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A grave danger for the Ganges dolphin (*Platanista gangetica* Roxburgh) in the Subansiri River due to a large hydroelectric project

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Abstract The Ganges River dolphin (*Platanista gangetica* Roxburgh) of Subansiri River may be in great danger of extinction due to the construction of the 2,000-MW Lower Subansiri Hydroelectric Project, which started in 2006. A recent survey indicates that there are now 29 Ganges dolphins, up from 21 in 2006. It is feared that drastic changes would occur in the downstream hydrology and ecology of the Subansiri River after the installation of the project, scheduled for 2012. The water discharge during a major part of the day in dry months would come down to a meager 6 cumecs from the present average of 450 cumecs (1 cumec is shorthand for cubic meter per second; also cms, or m^3/s (m^3s^{-1}). Riverine mega fauna like the dolphin would be worst hit by this extremely low discharge. Dumping of an extra amount of sediment from different construction phases has already increased sediment load in the Subansiri downstream and degraded some earlier pockets of dolphin up to 20 km below the dam site. There is reason to believe that high sediment influx might have silted up some of the deeper pools downstream, a preferred habitat of dolphins, forcing them to congregate close to the confluence of the Subansiri.

Keywords Hydroelectric project · Ganges River dolphin · Conservation

1 Introduction

Platanista gangetica (Roxburgh 1801) is the most primitive group of all river dolphins. The ancestors of the four extant river dolphin taxa were inhabitants of Miocene epicontinental seas (Kellogg 1959; Gottfried et al. 1992; Morgan 1994; Hamilton et al. 2001). Possible relatives of *Platanista* are Squalodelphinidae and at least some members of Squalodontidae, two well-known, extinct families of archaic, medium-sized heterodonts (Muizon de 1994; Fordyce and Barnes 1994). Other fossil relatives of the Platanistidae include members of the Dalpiazinidae (Muizon de 1994) and Waipatiidae (Fordyce and Barnes 1994). If these lineages are monophyletic, then *Platanista* is the sole extant member of a once-abundant and diverse clade of archaic odontocetes. They are side-swimming, blind, and highly endangered. Rice (1998) recognized two subspecies in the genus *Platanista*, and they are the Indus River dolphin, *Platanista gangetica minor* and the Ganges River dolphin, *P. gangetica*. Ganges susu (*P. gangetica*) and the Indus bhulan (*Platanista minor*) are obligate river dolphins and their total abundance may be in the low thousands (Smith et al. 2000). Both the *susu* and bhulan are classified as endangered by IUCN (IUCN 1996). According to Behera (2005) the high mortality rate of the Ganges River dolphin in India is combined with low political will, absence of grassroots support for river dolphin conservation, absence of proper co-ordination among members, and

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lack of conservation awareness among people. The Ganges River dolphin is in grave danger of extinction in the Subansiri River. The National Hydroelectric Power Corporation (NHPC), which is executing the 2,000-MW Lower Subansiri Hydro Electric Project (LSHEP) in the Subansiri River, a healthy habitat of the Gangetic dolphin, has secured the environmental clearance from the Union Ministry of Environment and Forest, India (MoEF), without any reference to *P. gangetica* of the Subansiri River Exclusion of this keystone species from the EIA report, is quite conspicuous (Baruah et al. 2009). This aquatic animal has recently acquired the status of India's national aquatic animal. In this paper, an attempt has been made to know their status, distribution, and foraging habitats prior to the commissioning of the hydroelectric project as well as its probable impact on the dolphin population.

2 Materials and methods

2.1 Location of sampling sites

Approximately 130 km of the downstream area from the dam site (Fig. 1) of the Subansiri River was studied for 5 years (2005–2009). For comparisons of encounter rates, the survey area was divided into four sectors delimited according to well-known locations: (1) Gerukamukh–Chowaldhowa ghat (ghat = ferry crossing; 10 km); (2) Chowaldhowa ghat–Khabalu ghat (45 km); (3) Khabalu ghat–Dhunaguri ghat (35 km); and (4) Dhunaguri ghat–Jamuguri ghat (40 km).

The physical parameters of the studied area were recorded as follows:

(a) Latitude–Longitude by GPS (Garmin Model no. GPS 12/FC, Serial no: 36874080, Taiwan).

(b) Sloping topography by Clinometer (Model Tangent BSE-15 made India).

(c) Distance between each sector and width of the channel by GPS (Garmin Model no. GPS 12/FC, Serial no: 36874080, Taiwan).

(d) River depth was measured by graduated tape with a heavy sinker tied at one end.

Secondary information on fisheries was gathered from registered (government) lease holders and also through systematic interviewing of the professional fishermen who have been fishing the river for 10 years or so.

