area in Haridwar^[141]

See also

- Fair river sharing
- Ganga Pushkaram
- Gangaputra Brahmin
- Ganges in Hinduism
- List of rivers by discharge
- List of rivers by length
- List of rivers of India
- National Waterway 1
- Swach Ganga (Clean Ganga) Campaign
- Unnao dead bodies row
- River bank erosion along the Ganges in Malda and Murshidabad districts

Notes

a. Haberman (2006)

"The Ganga Action Plan, commonly known as GAP was launched dramatically in the holy city of Banares (Varanasi) on 14 June 1985, by Prime Minister Rajiv Gandhi, who promised, 'We shall see that the waters of the Ganga become clean once again'. The stated task was 'to improve water quality permit safe bathing all along the 2,525 kilometers from the Ganges's origin in the Himalayas to the Bay of Bengal, and make the water potable at important pilgrim and urban centres on its banks'. The project was designed to tackle pollution from twenty-five cities and towns along its banks in Uttar Pradesh, Bihar and West Bengal by intercepting, diverting, and treating their effluents. With the GAP's Phase II, three important tributaries—Damodar, Gomati, and Yamuna—were added to the plan. Although some improvements have been made to the quality of the Ganges's water many people claim that the GAP has been a major failure. The environmental lawyer M. C. Mehta, for example, filed public interest litigation against project, claiming 'GAP has collapsed.'"

b. Gardner (2003)

"The Ganges, also known as the Ganga, is one of the world's major rivers, running for more than 2,500 kilometres from the Himalayas to the Bay of Bengal. It is also one of the most polluted, primarily from sewage, but also from animal carcasses, human corpses, and soap and other pollutants from bathers. Indeed, scientists measure fecal coliform levels at thousands of times what is permissible and levels of oxygen in the water are similarly unhealthy. Renewal efforts have centred primarily on the government-sponsored Ganga Action Plan (GAP), started in 1985 with the goal of cleaning up the river by 1993. Several western-style sewage treatment plants were built along the river but they were poorly designed, poorly maintained and prone to shut down during the region's frequent power outages. The GAP has been a colossal failure, and many argue that the river is more polluted now than it was in 1985." (p. 166)

c. Sheth (2008)

"But the Indian government, as a whole, appears typically ineffective. Its ability to address itself to a national problem like environmental degradation is typified by the 20-year, \$100 million Ganga Action Plan, whose purpose was to clean up the Ganges River. Leading Indian environmentalists call the plan a complete failure, due to the same problems that have always beset the government: poor planning, corruption, and a lack of technical knowledge. The river, they say, is more polluted than ever" (pp. 67–68)

d. Singh & Singh (2007)

"In February 1985, the Ministry of Environment and Forest, Government of India launched the Ganga Action Plan, an environmental project to improve the river water quality. It was the largest single attempt to clean up a polluted river anywhere in the world and has not achieved any success in terms of preventing pollution load and improvement in water quality of the river. Failure of the Ganga Action Plan may be directly linked with the environmental planning without proper understanding of the human–environment interactions. The bibliography of selected environmental research studies on the Ganga River is, therefore, an essentially first step for preserving and maintaining the Ganga River ecosystem in future."

e. Puttick (2008)

"Sacred ritual is only one source of pollution. The main source of contamination is organic waste—sewage, trash, food, and human and animal remains. Around a billion litres of untreated raw sewage are dumped into the Ganges each day, along with massive amounts of agricultural chemicals (including DDT), industrial pollutants, and toxic chemical waste from the booming industries along the river. The level of pollution is now 10,000 percent higher than the government standard for safe river bathing (let alone drinking). One result of this situation is an increase in waterborne diseases, including cholera, hepatitis, typhoid, and amoebic dysentery. An estimated 80 percent of all health problems and one-third of deaths in India are attributable to waterborne illnesses." (p. 247)

"There have been various projects to clean up the Ganges and other rivers, led by the Indian government's Ganga Action Plan launched in 1985 by Rajiv Gandhi, grandson of Jawaharlal Nehru. Its relative failure has been blamed on mismanagement, corruption, and technological mistakes, but also on lack of support from religious authorities. This may well be partly because the Brahmin priests are so invested in the idea of the Ganges' purity and afraid that any admission of its pollution will undermine the central role of the water in ritual, as well as their own authority. There are many temples along the river, conducting a brisk trade in ceremonies, including funerals, and sometimes also the sale of bottled Ganga jal. The more traditional Hindu priests still believe that blessing Ganga jal purifies it, although they are now a very small minority in view of the scale of the problem." (p. 248)

