

Review Article

## Lockdown impact on dolphins as an aquatic health indicator and maintenance of sustainable Gangetic ecosystem: An overview

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### Abstract

A healthy ecosystem is a subject matter of interest because of its rich biodiversity. But natural climatic changes, as well as various man-made anthropogenic factors, not only emit greenhouse gases into the atmosphere resulting in global warming but influence various ecosystems of the earth. The aquatic ecosystem is one such example where the dolphin, with its complex behaviour, is recognized as one of the most intelligent members. The natural hydrodynamic body system speeds up underwater and the SONAR system communication technology helps dolphins to work as an efficient aquatic health indicator. But human activities, including aquatic poaching and fishing, creating underwater noise pollution and undesirable infrastructures and producing debris from their generated wastes obstruct the proper functioning of these systems and ultimately contribute to their habitat loss. So, dolphins' (Gangetic ones in India) disappearance from their comfortable living zone was inevitable and observed in the past few decades as they migrated to areas with more favourable conditions. The available information related to the rejuvenation in the qualities of the Gangetic water and the restoration of the dolphin's habitat during COVID pandemic confirmed the absence of the negative impact of human activities on the Gangetic ecosystem. Hence, identification of the important steps to be implemented by the concerned authorities in post-COVID situation and their maintenance by the common people is necessary to balance such important aquatic biodiversity in the long run, keeping the country's developmental activities operational. This review article is an endeavour towards that direction.

**Keywords:** Aquatic, Biodiversity, Dolphin, Gangetic ecosystem, Health indicator, Lockdown

## INTRODUCTION

Biodiversity, being the ecological life support in the successful running of different ecosystems, helps supply fresh air with all important oxygen and the clean water for living beings, conservation of which provides a strong foundation for nature protection, whatever the forms. The aquatic biodiversity related to the present work is made up of some highly interconnected ecosystem components with specific features and diversities encompassing all levels of biological organization. Maintenance of such biodiversity, which produces plant biomass from sunlight and other nutrients, provides the basic food source for all the life underwater and, in turn, is very challenging for humans. The runoff from agricultural and urban areas, various constructions etc., resulting in water diversion are identi-

fied as some major man-made barriers to freshwater environments (Cantonati et al., 2020). In larger water bodies like the sea and the ocean, vast creature population including the dolphin live in harmony maintaining the ecosystem. Here the impact of such human ecological footprints is difficult to monitor as they are not accessible to all and most importantly, they do not belong to the jurisdiction of any nation. But the Gangetic dolphin species, being at the apex of the food chain can ensure the health of the entire river environment as well as the conservation of its aquatic lives (Sinha et al., 2014) naturally. This is reflected in its safe migration through the Ganges using the specially shaped streamlined body structure and the SONAR communication system. The man-made oppositions affect these natural activities easily. On the other hand, human intervention in

different ways can severely alter the Gangetic water quality parameters to directly affect the health and hygiene of this aquatic mammal and its other water users. Their combined effects produce a serious degrading impact on the biodiversity balance of its surrounding ecosystem dictating the urgent need for the Gangetic water rejuvenation. The present study gives an overview of the required transition considering all relevant aspects.

## **GANGETIC DOLPHINS' NORMAL ACTIVITIES AND THE AQUATIC ENVIRONMENT**

### **Hydrodynamic body system and shedding**

The dolphins use their hydrodynamic body structure and desquamation activity once every two hours, to reduce the frictional drag in underwater movement, requiring substantial food for nourishment (Nagamine *et al.*, 2004). So aquatic food chain must be maintained properly, even at the lower level, to secure the supply line. This justifies the requirement of a safe and healthy aquatic environment for all living beings.

### **Practice of echolocation**

Dolphins may be seen on the water's surface but spend most of their lives in deep water. Because of the relatively poor visibility there, dolphins use echolocation to effectively find their directions by sensing sound waves and interrogating their environment. The noise-free and waste-free underwater environment can only maintain the echolocation activity properly. Such natural SONAR system helps the dolphin to identify and capture prey and they use it to coordinate their group behaviour, including warning messages sharing to each other (Branstetter *et al.*, 2012).