2.2 Survey of Gangetic dolphin

As suggested by Smith and Reeves (2000a), the vessel-based dolphin survey was conducted from November to January for three consecutive years (2006–2009), as this is the period of minimum river discharge when dolphins are easiest to count (Wakid 2005). Boat speed was maintained at 8–10 km in a downstream direction following the deepest channel with a zigzag pattern from bank to bank. Altogether, five observers were used at a time with three primary observers (two searched 60° right and left, whereas the third observer searched in the central 30° right and left), one data recorder and one rear observer (observing 180° behind the survey vessel). Positions of observers were rotated every 30 min to avoid fatigue. During the night camping, it was assumed that an equal number of dolphins were missed due to their movements in between surveyed and un-surveyed areas overnight.

The locations of the dolphin sightings were recorded with GPS. A dolphin group was defined as dolphins no more than 500 min apart, within an area of similar hydrological characteristics. Group sizes were evaluated with a best, high, and low estimate of numbers to incorporate a degree of uncertainty. A low and best estimate of zero was used if the sighting was unconfirmed or if there was a possibility that the dolphin was following the vessel and might have already been counted. A 20-min stoppage was made in areas of high dolphin abundance to make a more accurate group size estimate. When a dolphin was sighted, the vessel continued moving downstream but active surveying for new dolphin groups was temporarily suspended while observers focused on obtaining an accurate group size estimate.

Weather conditions were recorded at 1-h intervals during the survey time with the following scale:

0 = Water surface glassy
1 = Ripples without crests
2 = Small wavelets with crests but no white-caps
3 = Large wavelets with scattered white-caps
4 = Small waves with fairly frequent white-caps.
From 3′ scale, the survey was postponed.
Visibility was assessed with the following scale:
0 = Clear
1 = Visibility less than 2 km
2 = Visibility less than 1 km

From visibility code 2′, the survey was postponed until conditions improved.

Besides considering the above different weather gradient scale, we also consider the visibility period, as we conducted our survey during November to January. Winter is the best season for counting dolphins in the Brahmaputra drainage system as also reported by Biswas et al. (1997), Biswas and Boruah (2000) and Wakid (2005). However, day length during winter (Dec–Feb) is only for 10 h (6 a.m. to 4 p.m.) in this part of the globe. Poor visibility due to heavy fog makes it difficult to start the population survey (of dolphin) before 8 a.m. It is, therefore, really difficult to cover the entire 110 km stretch of the Subansiri in a day.