"Wildlife is also under threat, particularly the river dolphins. They were one of the world's first protected species, given special status under the reign of Emperor Ashoka in the 3rd century BC. They're now a critically endangered species, although protected once again by the Indian government (and internationally under the CITES convention). Their numbers have shrunk by 75 per cent over the last 15 years, and they have become extinct in the main tributaries, mainly because of pollution and habitat degradation." (p. 275)

f. Thapar (1971)

"The stabilising of what were to be the Arya-lands and the mlechha-lands took some time. In the *Rig Veda* the geographical focus was the *sapta-sindhu* (the Indus valley and the Punjab) with Sarasvatī as the sacred river, but within a few centuries *ārya-varta* is located in the Gaṅgā-Yamūnā Doāb with the Ganges becoming the sacred river" (p. 415)

- g. Salman & Uprety (2002) pp. 172, 178–87, 387–91) Treaty Between the Government of the Republic of India and the Government of the People's Republic of Bangladesh on Sharing of the Ganga/Ganges Waters at Farakka.
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- h. The IPCC report is based on a non-peer reviewed work by the World Wildlife Federation. They in turn, drew their information from an interview conducted by *New Scientist* with Dr. Hasnain, an Indian glaciologist, who admitted that the view was speculative. See: "Sifting climate facts from speculation" (<https://www.newscientist.com/article/mg20527432.800-sifting-climate-facts-from-speculation.html>) 13 January 2010. and "Pachauri calls Indian govt. report on melting Himalayan glaciers as 'voodoo science'" (http://www.thaindian.com/newsportal/health/pachauri-calls-indian-govt-report-on-melting-himalayan-glaciers-as-voodoo-science_100301232.html) Thaindian News. 9 January 2010. On the IPCC statement withdrawing the finding, see: "IPCC statement on the melting of Himalayan glaciers" (<http://www.ipcc.ch/pdf/presentations/himalaya-statement-20january2010.pdf>) (PDF). IPCC – Intergovernmental Panel on Climate Change. 20 January 2010.
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- i. Bharati (2006)
 "The World Bank estimates the health costs of water pollution in India to be equivalent to three per cent of the country's gross domestic product. With Indian rivers being severely polluted, interlinking them may actually increase these costs. Also, with the widely recognised failure of the Ganga Action Plan, there is a danger that contaminants from the Gangetic basin might enter other basins and destroy their natural cleansing processes. The new areas that will be river-fed after the introduction of the scheme may experience crop failures or routing due to alien compounds carried into their streams from the polluted Gangetic basin streams." (p. 26)
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- j. Caso & Wolf (2010)
 "Chronology: 1985 *India launches Phase I of the Ganga Action Plan to restore the Ganges River; most deem it a failure by the early 1990s." (p. 320)
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- k. Dudgeon (2005)
 "To reduce the water pollution in one of Asia's major rivers, the Indian Government initiated the Ganga Action Plan in 1985. The objective of this centrally funded scheme was to treat the effluent from all the major towns along the Ganges and reduce pollution in the river by at least 75%. The Ganga Action Plan built upon the existing, but weakly enforced, 1974 Water Prevention and Control Act. A government audit of the Ganga Action Plan in 2000 reported limited success in meeting effluent targets. Development plans for sewage treatment facilities were submitted by only 73% of the cities along the Ganges, and only 54% of these were judged acceptable by the authorities. Not all the cities reported how much effluent was being treated, and many continued to discharge raw sewage into the river. Test audits of installed capacity indicated poor performance, and there were long delays in constructing planned treatment facilities. After 15 yr of implementation, the audit estimated that the Ganga Action Plan had achieved only 14% of the anticipated sewage treatment capacity. The environmental impact of this failure has been exacerbated by the removal of large quantities of irrigation water from the Ganges which offset any gains from effluent reductions."
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- l. Tiwari (2008)
 "Many social traditions and customs are not only helping in environmental degradation but are causing obstruction to environmental management and planning. The failure of the Ganga Action Plan to clean the sacred river is partly associated to our traditions and beliefs. The disposal of dead bodies, the immersion of idols and public bathing are the part of Hindu customs and rituals which are based on the notion that the sacred river leads to the path of salvation and under no circumstances its water can become impure. Burning of dead bodies through wood, bursting of crackers during Diwali, putting thousands of tonnes of fuel wood under fire during Holi, immersion of Durga and Ganesh idols into rivers and seas etc. are part of Hindu customs and are detrimental to the environment. These and many other rituals need rethinking and modification in the light of contemporary situations." (p. 92)
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