



Research Paper

Impact of Construction of Waterways on the Gangetic Dolphins: An Overview

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ABSTRACT: The fascinating Gangetic dolphin, *Platanistagangeticagangetica*, is distributed in the Ganges-Brahmaputra-Meghna and Karnaphuli-Sangu river systems of India, Bangladesh, and Nepal. The Gangetic dolphin is an important creature since it is not only an indicator species for the river ecosystem, but also occupies the apex position in the aquatic food chain. Their habitat is severely fragmented due to dams and barrages, poaching, habitat degradation, river water pollution, accidental killing and over-exploitation of prey. Further, the dry season water depth in Ganges has severely diminished in recent years due to higher water allocation to canals for drinking and irrigation projects. In 2016, the Government of India proposed the National Waterways Act, initiating the construction of 111 inland waterways, along a total length of about 20,275 kilometers across twenty-four states and two union territories of India. The Ganga watercourse, also called the National Waterway 1 or NW1 (Varanasi-Haldia stretch), is being designed to transport passengers and cargo from the eastern seaport of Haldia to Varanasi, about 1,360 km inland. Of the total 111 inland waterways proposed, 38 are habitats of the Gangetic dolphins.

The proposed scale of development –the two-way movement of large barges including intrusive methods of making the river navigable –has the potential to destroy the dolphin habitats in these water bodies. Without a habitat, these dolphins cannot be saved. This paper primarily focuses on the impacts of dredging, vessel traffic, and pollution resulting from the construction of National Waterways on the endangered Gangetic dolphins.

Keywords: National Waterways, Gangetic Dolphins, Dredging, Pollution, Vessel Traffic, Habitat Fragmentation, India

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I. INTRODUCTION

The Ganges river dolphin *Platanistagangeticagangetica*, commonly known as susu, inhabits the Ganga-Brahmaputra-Meghna and Karnaphuli-Sangu river systems of India, Nepal and Bangladesh, and the area between the foothills of the Himalaya and the estuarine zone (Sinha and Sharma 2003). This species has already become extinct from the majority of its previous distribution ranges and the range is further declining due to various anthropogenic factors (Jones 1978; Choudhary et al. 2012). Since 2004, the Ganges river dolphin is categorized as endangered, and is recorded in the IUCN Red List due to decline in its range and population size (IUCN 2004; Smith et al. 2012). All of the three Asian species of freshwater dolphins are categorized as endangered or critically endangered. In decreasing order of the level of threat experienced, the species are baiji (*Lipotesvexillifer*) in River Yangtze of China (population: a few tens), bhulan (*Platanista minor*) in River Indus of Pakistan (population: a few hundred), and susu (*Platanistagangetica*), population about 1200 – 1800. Although there is no reliable estimate of dolphin population for the Ganges system, during an earlier study, the total population of Gangetic dolphins was crudely estimated to be ranging between 4000-5000 (Jones 1982; WWF 2017). According to WII (2018), dolphin population was about 10000 during late 19th century, which reduced to 3526 in 2014. The population of dolphins stabilised between 2012 to 2015, however, the dolphin population has dwindled significantly in recent years. A total of about 2000 dolphins have been estimated in the Ganga-Brahmaputra river systems in the Indian subcontinent (Sinha 1999). The fourth freshwater species, boto (*Zniageoffrensis*) is found in the Amazon River System in South America, population of which is estimated to be about 5000. These four species, together make up the only freshwater dolphin species in the world. As their

name suggests, river dolphins live only in fresh water, their physiological and ecological requirements apparently make it impossible for them to live in marine waters. In 2010, the Government of India declared the Gangetic dolphin as the 'National Aquatic Animal', cementing its importance to India's natural heritage.