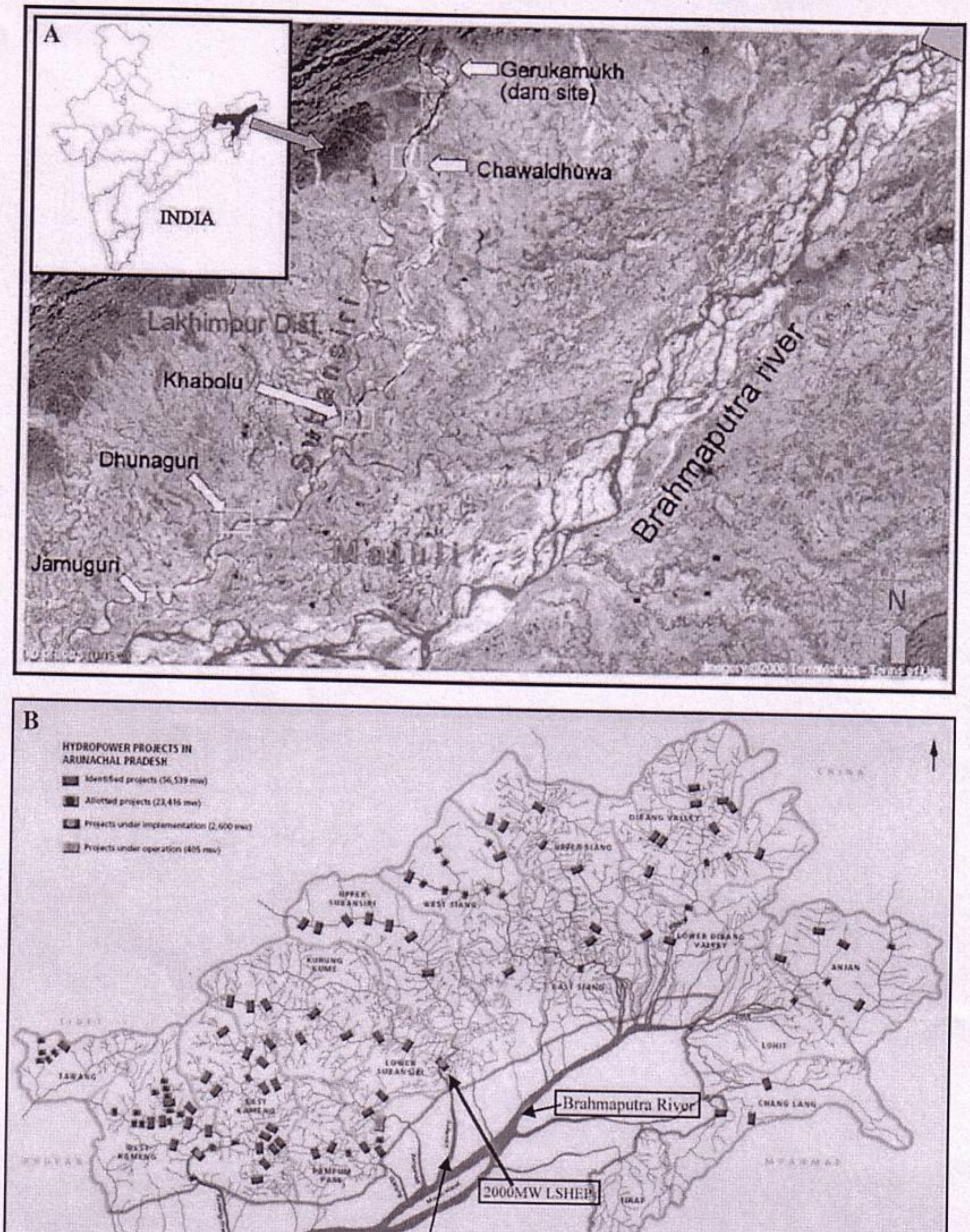

Fig. 1 **A** Study area. **B** Proposed dam sites of Northeast India

That's why it was planned to cover half of the stretch in the downstream from upstream to downstream in one day (7:30 a.m. and 3:30 p.m., 07 h) and the rest part of the river in the following day. Hence, a total of 14 h were spent for surveying from upstream to downstream. Again, the head count of dolphin continued from downstream to upstream in the similar fashion and the average of the two surveys was taken. In each of the months, close observation for structure, size, and color of the individual animals was made to minimize the chances of double counting (WWF 2006).

2.3 Data analysis

The highest total of the day was taken as the minimum population estimate. To reduce the chances of over-estimating or double counting, observation spots that were within 1 km of the river stretch was considered as a single spot. Animals of the same size, i.e., adult, sub-adult, or calf, seen at more than one spot falling within 1 km during a scan of 30 min (video as well as still photography) were treated as a single individual. However, if any animals sighted within 1-km area were of different size class, they were taken as two different individuals (WWF 2006).

Secondary information regarding their feeding habitat was obtained by consulting with the local fishermen as well as riverine communities who have a great knowledge on the diurnal activities of dolphins.

3 Results and discussion

3.1 Physical status of the dolphin-sighting habitat

The Subansiri River is glacier fed and perennial. It is sustained by snowmelt runoff, the ablation of glaciers, and monsoon rainfall. During the wet spell, the flow of the Subansiri is powerful and thus capable of moving very large objects, including boulders, cobbles, and pebbles up to 10–17 km downstream, for which the river bed is composed of hard sediment. From the point of the dam site to Chowaldhowa ghat, the slope is rather steep (–2.03 m/km). Thereafter, the riverbed is almost flat (0.02–0.03 m/km). However, near the confluent with the Brahmaputra, the gradient was found little higher (0.12 m/km). A sharp 23-m inclination of river bed in this part (MSL of Gerukamukh is 99 m as against 76 m in the Chowaldhowa ghat) also helps in easy movement of these hard sediments with sand, silt, and clay.

Latitude, longitude, sloping topography, and distance between each sector, depth, and width of the river together with description of the dolphin sighting locations are depicted in Table 1.

Table 1 Description of areas with dolphin sighting in the Subansiri River

Slope of the river bed	Maximum depth in lean period (m)	Maximum width during lean period (m)
2.03 m/km between A & B	Sector I: 9.3	Sector I : 118
0.02 m/km between B & C	Sector II: 11.5	Sector II: 107
0.03 m/km between C & D	Sector III: 13.6	Sector III: 113
0.12 m/km between D & E	Sector IV: 15.3	Sector IV: 89

3.2 Status and distribution of river dolphin downstream of the Subansiri River

There was a gradual increase in their numbers from 21 to 29, i.e., 21, 23, 26, 29, with an encounter rate of 0.19, 0.21, 0.24, 0.26 dolphin/km in 2006, 2007, 2008, and 2009, respectively. This in contrast with the observation made in the Brahmaputra where encounter rate was 0.19 individual/km in 2005 and 0.20 individual/km in 2008 (Wakid 2005). That the higher encounter rate of 0.26 dolphin/km dolphin in the Subansiri is either due to immigration of a few individuals from the Brahmaputra or that a 27.58% increase in the population might be due to natality as 2–3 new born dolphin were observed every year during the study period and this fact was corroborated by the local fishermen.