### **Population and distribution of the Gangetic dolphin**

The Gangetic dolphin (*Platanista Gangetica*) is the top-level predator in the Gangetic river system and was officially identified in 1801. These are found mainly in the Indian subcontinent's Karnaphuli-Sangu and Ganga-Brahmaputra-Meghna river flowing through Nepal, India, and Bangladesh. But at present, the species is extinct from most of its early distribution ranges of the river and is mainly confined in India over seven states namely, Assam, Uttar Pradesh, Madhya Pradesh, Rajasthan, Bihar, Jharkhand and West Bengal. Various estimates suggest that the Gangetic dolphin population has diminished to about 2,500 - 3,000 in India, though no exact count is available. However, the Ministry of Environment, Forest and Climate Change reported in November 2019 that there were about 962 dolphins in Assam and 1,272 dolphins in Uttar Pradesh (Dolphin population data.pdf).

## **MAN-MADE OPPOSITIONS: PRE-LOCKDOWN SITUATION**

### **Effect on the dolphin population**

The data indicate that dolphin's survival is increasingly at stake as they face several oppositions in their daily lives (file:///D:/folder-h/iswmaw%20Publ/Dolphin%201.pdf). Direct killing for meat and oil for medicinal purposes and incidental capture in fisheries – the by-catch are two short-term processes that reduce dolphin numbers instantaneously. But there are other human interventions which create long-term effects in the aquatic environment and hence reduce their survival probability more drastically.

### **Noise pollution**

As hearing is identified as the dolphin's most important sense for active echolocation, noise pollution affects the dolphin's natural movement. Common man-made underwater noise arises from shipping traffic, air-gun use for seismic surveys and military sonars, which mask natural biological and ambient levels of sound in its environment. Their potential impacts range from physical damage to the dolphins to their changed behaviour with increasing stress and displacement from their habitats, which may seriously affect the dolphin populations. (Mallik *et al.*, 2022).

### **Chemical pollution**

Waste Chemicals from domestic sewage, agricultural run-off, waste sites' seepage, and accidental spills at water bodies regularly emerge from agricultural and industrial discharges and operational discharges from mines and oil rigs. Additionally, persistent organic pollutants from commercial sectors, including pesticides like DDT, along with municipal liquid waste into the Ganges, cause mainly physical, chemical and microbial contamination of its water (Hossain, *et al.*, 2020). Its impact ranges from the dolphin's habitat degradation (Sinha *et al.*, 2014) to direct physical poisoning, resulting in the damage of its reproductive and immune systems along with other aquatic mammals which may lead to their increased mortality (Nabi *et al.*, 2022).

### **Water management techniques**

For dolphin species with limited movement range like the Gangetic dolphin, habitat loss appears very critical, which is also caused by various water management techniques like construction of dams, barrages, fishing structures, major river modifications, flood control, and abstraction of water for human use. Additionally, rainfall deficiency, with a minimum during the lean season from December to May, causes less discharge and water flow into the river. These affect the Ganges' self-cleaning processes degrading its water quality. Less flow and rainfall result in an insufficient depth of the

**Table 1.** Status of flow obstructions, water abstractions & pollutions from industry

Man-made constructions in the Ganges & its tributaries	Purpose & Output	Industrial sources of pollution	Water quality of the Ganges at various locations
In India, there are 39 hydroelectric projects in the Ganga basin, where no. of major and minor projects are 27 and 12 respectively. One such example is mentioned below as	As mentioned by the statistics of All India installed capacity of power stations of March 2020, hydropower was found to constitute about 23.01% of the total power production	The wastewater discharged into the Ganga basin is ranged between 6500-6700 MLD (Minimal Liquid Discharge) in its middle and downstream stretch, where around 20% is toxic load and comes from industries which include Effluents from	Industrial effluents alone account for about 12% of the total volume in the river Ganga and so the water quality was found to be unfit for even bathing at most of the monitoring centers along the river except the upper stretches in Uttarakhand till Haridwar.
Tehri Dam on Bhagirathi	Hydropower generation (total installed capacity of 4987 MW is in operation at present) & water discharge regulation during lean season	i) Distilleries, Tanneries in Kanpur ii) Paper and Sugar Mills in the Yamuna, Kosi, Ramganga and Kali river catchments	In fact, the water for the remaining stretch had always been placed in Class B till it merged into the Bay of Bengal, since the state of Uttarakhand was formed in the year of 2000
Bhimgowda Barrage at Haridwar over the Ganga	Diverts a large amount of water into the Upper Ganga Canal to provide water for irrigation in Uttarakhand and Uttar Pradesh		
Bijnore Barrage, 76 km downstream of Haridwar	Diverts water into the Lower Ganga canal		
Narora, about 155 km downstream of Bijnore Barrage	Diverts water into the Lower Ganga canal		
Barrage at Kanpur	Diverts Ganga to meet the drinking water requirements.		