Surveys of river dolphin populations and their distribution range have been ascertained through several studies (Sinha et al. 2000; Behera 2006; Choudhary et al. 2006). There is no credible estimate of range-wide abundance, however, the long-term observations have helped in identifying broad habitat requirements of the species (Smith and Braulik 2008; Smith et al., 1994, 2009, 2010). Dolphins have been sighted throughout the Ganga from the Middle Ganga Barrage, Bijnor (129 km downstream of Haridwar) to Sagar Island in the Bay of Bengal (Sinha and Sharma 2003). More than half of the Gangetic dolphins in India (over 3,000 at present) survives in a 500-km stretch of the Ganges in Bihar (Sinha et al. 2010a). There have been no recent dolphin reports between the Middle Ganga Barrage at Bijnor and the Bhimgoda Barrage near Haridwar. The presence of Gangetic dolphins in the specific river stretches indicates a healthy riverine ecosystem as it signals greater biodiversity due to its position at the apex of the aquatic food chain (Wakid 2009). It is also due to the fact that Gangetic dolphins share their habitat with crocodiles, water turtles and wetland birds, and most of these are dependent upon fishes. Vikramshila Gangetic Dolphin Sanctuary, a 60 km stretch of the Ganges river from Sultanganj to Khalgaon located in Bhagalpur district of Bihar, comprises the only protected Asian area that aims to protect and conserve the Gangetic dolphins (Choudhary et al. 2006; Das and Maurya 2015). This stretch supports a rich biodiversity of phytoplanktons and zooplanktons. Recently, workers have estimated the population of the Gangetic dolphin in different parts of the Ganga River and its tributaries, e.g., Girwa river in Katarniaghat Wildlife Sanctuary in Uttar Pradesh, Chambal river (Pali-Pachnada), Yamuna river (Pachnada-Allahabad), Ghaghara river, Saryu river and Rapti river (Singh and Behera 2018). Dolphin presence was reported in about forty per cent of segments in the Gandak river, with a best count of 257 (range 250–267) and average individual encounter rates at 0.75 dolphins/km (Choudhary et al. 2012).



Figure 1: *Platanista gangetica* (The Gangetic dolphin) as seen in their natural habitat in Ganges
Source: Sinha 2018; Bangladesh Cetacean Diversity Project

In the recent years, due to increasing anthropogenic activities such as habitat degradation, dams barrages, and pollution along with mortality in fishing nets are expected to have an adverse effect on their future populations (Figure 2). According to Sinha and Sharma (2003) siltation and construction of the barrage can be identified as the primary reason behind habitat degradation of dolphins in Son and the Kosi rivers during a survey conducted in February and March 2001. According to the study, local fishermen reported absolute elimination of the dolphin population in the 100 km stretch of the Son from Uttar Pradesh - Bihar border to the Son Barrage at Indrapuri. In the monsoons, the dolphins migrated for approximately 200 km from the main stem of the Ganges into the Son River, right up to the barrage. Around 87 dolphins were reported in the whole stretch of about 300 km between the Kosi Barrage at the Indo-Nepal border and its mouth at Kursela in Bihar (Sinha and Sharma 2003). A survey conducted during the late 1990s in the lower reaches of the Ganga in West Bengal reported exactly 152 dolphins in the Bhagirathi-Hooghly river system downstream of Farakka Barrage (Sinha 1997). A 300km long stretch downstream of Farakka Barrage has very low flow during dry seasons due to insufficient release of water which has eliminated their habitat until the Ganges-Brahmaputra confluence brings sufficient water. The salt-water intrusion into the Sunderban delta due to insufficient siltation after Farakka Barrage came into existence has also caused decline in their population. It is reported that the highest number of dolphins persevere in the mainstream of Ganges between Allahabad and Farakka with very sparse population between Narora and Allahabad (Sinha et al. 2000). Their population between two barrages at atBijnor and Narora (166 km) in Uttar Pradesh is between 35 and 39 (Table 1).