Though the total downstream is approximately 130 km (dam site to confluence with Brahmaputra), the river dolphin is confined to 100–110 km upstream of the confluence. Absence of dolphins in the first 20 km below the dam is due to the rocky nature of the riverbed and harsh riverine conditions due to transportation´ of debris from the site, which makes the river water murky and consequently, degrades the habitat for the dolphin. The deeper pools (depth ranging from 6.0 to 15.3 m) of the Subansiri usually act as natural habitats for dolphins during lean months when the average depth of the river hardly exceeds 3 m, a minimal requisite water cover for river dolphin (Biswas et al. 1997). Interestingly, they again return back to their original territory in April–May when the river swells with the melting of ice as well as due to pre-monsoonal rain. As a whole, dolphins are usually sighted in the confluences with the Brahmaputra and in certain spots like the confluence of the rivers Dikrong, Ranga, Luit, and Korha. Given the choice, however, the river dolphins prefer deep water, and particularly favor counter-current pools of eddies that provide refuge from the swift current of the river. Similar observations were also reported for a small 'residential' population of dolphin in Kulsi River (Mohan et al. 1998). It appears that the natural flow regime of the Subansiri maintains downstream 'health' by longitudinal connectivity and facilitates adequate a safe habitat for the dolphin.

3.3 Impact of habitat alteration

Since the inception of the hydroelectric project in 2003, an extensive collection of boulders, stone, gravel, sand from the riverbed, massive construction activities like the coffer dam, temporary diversion of the river, reservoir, a power house, and construction of roads for carrying construction materials have generated tons of debris, which ultimately increase the sediment load downstream. Prior to construction of the dam, the sediment influx in the Chowaldhowa ghat was 94,830 t/day in 2003, which was subsequently increased by 39.21% (156,012 t/day) and 43.65% (168,293 t/day) at the same station in 2008 and 2009, respectively. Increased sediment load led to mid-channel bar formation as well as bank erosion at the lower reaches of the river where the gradient is flat. These geomorphological changes coupled with siltation of pools between Chowaldhowa ghat and Khabolo ghat has compelled the dolphins to move further downstream for adequate water cover.

At present, the average discharge of Subansiri River is 450 cumecs during the lean season (November to February). However, after commissioning of the project, the flow will only be 6 cumecs, as the project goes "off line" for power generation for the most part of the day during the lean period. During the evening 'peak' period, when all of the eight turbines will be operative, the downstream flow discharge will be suddenly increased to 2,400 cumecs. It is obvious that such an adverse change in the natural flow regime will adversely disrupt ecological integrity as well as sustainability of fishes and other aquatic biota including the river dolphin. Reeves et al. (2000) reported that large water-development projects like high dams have had profound effects on the ecology of rivers, and they are certainly the main causes of habitat degradation within some large river environments. Dam construction and operation cause major changes in the flow regime, sediment load, and water quality of rivers. Dams eliminate many of the dynamic attributes of downstream waters and block the flow-through of sediment essential to the formation of islands and bars. Downstream flows are normally not allowed to overspill riverbanks onto adjacent floodplains, and as a result, fish production decreases dramatically. Natural fluctuations in flow, temperature, and detritus loading, which provide optimal conditions for a large number of aquatic organisms, are suppressed by dams, and the number of ecological niches available for supporting diverse communities of riverine biota is reduced (Reeves et al. 2000). River cetaceans are among the organisms that are particularly vulnerable to the effects of interrupted movements and habitat degradation caused by dams and other related water-development projects (Chen Pand Hua 1989; Reeves et al. 1991; Reeves and Leatherwood 1994; Smith et al. 2000; Ahmed 2000; Liu et al. 2000; Sinha et al. 2000; Smith and Reeves 2000b). Development of hydroelectric projects in Asian rivers, the *susu's* metapopulation has become increasingly fragmented (Reeves et al. 2000). The population of the Padma River system is said to be "fast declining" due to the construction of the Farakka Barrage (Reeves and Brownell 1989). Damming off a river is known to alter geomorphic processes and to degrade downstream habitats for both dolphins and their prey. Hence, ecological security to this animal along with other biota in the Subansiri River system is strongly needed within a very short period; otherwise it will be too late to protect Gangetic dolphin in the Subansiri river.

3.4 Recommendations for conservation of the Ganges dolphin in the Subansiri River

1. More scientific studies should be done on the habitat ecology and behavior for the ecological security of the dolphin population in the Subansiri.
2. Anticipated effects of the 2,000-MW LHEP on the dolphin habitats should be calculated with mathematical modeling/ecological modeling.
3. Present minimum average flows discharge, i.e., 450 cumecs in the lean season, is to be maintained for long-term sustainability of the dolphin population in the Subansiri.

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