Data on the same row of column 1 fits with column 2 whereas columns 3 and 4 supplement each other; Data Source : [Dutta et al. (2020), Acharya et al. (2016) and Kamboj et al. (2019) ]

Ganges (National Water Policy, Government of India, Ministry of Water Resources, Clause 3.3 of India's National Water Policy Sedimentation, (2012)). Only 38.7% of the river stretch was found to have a depth of 4 m or above (Dutta. *et al.*, 2020), which prevents dolphin migration, confining them to few fragmented and non-supportive habitat, which ultimately lead to their population decline (Singh *et al.* 2022), ([https://nmcg.nic.in/writereaddata/fileupload/34\\_GangeticReport.pdf](https://nmcg.nic.in/writereaddata/fileupload/34_GangeticReport.pdf))

### Climatic change

Global warming causing an apparent temperature change rate of around (3-4) °C in higher latitudes within the last few decades appears too fast for the dolphins to adjust after exposure. Higher water temperature and climatic change are compounded to produce the sea level rise and changing weather patterns with greater storminess and result in habitat degradation with impact on the prey availability and loss of the ocean and sea dolphins (Wild *et al.*, 2019). But for Gangetic dolphin population, this effect may not be too severe.

### Effect on the Ganges

Originating from the Himalaya's Gangotri glacier, India's National River, the Ganges passes through a huge population belt accommodating around 43% of its population and ultimately falls into the Bay of Bengal (Dutta *et al.*, 2020). This uncontrolled and unplanned growth of urbanisation produces several large-scale anthropogenic factors, as mentioned. Net effect modifies its bio-geomorphological functions (Sinha *et al.*, 2017) significantly. The detailed assessment (<http://cwc.gov.in/sites/default/files/ganga-river-basin-assessment-report.pdf>, 2018) must be followed to identify possible management strategies for optimization of the use of the Gangetic basin water resources for its socio-economic benefits, obviously after protecting the Gangetic ecosystem. One such important indicators is the fishery which extracts habitat suitability information from an ecological point of view. Water management processes and increasing pollution, mainly the industrial ones, affect the river Ganges by making its water unfit (Dutta *et al.*, 2020 ; Acharya *et al.*, 2016 ; Kamboj *et al.*, 2019) for a healthy ecosystem (Table 1) . The

data for water abstractions and diversion reveal that up to 60% of the annual flow of the main stem of the Ganges and its tributaries had deviated towards different irrigation canals (Shah *et al.* (2019)).