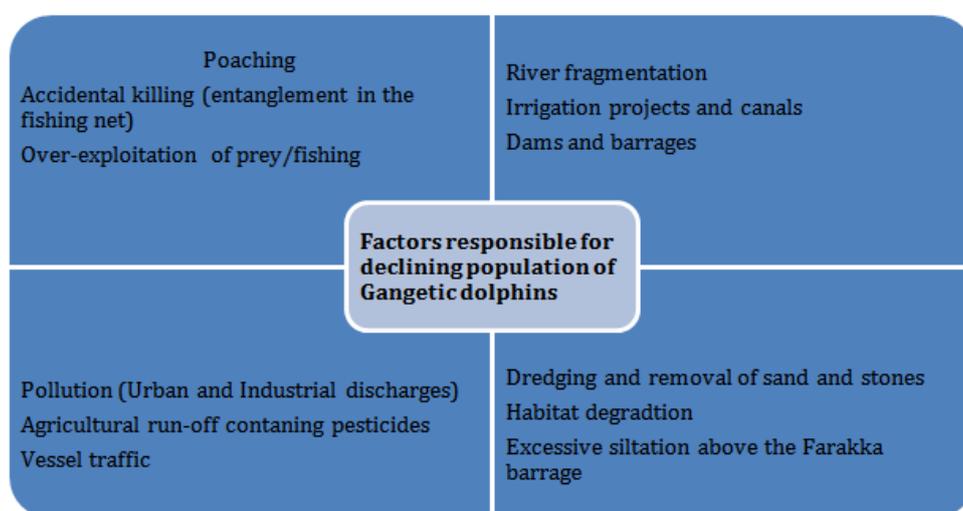


Figure 2: Factors responsible for declining population of Gangetic dolphins

Gangetic dolphins are prone to being trapped in gillnets because their habitat of choice coincides with locations where fishing is done on a large scale. It was recommended to encourage the promotion of community-based fishing cooperatives which could award regulated ownership rights to certain river sections in exchange for utilizing sustainable fishing techniques that are less harmful to dolphins (Choudhary et al. 2006).

Table 1: Stretch in the Ganga river system where Gangetic dolphins have been reported

River Systems of Ganga Plain	Stretch where dolphins were reported	Estimates of population size
Ganga River	Between Haridwar – Bijnor barrage	completely disappeared WII (2018)
	Between Bijnor and Narora in Uttar Pradesh	35–39 (Behera and Mohan 2005; Behera 2006)
	Between Narora Barrage and Anupshahar	28 (Bashir et al. 2010)
	Between Narora and Kanpur	Nil (Sinha 1999)
	Allahabad to Buxar	204 (Sinha 1999)
	Vikramshila Gangetic Dolphin Sanctuary, 60 km stretch between Sultanganj to Kahalgaon	81–92 (Sinha et al. 2000) 88–174 (Chaudhary et al. 2006)
	Buxar to Manihari ghat	808 (Sinha et al. 2010a)
	Manihari ghat to Farakka	115 (Sinha 1999)
	Waterways in the Sunderbans forest	196–225 (Smith et al. 2006)
Yamuna River	Chambal river to Yamuna-Ganga confluence at Allahabad	31 (Sinha et al. 2010a)
Chambal River	Batesura and the confluence of the Yamuna River	45 (Singh and Sharma 1985)
Gandak River	40% of segments in the Gandak River between	250–267 (Chaudhary et al. 2012)

	Gandak barrage to the confluence of Ganga, near Patna	
Ghaghara River	Girijapuri Barrage to Deorighat	295 (WWF-Nepal 2006)
Son River	Post construction of the barrage at Indrapuri in 1965, dolphin migration came to a halt and no more dolphins are sighted now. At Koilwar, 15-20 dolphins were reported during the monsoon, but wiped out due to drift gillnets with large mesh size used for fishing	nearly wiped out (Sinha and Sharma 2003)
Kosi River	from Kosi Barrage at Birpurat the Indo-Nepal border to Kursela in Bihar	87 (Sinha and Sharma 2003)

II. OVERVIEW OF INDIA'S INLAND WATERWAYS PROJECTS

About 111 Inland National Waterways (NWs) covering around 20,275 km have been identified in India for inland water transport including cargo as well as passenger / cruise vessels as per The National Waterways Act, 2016. NW1 covers a distance of 1620 km on Prayagraj-Haldia stretch of the Ganga-Bhagirathi-Hooghly Rivers passing through UP, Bihar, Jharkhand and West Bengal. The purpose of the development, as put forth by the Government of India, is to utilize these waterways as an 'environment friendly and sustainable mode of transport' (PIB 2016). Waterway development is planned to occur alongside river interlinking and construction of more barrages. Until this happens, the plan is dependent on mechanized dredging of river bottom sediment to maintain minimum depths for passage for large vessels. The implementation of the water development project would also include the construction of more barrages along the river along with heavy dredging of silt to maintain a width of 45 metres and a depth of 3 metres. This navigability would enable passage for barges carrying 1500-2000 tonnes of cargo.

The Jal Marg Vikas Project has also been initiated for increasing the capacity of National Waterway-1 (river Ganges) from Haldia to Varanasi (Gadkari 2017). The aim of the project is to enable the movement of 1500-2000 tonne vessels. The project is scheduled to be completed by 2022 with technical and financial aid from World Bank, approximately costing Rs. 5369 Crore (USD 745.69 million). An inevitable consequence of the Jal Marg Vikas Project is the colossal increase in vessel traffic and river pollution, which will have a dire impact on the Gangetic dolphin population. The intended development of inland waterways overlaps with approximately 90% of the endangered dolphin population (Rao, 2016). Systematic operations risk-rating as assessed for NW1 is provided in Table 2.

Table 2: Systematic operations risk-rating as assessed for National Waterway- 1

Risk Category	Current Rating
Political and Governance	Moderate
Macroeconomic	Low
Sector Strategies and Policies	Moderate
Technical Design of Project or Program	Considerable
Institutional Capacity for Implementation and Sustainability	Considerable
Fiduciary	Considerable
Environment and Social	Severe
Stakeholders	Considerable
Other	Low
Overall	Considerable

Source: Arnab (2019)

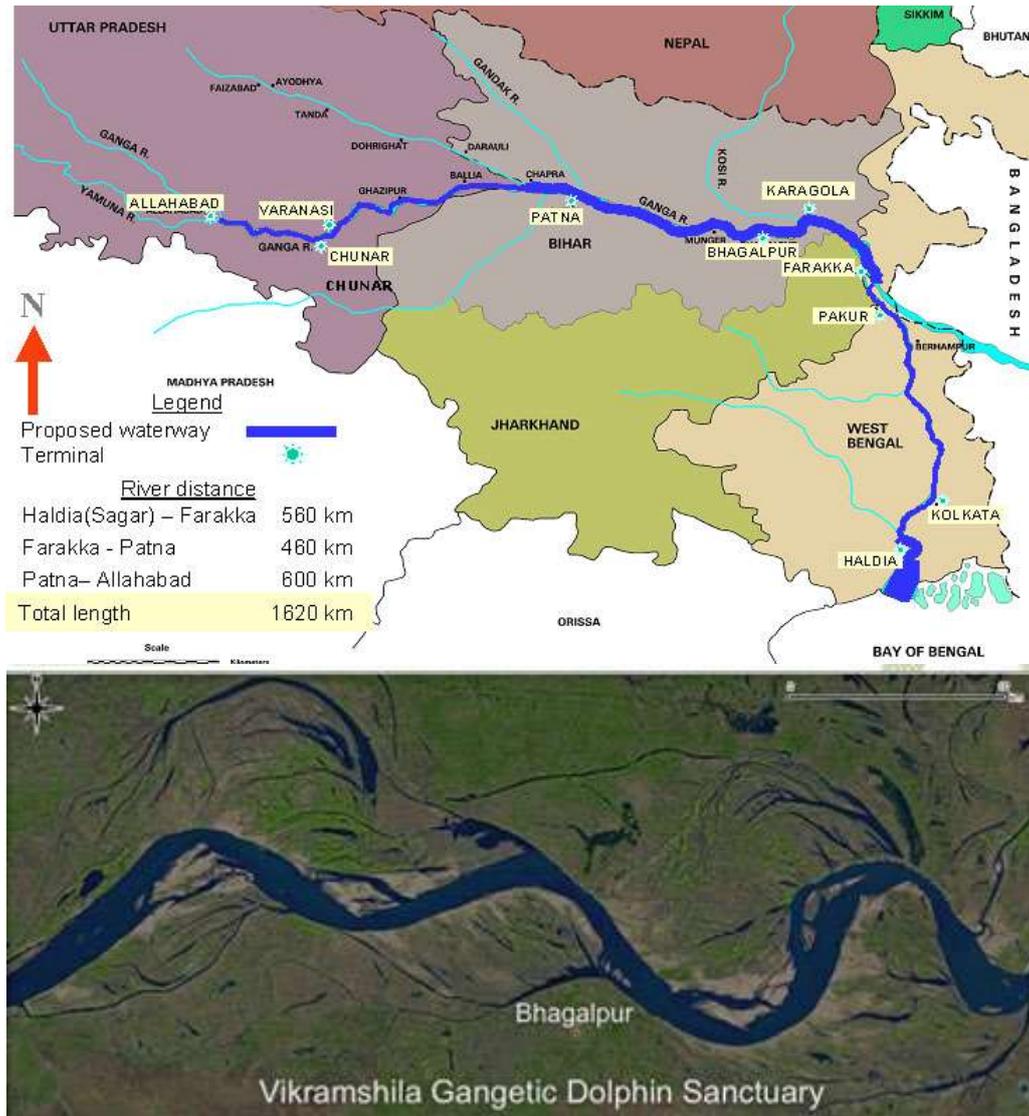


Figure 3: National Waterways 1 on Ganges and stretch of Vikramshila Gangetic Dolphin Sanctuary