### **GANGETIC DOLPHIN AND ITS HABITAT QUALITY TRANSFORMATION IN COVID 19 PANDEMIC**

Various human activities, as discussed above, were found to severely influence the dolphin's natural intelligent behaviour and its capability to indicate the health of its habitat when the Gangetic ecosystem and its biodiversity protection are kept in focus. The study revealed that the absence of human activities on natural water flow during the unprecedented COVID-19 outbreak and the imposed lockdown in 2020 helped maintain this aquatic creature's normal growth and movement (Mallik *et al.*, 2022). At the same time, the Gangetic water quality parameters' updated data (Table 2) during the lockdown in different stretches along its flow line confirmed significant improvement compared to pre-COVID situations (Sinha *et al.*, 2014; Dutta *et al.*, 2020; Balamurugan *et al.*, 2021). So it is clear that countrywide closure in all sectors incidentally initiated the process of the Gangetic water quality upgradation, thus naturally reviving the Gangetic dolphin's habitat (Singh *et al.*, 2022), which previously adapted methods failed to achieve. Pre-COVID and COVID-time data related to human's obstructions and interferences (Table 1) and their absences (Table 3) verified and substantiated the changes. As a result, dolphins were spotted, after long years of gap, at various locations along the river. The manifestations of such a two-fold effect of lockdown on the Gangetic ecosystem need to be scrutinised for the identification of necessary measures for the future.

### **LOCKDOWN AND ITS IMPACT**

#### **Gangetic Water quality**

The COVID-19 pandemic disrupted daily activities across multiple sectors globally. But it showed a very positive impact, though at the preliminary level, on water resources, including the Gangetic water system, from its biodiversity maintenance point of view. Analysis of collected water samples (Table 2) from different sites of the Gangetic flow line revealed a notable level of improvement in water quality parameters, which included a significant increase in the dissolved oxygen (DO) levels, a decrease in biological oxygen demand (BOD) and total coliforms (TC) level (Dutta *et al.*, 2020; Mukherjee *et al.* (2020) ; Roy *et al.*(2021), Dhar *et al.* (2020) ) during the lockdown period. The shutdown of major industries and agricultural activities reduced the production of industrial pollutants and solid waste for nationwide closure from March 23, 2020 to September

30, 2020. ([https://loksabhadocs.nic.in/refinput/new\\_reference\\_notes/english/06072020\\_130\\_300\\_1021205239.pdf](https://loksabhadocs.nic.in/refinput/new_reference_notes/english/06072020_130_300_1021205239.pdf)), (<https://dst.gov.in/study-shows-significant-reduction-heavy-metal-pollution-during-covid-19-pandemic>). Also analysis of rainfall data indicated that during ([https://mausam.imd.gov.in/Rainfall/DISTRICT\\_RAINFALL\\_DISTRIBUTION\\_COUNTRY\\_INDIA\\_cd.pdf](https://mausam.imd.gov.in/Rainfall/DISTRICT_RAINFALL_DISTRIBUTION_COUNTRY_INDIA_cd.pdf)) March 1 to May 6, 2020, most of the districts under the Gangetic basin observed up to 60% excess rainfall than the normal, contributing to the increased discharge and hence in flow volume in the river which diluted the pollutants. Incidentally, around eight weeks of the total lockdown period coincided with the harvesting season, so the agricultural sector did not withdraw much water, thus contributing to further flow enhancement in the Ganges. It may be considered, as an example, that in April 2020, the water in Yamuna increased to 3900 cusecs compared to its previous year value of 1000 cusecs (Dutta, *et al.*, 2020).

As industrial and commercial operations during lockdown were completely stopped, there was a massive reduction in electricity demand which caused a dip in hydropower production and hence allowed more water releases into the river. According to the Power System Operation Corporation in India, electricity production fell by 32.2% to 1.91 kilowatt-hours/day compared to the 2019 levels (<https://www.downtoearth.org.in/news/energy/covid-19-daily-electricity-demand-dips-15-globally-says-report-70904>, 2020).

So taking together, these lockdown-time effects resulted in an overall increase in the Ganges' baseflow, enhancing the river's self-cleaning process and the smooth movement of the dolphin.

It must be mentioned that domestic sewerage discharge characterized by a large amount of organic matter (protein, fat, starch, and urea), pathogenic microorganisms, and suspended matter (Youzhou, 2021) was not reduced during this period as expected (<https://dst.gov.in/study-shows-significant-reduction-heavy-metal-pollution-during-covid-19-pandemic>). According to the National status of wastewater generation & treatment and from observed variation in flow and organic load of domestic priority drains, the amount discharged into the Ganges was found to be 403.21 MLD in the state of Uttarakhand (along the stretch of Gangotri to Haridwar) during the pre-monsoon period of 2018. On the other hand, the sewage generation during the 2020-21 lockdown was reported to be 495 MLD in the same state ( [https://www.cpcb.nic.in/ngrba/identified\\_drains\\_postmonsoon-2018.pdf](https://www.cpcb.nic.in/ngrba/identified_drains_postmonsoon-2018.pdf)) when industrial effluents were not significant. As wastewater treatment removes mainly organic matter and nutrients, the organic pollution level from domestic sewage during lockdown is diluted in the river comparatively faster than the inorganic pollution, which comes mainly from the chemical pollution of the industries. These contain high chemical oxygen

**Table 2.** Water quality parameter comparisons of the mainstream of the river Ganges during 2019 [pre-lockdown, PL (March-May) 2019] and 2020 [lockdown, L (March-May)2020] (Average values)

Ganges at	BOD (mg/L)	DO (mg/L)	Total coliform (MPN/100 mL)
Kannauj (u/s)	2.93(PL) 2.1(L)	8.2 (PL) 8.77(L)	4000 (PL) 3700 (L)
Kanpur (u/s)	3.37(PL) 2.9 (L)	8.43(PL) 7.8(L)	4167(PL) 4333(L)
Varanasi (Rajwari)	3.2(PL) 3.43(L)	7.77(PL) 8(L)	15,000(PL) 11,333(L)
Patna	2.1(PL) 1.8 (L)	NA	13000(PL) 1400 (L)
Murshidabad (Behrampore)	2.7(PL) 0.2(L)	7.08(PL) 7.53(L)	210,000(PL) 6500(L)
Howrah bridge	3.44(PL) 1.75(L)	5.86(PL)	73,417(PL)50,000(L)
Babughat	NA	4.0 (PL) 6.3(L)	10,942.5(PL) 2,225(L)
Diamond Harbour	3(PL) 1.2(L)	6(PL) 12 (L)	NA

[Data source:Uttar Pradesh Pollution Control Board as used by Dutta et al. (2020), & Mukherjee et al. (2020) , Roy et al.(2021), Dhar et al. (2020) ] NA - Not Available

demand (COD) to destroy the river's self-cleaning properties (Bhaskar *et al.*, 2020). During the lockdown, in the absence of industrial pollution, such self-recovery characteristics of the Ganges thus improved, contributing to the enhancement of water quality.

#### Aquatic life

As the nationwide lockdown rejuvenated the Gangetic water quality, the effects of various potentially distressing factors on the health of the Gangetic ecosystems were revived. It was confirmed by the reappearance of dolphins along various stretches of the Ganges. They got plenty of food and moved smoothly from one place to another in the clean and peaceful river as human interference was drastically reduced. Both of these factors of Gangetic water quality improvement and the reappearance of dolphins are correlated and reported in Table 3, as per the observation of the Uttarakhand Pollution Control Board and the Central Pollution Control Board from various monitoring stations (<https://ueppcb.uk.gov.in/pages/display/96-water-quality-data-2020>).

#### ACTIONS TAKEN TO SAVE THE GANGETIC ECOSYSTEM & ITS HEALTH INDICATOR

##### Pre-lockdown initiatives

In 1985 the Ganga Action Plan was launched in which the Gangetic dolphin was included after one year as a priority species in the First Schedule of the Indian Wildlife (Protection) Act 1972 to stop its hunting and to provide conservation facilities by establishing dolphin sanctuary. Vikramshila Gangetic Dolphin Sanctuary (VGDS), the protected area for the endangered Gangetic dolphins in Asia, was established in the Bhagalpur district of Bihar in 1991 under this Act, where half of the total population was found. World Wildlife Fund (WWF)-India identified a total of 9 stretches from the foothills of Arunachal Pradesh up to Dhubri

near the Bangladesh Border and in the states of Bihar, Uttar Pradesh, and Madhya Pradesh as optimal habitats for the Gangetic dolphin population. ([https://www.wwfindia.org/about\\_wwf/priority\\_species/threatened\\_species/ganges\\_river\\_dolphin/](https://www.wwfindia.org/about_wwf/priority_species/threatened_species/ganges_river_dolphin/)).