III. DEPENDENCE ON ECHOLOCATION

Evolutionary adaptation to a fluvial environment often with in silty and cloudy waters has resulted in a regression of the eyes of Gangetic dolphins (Sinha and Sharma, 2003). They can merely sense the direction of diffuse light due to the absence of crystalline eye lens. This led to the development of a sophisticated echolocation system. Gangetic dolphins are heavily dependent on echolocation for most of their activities- navigating, feeding, avoiding danger, finding mates, breeding, and nursing babies. Gangetic dolphins cannot chew their prey – usually fishes and shrimps, and hence swallow them. They catch their prey by emitting ultrasonic sound to guess distance and size. Habitat suitability factors and preference for Gangetic dolphins are summarized in table 3.

The intended development of inland waterways overlaps with approximately 90% of the endangered dolphin population (Rao, 2016). Collisions with vessels and the resulting noise is seriously concerning for the dolphins, gradually pushing them to the verge of extinction. In addition, river dolphins experience difficulty in finding food and navigating because of dredging, which obscures hearing of lower echolocation frequencies.

Table 3: Habitat suitability factors and preference for Gangetic dolphins

River bottom and soft sediment	food gathering in the mud bottom of rivers, mud dweller fishes in shallow water, prefers soft sediments than rocky bottom
Flow	streams produce an eddy counter-current system in the mainstream flow, also prefers areas where the current is relatively weak
Ecotone	ecotone generated by the change between scour pools and running waters, seen as eddy turbulence
Shallow tributaries	prey on lifeforms moving across the main channel, while identifying foraging

	opportunities from within the hydraulic refuge of counter-currents and connected shallower tributaries. The distribution is limited only by lack of water and rocky barriers.
Meandering channels	found in marginal habitats where the river meanders sharply and creates eddy countercurrent systems prefers, downstream of sandbars, also prefers areas where rivers meet or downstream of shallow segments,
Water depth	travels upstream when water level rises, and from there enters smaller streams and the flooded lowlands, minimum depth requirements of 5.2 m for adults and 2.2-2.4 m for mother-calf pairs
Deep pools	preference for deep water pools, presence of dolphins in deep pools increases along the gradient of river flow reduction, dolphins not found in interceding segments because of low flow rates
Channel islands	upstream and downstream of mid-channel islands, monadnocks or rock islands generate large counter-current pools

Source: based on various studies - Smith et al. 1998; Sinha et al. 2000; Sinha and Sharma 2003; Behera and Mohan 2005; Choudhary et al. 2006; Kelkar et al. 2010

Relatively less research is available assessing the long-term comprehensive impacts of waterways construction on the Gangetic dolphin. However, systematic field observations clearly indicate that river dolphins showed consistent, drastic shifts in acoustic behaviour during exposure to noise, resulting in high levels of metabolic stress. During dredging and passage of vessels, surfacing (breaths per minute) of dolphins exhibited suppression of frequencies three times lower than in their absence. Masking echolocation clicks by dredging sound levels, dolphin acoustic activity decreased and evasive behaviour increased (Kelkar 2017).

IV. CHALLENGES

4.1 Dredging

Distinct from most of the world's primary watercourses, the flow regime in the Ganga River is largely monsoon-dependent – it expands during the monsoon rains and contracts in the dry winters and summer months. It is noteworthy that small boats are able to move along this seasonal river, but big cargo barges require a certain minimum depth. The passage of large vessels requires an assured depth (2-4 meters) and width (45-60 meters), which most Indian rivers – including the longest waterway – do not have. Therefore, shipping on the Ganga is restricted because of the differing water depths along its stretch. Presently, the traffic is primarily restrained to the river's downstream stretch between Farakka and Haldia where the water has sufficient depth (2.5 m - 3.0 m) for boats to move throughout the year. Large scale dredging of the riverbed would be required so that larger boats carrying cargo up to 2000 tonnes can easily sail in the river.