But direct killing, habitat pollution and its fragmentation by dams and barrages, indiscriminate fishing continued to decline its numbers where lack of awareness and, increasing anthropogenic pressures, absence of a well-coordinated conservation plan became prevalent. As a result, the International Union for the Conservation of Nature retained the Gangetic dolphin in their endangered species list.

Later, the Conservation Action Plan of Government for the Gangetic Dolphin 2010-2020 ([https://nmcg.nic.in/writereaddata/fileupload/34\\_GangeticReport.pdf](https://nmcg.nic.in/writereaddata/fileupload/34_GangeticReport.pdf)) identified the effect of irrigation canals, depletion of prey base, and impact of river traffic on dolphin populations. The National Mission for Clean Ganga (NMCG), implementing the government's flagship scheme Namami Gange (2014), took some initiatives, including celebrating 5<sup>th</sup> October as National Ganga River Dolphin Day to raise consciousness among all. Some significant improvements around the Ganges in Kanpur have also been experienced under this scheme. The Sisamau drain, the highest source of untreated municipal sewage with 183.29 MLD discharge rate passing through the densely populated Kanpur city, was used to discharge into the Ganges. In 2019, the Namami Gange project stopped the drain, significantly reducing water pollution. In December 2019, 8 large drains discharging untreated wastewater of Kanpur into the Ganges were tapped and diverted to the Sewage Treatment Plants to reduce Gangetic pollution (Dutta *et al.*, 2020).

##### Post-lockdown proposals

The Gangetic water quality improvement along its various stretches during the lockdown period was not experienced earlier in the last 30-40 years when various ambitious government schemes utilised a handful of

budgets. So temporary lockdown effect in retrieving a healthy Gangetic ecosystem must deserve more attention to maintain similar river conditions in post-lockdown, as observed during the lockdown. Accordingly, the following steps should be practised religiously. The Gangetic water quality improvement has been experienced especially in and around the urban areas and industrial clusters (<https://pib.gov.in/>

PressReleasePage.aspx?PRID=1881830). Removal of chemical pollution and reducing toxic load by stopping untreated sewage and effluents from falling in the river is must. Such pollution basically destroys aquatic animals living near the bottom of the food chain, ultimately affecting the population of top-level predators like dolphins and thus the aquatic biodiversity.

The lockdown period witnessed larger rainfall than the

**Table 3.** Water quality revival at lockdown and reappearance of the Gangetic health indicator

Water quality before lockdown at locations of	Water quality during lockdown	River & State	Reappearance of Dolphin population during lockdown in 2020
Uttarakhand, after its formation in 2000, the water had always been listed as Class B	DO, BOD and Total coliform (TC) level were within the prescribed level between Rishikesh to Haridwar and ranked as Class A for the first time in the last two decades & declared as fit for drinking	Chambal, tributary of the Yamuna at Madhya Pradesh, Uttar Pradesh, and Rajasthan	Dolphin population increased, where 82 adults and 20 calves were spotted in river Chambal for the first time in six years, according to the Annual Animal Survey in Chambal river conducted by three states.
the upstream of Kanpur, water was found highly polluted	A noticeable improvement observed during the lockdown because of the shutdown of the industrial and commercial sectors along the stretch with a reduction of about 1300 to 1340 MLD of industrial waste water making the Ganga cleaner.	The Ganges at Uttar Pradesh	Gangetic Dolphins were seen at Katarniaghat in the Terai belt of the state. The census found a total of 41 dolphins in the Gangetic stretch between Bijnore and Bulandshahr Narora Barrage, with an increase in population of 4 calves and 2 adults from the previous year, showing healthy population growth
monitoring locations of Uttar Pradesh (except Bijnore) reported increasing trends in the ammoniacal nitrogen observed values, the toxic pollutant	Increased discharge of the untreated and partially treated wastewater from municipal sewage and slower dilution rate during initial period of the lockdown, though the locations later showed ammoniacal nitrogen level less than the prescribed level of 1.2 mg/L limit.		
36 monitoring stations along the main channel of Ganges recorded large TC and Faecal coliform (FC) counts making the water quality unfit even for bathing, with the exception at upper stretches in Uttarakhand till Haridwar.	Most of the stations recorded large reductions in the TC and FC counts, water quality improved between Haridwar and Kanpur and found suitable for bathing (Class B) at 27 monitoring stations, 9 more stations were found suitable for propagation for wildlife and fisheries (Class C)	Ganges in West Bengal  Ganges at Bihar	Gangetic dolphins were spotted at Babughat, Kolkata, after 30 years.  Gangetic dolphins had become more visible in the Vikramshila Gangetic Dolphin Sanctuary (VGDS), 60 km long segment of the middle Ganges River in Bihar