As a result, this has created the need for dredging and severe cutting of the riverbed for deepening and widening waterways (Dharmadhikary 2018). Heavy dredging displaces river sediments, ruining fish breeding grounds and critical habitats of endangered fresh-water turtles, fishes, sensitive aquatic invertebrates and other organisms. Dredging has altered the nature of the river environment and completely destroyed counter currents, a favorite dolphin habitat. Its detrimental effect is exacerbated in smaller tributaries, and the displacement of woody debris, stones, and sand further impacts the sanctity of the riverine ecosystem (Sinha et al. 2010). The practice of dredging raises several environmental challenges directly and indirectly impacting the Gangetic dolphins. By minimizing the hydro-geomorphological intricacy and volatility of the river habitat that nourishes the prey of Ganges river dolphins, dredging heavily impacts the ability of the dolphins to acquire food. It ruins benthic flora, fauna and their habitats that include organic waste. A large number of river fauna are detritivores (those who feed on detritus). These serve as food for the Gangetic dolphins (Sinha 2018). According to Kelkar (2017) substrate-breeding fish species are adversely impacted by dredging and may face local extinction after failed breeding. Further difficulties for riverine fauna due to capital dredging include excessive noise that harms the blind Ganges dolphins whose vital activities are dependent upon echolocation, as mentioned in section 2. River dolphin's sensing of lower echolocation frequencies may be obscured by sounds from dredging activities and vessel engines. This has a considerable negative impact on the dolphin's navigation and food finding capabilities. Finally, the physical displacement of river sediments as a result of dredging further disturbs the river dolphins.

4.2 Vessel Traffic

The central reasons for the large-scale expansion of the waterways are: a) Transport of coal, bulk and oversized cargo, hazardous wastes, mineral oil, industrial machinery, automobiles, etc.; b) Tourism, and c) Passenger movement. A study has estimated cargo traffic at 21.89 million tonnes by 2021 on National Waterway-1, which was 5.5 million tonnes in 2017-18 (Times of India 2018). Possibly without Environmental or Wildlife Clearances, Vessels of the IWAI (Inland Waterways Authority of India) have been frequently dredging inside the Vikramshila Gangetic Dolphin Sanctuary (Personal communication with SK Chaudhary). Endangered Ganges river dolphins also face the additional risk of being hit by vessels and of being dislocated from their habitat due to disruptions produced by vessels. The cargo vessels travelling through the waterway

require sturdy propellers for the adequate thrust to move forward. When the blind Gangetic Dolphin comes in contact with these propellers, it is shredded to bits. Reports of dolphin mortality due to collisions await confirmation.

The high levels of noise and disturbance created by vessel traffic have severe impacts on the dolphins. According to a report, the Gangetic Dolphins deliberately staying away from the river stretch with substantial traffic in and around River Hooghly in Kolkata, preferring more tranquil areas where fewer vessels commuted. (Sinha 1997). Additionally, a study shows how the presence of large vessels in the proximity of the dolphins can lead to them getting agitated- “A river dolphin took a tired lunge before diving into the Hooghly river next to a noisy, mammoth, crowded vessel ferrying passengers on National Waterway No. 1 (NW-1) in Kolkata. Its tail stood up stiff, flicking wildly, straight out of the water before it dived down headfirst. Such a dive indicates acute distress in dolphins. It heaved, surfacing after seven minutes, a longer interval than normal” (Kelkar 2017).

4.3 Barrages and impoundments

Several impounding structures such as dams and barrages create a physical barrier for all the migratory river species, including dolphins. It is expected that with navigation traffic, to maintain sufficient water many barrages would be required. Sudden fluctuations in water levels may disturb their habitat badly. However, it is very important to maintain adequate dry-season flows by ensuring flow augmentation as well as reducing water allocation to canals. As water is diverted from barrages for irrigation, large stretch of river channel becomes too shallow for the dolphins to survive. It is very important to maintain adequate flow during lean seasons to assure suitability of the river habitat and connectivity for dolphins. It has been observed that they are often isolated in pools and river branches in the dry season due to disappearance of lateral and longitudinal channel connectivity. Many huge dams in the Ganges river basin have intensely altered natural flow regimes especially in the low-flow dry seasons affecting the habitat and range of many iconic species of the riverine ecosystems (Choudhary et al. 2012). Low-flows and altered flow regimes due to barrages and impoundments could have negative impacts on Gangetic dolphins as well as their prey population. Isolated subpopulations of Gangetic dolphins in Nepal and in the Karnaphuli-Sangu River System of Bangladesh have faced extinction or critical reduction in their population by the barrier effects of impounding dams and barrages (Haque 1976, Smith et al. Moreover, after the construction of barrage at Indrapuri in 1965, dolphin migration completely came to a halt without any new dolphin sightings since (Sinha and Sharma 2003). Excessive siltation just above the Farakka-Barrage has adversely affected the habitat of Gangetic dolphins. The severely regulated and contaminated Yamuna River has a dramatic decrease in dolphin distribution (Sinha et al. 2000; Chaudhary 2003; Das et al. 2005; Smith and Reeves 2009).

4.4 Pollution

A direct impact of the increased vessel traffic is a substantial increase in river pollution. Evidently, a large proportion of the ships passing through the Ganga River will be carrying cargo of mostly coal and crude oil. Fuel leaks and oil spills are inevitable considering the planned traffic load. High levels of pollution can directly kill dolphins, and completely destroy their habitat. Being at the top of the food chain, the Gangetic dolphin is known to contain higher levels of toxic chemicals. Ambitious plans to transport 300 million tonnes of coal annually through the waterways by 2020, therefore, pose a serious danger. The problem of pollution may further increase in future because of less capacity of rivers to dilute pollutants in wake of reducing flows due to diversion projects.

A study carried out by the United States National Oceanic and Atmospheric Administration (NOAA) which focused on the impacts of the Deepwater Horizon Oil Spill on the bottlenose dolphins clearly indicates that the affected dolphins showed significantly higher incidences of lung disease and hormonal abnormalities (Than 2013). Scientists used ultrasound exams to discover 14 cases of severe lung disease in a sample of 99 bottlenose dolphins — which is remarkable considering the relative rarity of pulmonary illness in dolphins living elsewhere. Oil exposure, moreover, led to lower reproductive success. Research indicated that female dolphins residing in the footprint of the spill birthed living calves only 19% of the time as compared to 65 percent in uncontaminated areas (Kellar et al 2017). Although effects might tend to differ slightly in case of the Gangetic Dolphins, the research does provide a context of the catastrophic outcomes of oil spills.

V. POLICY RECOMMENDATIONS

Although the Indian Government has shown deep concern for the National aquatic animal and formulated conservation action plans, the conservation schemes have failed to have pronounced effects. Rather, the situation appears to have worsened as evidenced by declining range and population, and the introduction of the National Waterways Act seems to have a negative impact on population of Gangetic dolphins. The conservation program should aim to alleviate the situation by proper implementation of existing policies, and

creation of effective implementation mechanisms. Policy Recommendations for conservation of Gangetic dolphins are highlighted in Figure 4. Some key policy strategies are discussed in the following section.

4.1 Making environmental clearances mandatory

There has been lack of study on the ecological and social risks the National Waterways Act poses to riverine ecosystems and communities. The Environmental Impact Assessment (EIA) 2006, under item 7(e) of its schedule mentions that environmental clearance is required for some developmental work (“ports, harbours, breakwaters, dredging”) in waterways. Despite the requirement, it is extremely appalling to note that work on National Waterway-1 passing through River Ganges- including dredging as well as construction of multi-modal terminal on the river at Varanasi- has been exempted by the Ministry of Environment, Forests, and Climate Change (DTE 2019).

Recommendation:

It is imperative to remove the ambiguity regarding Environmental Clearances. To do so, the Ministry of Environment, Forests, and Climate Change must explicitly state that dredging, river ports, terminals, and jetties for inland waterways require environmental clearance for all National Waterways. This should be without any exemptions. Moreover, the Environmental Impact Assessment should be forthwith amended to encompass waterways in their entirety. This should cover all its components including, but not limited to, dredging, river ports, terminals, and jetties.