\*1 (Uttarakhand), 21 (Uttar Pradesh), 4 (Bihar), 10 (West Bengal)

Data on the same row of column 1 fits with 2 whereas columns 3 and 4 supplement each other

Data Source : [Dutta *et al.* (2020), Choudhary *et al.* (2022). <https://timesofindia.indiatimes.com/travel/things-to-do/lockdown-effect-gangetic-dolphins-spotted-at-kolkata-ghats-after-30-years/articleshow/75375783.cms>, <https://www.indiatimes.com/news/india/india-gangetic-dolphin-count-rises-to-41-525065.html>, <https://www.hindustantimes.com/cities/bhopal-news/lockdown-revives-aquatic-life-in-chambal-river-101624287337996.html> ]

average time, resulting in more flow in the Ganges with better prospects for diluting the pollutants. It might be related to the reduced anthropogenic emissions caused by the COVID-19 restrictions. The lockdown favoured the hydrological cycle over India and other South Asian countries, which started facing water scarcity in the past decades. It was estimated that aerosol concentrations over Asia played a key role in modulating the Indian summer monsoon rainfall (Fadnavis *et al.* (2021)). For proper Gangetic flow maintenance, various constructions along its flow line should also be minimised, enhancing self-cleaning processes, maintaining the required depth of the Ganges and hence the healthy habitat by reducing its fragmentation and encouraging smooth movement of its animals, including the dolphin. Any activities which might increase water temperature, harming its habitat, should not be encouraged as well. For a long-term solution, an initiative must be taken for proper environmental regulation implementation, so far as the revival of the Gangetic River's health is concerned. But major schemes regarding the regulation of the highly polluting industries operating in the river's catchments are still awaited. The requirement for discharge norms and standards compliance should be reviewed and accompanied by strong enforcement of laws and regulations for proper monitoring and vigilance. Here spreading the message of awareness through campaigning for the common people and by involving the fishermen and the people living on the riverside can only produce the desired output of the projected conservation plans of the concerned authorities.

## Conclusion

Positive impacts of the countrywide lockdown effect of COVID 19 pandemic on India's national river, the Ganges and its health indicator, the Gangetic Dolphin, which is incidentally India's national aquatic animal, are reviewed here considering all possible environmental aspects. The restoration of the dolphin population along the various stretches of the Ganges, during the lockdown period provided a primary indication of the improvement in the pollution status of the Gangetic ecosystem. State and central pollution control boards' information on the Gangetic water quality validated the possibility. Accordingly, a detailed search and study helped to identify a few necessary steps to be implemented in the post-pandemic situation to improve and maintain the health of the Gangetic environment. Industrial effluents and municipal and domestic wastes containing toxic chemicals generated in the region on and around the banks of the Ganges must be treated properly following necessary and stringent environmental regulations before falling into the Ganges. Additionally, building dams and other constructions in numbers

for water diversion or hydroelectricity production along the river and water abstractions for irrigation need to be controlled. It will help maintain the required flow and depth of the Ganges, which can activate the Ganges' self-cleaning capability and preserve the habitats of its aquatic lives, including the dolphin. Also less environmental pollution during lockdown may be related to the more rainfall during the pandemic, which may be considered as the blessing of nature contributing to the country's developmental paradigms, lifestyles and economic pursuits as nobody wants the improvement in the ecosystem to happen at the cost of a pandemic.

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## Conflict of interest

The authors declare that they have no conflict of interest.

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