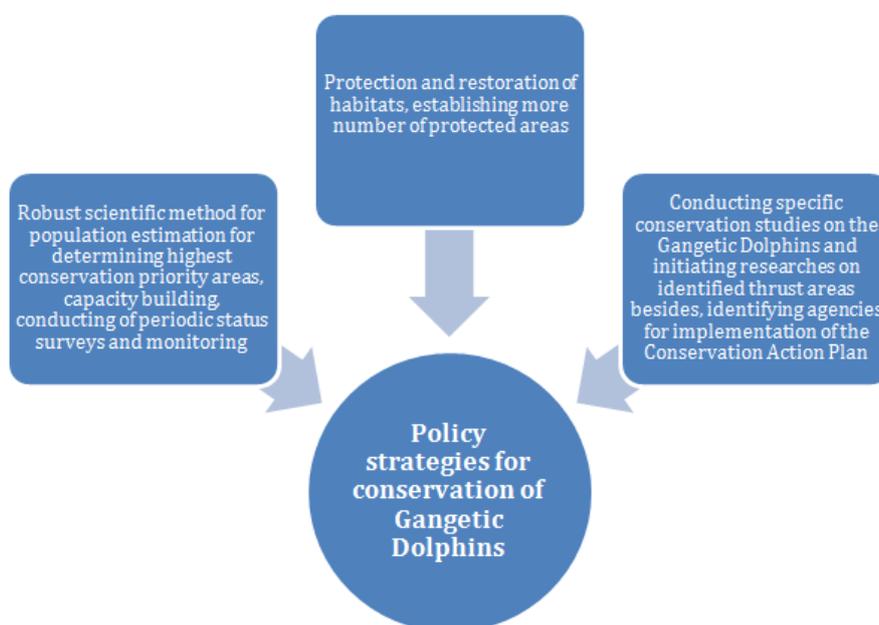


Figure 4: Policy Recommendations for conservation of Gangetic dolphins

4.2 Assessing the budget, efficacy, and expectations of National Waterways

Big global rivers, including the Amazon, Thames, and Clyde, have a perennial flow. Unlike these rivers, where the development of Waterways has proved to be profitable, the Ganges and most other Indian rivers are monsoon-fed and do not have voluminous discharge of their own. Additionally, India has a history of water mismanagement. This is resulting in most of its rivers running waterless in the dry season. High levels of water required for navigation are available only during monsoon months. The construction of waterways bears heavy environmental, social, as well as financial costs. Thus there is a need for assessing its budget and efficacy.

Recommendation: There is a need to bring out a detailed report for development of inland waterways. The planning and implementation of activities may be done in a transparent manner as an integral part of the document. This should be done with active participation of local communities, civil society organizations, environment protection groups and concerned citizens. The participatory process must be applicable from planning to all stages of decision-making. The impact assessment and feasibility studies may also required to be transparent and participatory in nature. This will encourage a mutually co-operative environment between all stakeholders.

4.3 Conducting extensive research on Gangetic dolphins

Currently, the research available on the Gangetic dolphins is not sufficient to competently tackle the issue of their protection. There is a necessity to fund extensive studies on the dolphins and other aquatic flora and fauna in order to obtain a clear context of the impacts of construction of waterways on the aquatic biodiversity. A proper understanding of the challenges we face will make us well-equipped to deal with the issue of conserving the Gangetic dolphins. Currently the focus should be on conducting more extensive empirical studies that focus on quantitative approaches for a comprehensive understanding of dolphin-habitat relationships that have been affected by waterways.

Recommendation: Specific conservation studies on Gangetic dolphins may be conducted. This will enable to obtain a comprehensive idea of the challenges faced by them, and allow finding ways to help them. The study can include topics like identification of sensitive aquatic regions. In such regions, a dredging management plan can be initiated. The plan may set limits to dredging and may prohibit disposal of dredged material in those regions.

VI. CONCLUSION

The population of Gangetic dolphins has reduced considerably due to river flow regulation and fragmentation. Several completed barrages, dams and diversion of water to irrigation canals have severely altered natural flow regimes particularly in the low-flow dry season. The species is facing the threat of extinction. It is important to note that the National Waterways Act 2016 proposes the construction of 111 inland waterways which are coinciding with 90% of the remaining Gangetic dolphin population. It is expected that the development of inland Waterways in 1620 kilometers of the Ganges might cause the extinction of the Gangetic dolphin. The Gangetic river dolphins are being affected both directly and indirectly through the construction of National Waterways. By destroying its natural habitat, the Waterways pose an imminent danger to the survival of the endangered species. The low availability food, resulting from dredging activities, for the blind dolphins coupled with the persistence of noise will be particularly challenging for them in the near future. The projected 4 times increase in the load of vessel traffic within the next 2-3 years is also a matter of deep concern, further contributing to the noise in addition to causing collisions and river pollution. While the prospective benefits of these developmental projects are not guaranteed, their detrimental impacts on the Gangetic dolphins in particular, and the river ecology and health as a whole, are numerous and cannot be ignored.

Altered flows due to waterways can adversely impact already endangered species. The dredging activities and channel modification along with flow regulation will result in local habitat, lowered variability in river discharge and simplification of channel morphology, reducing the overall range for dolphins. Flow alteration and disturbances will also affect the movement, migration patterns and behaviour of dolphins. Adequate flow releases and as well as ensuring the provision of ecologically relevant river flows must be made binding with high priority in the Ganga basin both at the policy and implementation level. There are also an urgent need of community participation in conservation program along with providing education and awareness to local people and fisherman. With adequate capacity building and awareness, incidental catches can be minimized.

Declaration: The authors declare no conflict of interests.

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