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# Population Assessment and Conservation Strategies of the Indus River Dolphin, *Platanista gangetica* Minor, in Indus River Sindh, Pakistan

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**ABSTRACT**

Indus Blind Dolphin is endangered species sighted in the Indus River from the Indus delta upstream to the Himalayan foothills prior to building barrages but the maximum number of this mammal is found in Guddu to Sukkur reach and lowest number at upstream of Guddu barrage and downstream of Sukkur barrage. Driving forces for water and dolphin reserve conservation are an agriculture-environmental trade-off, water use and alteration of rivers for irrigation and agriculture and inadequate consideration on the habitat of highly valuable species such as Platanista gangetica minor, water demand increase with urban development and industrial activities, water pollution from Industries and agriculture wastewater, fishery-dolphin conflict causes physical damage to dolphins by boat and unintended dolphins/fish catch by gillnet.This paper presents the assessment of threats to Indus dolphin population growth, water quality, and other risk activities in stretch Guddu to Sukkur barrages. The total 1419 Indus dolphin was counted during a survey of dolphin in 2019, while918 in2011 respectively between Guddu and Sukkur Barrages. As result, 501 Indus dolphin number has increased in a period of 8 years. The analyzed results reveal that all the tested parameters ie. pH; Cond, TDS; Cl, TH, Alk, $SO_4$, and $NO_2$ are within the permissible limits as per standards NEQS and WHO. Moreover, the Standard Deviation of all parameters shows low deviation at different locations. The correlation matrix of all parameters of collected samples. The pH has a very strong correlation with $NO_2$, and $SO_4$ has a strong relation with conductivity and total hardness, and alkalinity.

## INTRODUCTION

Indus River Dolphin *Platanista gangetica* minor is locally known as 'bhullan'Indusis (**Isaac *et al.*, 2007**). The Indus River dolphin, *Platanista gangetica* minor, is endemic to Pakistan and occurs only in the Indus River system. The Indus River Dolphin is severely affected due to the increased anthropogenic activities. Changes in the aquatic ecosystem lead to alterations in both the habitats of vertebrate species and water quality parameters **(Braulik *et al.*, 2006; Hassan *et al.*, 2020a, b)**. The major threat has

been depicted from the depletion of river biota. Consequently, stranding and mortality in the irrigation canals have been witnessed, reduction of prey base due to the use of small size mesh nets; poaching for oil and medicines. In addition, threats were originated from pollution from domestic, agrochemical and industrial wastewaters, fragmentation between barrages, sedimentation, high floods and drought due to climate changes. Historically, it occurred in the Indus main stream and the Sutlej, Beas, Ravi, Chenab, and Jhelum tributaries. It ranged from the Indus delta upstream to the Himalayan foothills where shallow water prevented further upstream movement. In the1870s, the range of the Indus Dolphin was reported to extend over 3,400km of the Indus River and its tributaries **(Anderson *et al*., 1879)**. Unfortunately, the building of barrages across the Indus River has limited the movement of dolphins within the fragmentation of the barrages. Hence, the movement of dolphins has been restricted within reaches of barrages which affected the population growth from the Indus delta to the Himalayan foothills. The Indus Dolphin population is divided into subpopulations at the six barrages reaches. Hence, the habitat of dolphins is limited to subpopulations across the Indus River between the Chashma-Taunsa, Taunsa-Guddu, Guddu-Sukkur, and Sukkur-Kotri barrages. A few Dolphins were still found downstream of the Sukkur barrage and upstream of the Chashma barrage **(Anderson *et al*., 1879; Braulik *et al*., 2001)**.

Indus dolphin is only one of four freshwater dolphin species and the second most endangered of the freshwater dolphins after the *Yangtze* dolphin in China **(Reeves *et al*., 1998)**. The blind dolphin of the Indus is endangered species of Pakistan and the migration of dolphins was first documented in the 1870s; just after the construction of the barrage and at that time the dolphin inhabited in the foothills of the Himalayas to the lower Indus system **(Khan *et al*., 2006)**. The present habitat of blind dolphins is between Jinnah to Kotri barrages' reaches. The major population of the dolphin is about 1200 and exists in an area about 200 km between Guddu to Sukkur reach of the Indus River. The dolphin population existing at Sukkur to Guddu reach is under serious threat from canal stranding, sedimentation, contamination from wastewater, net entanglement, and the unsustainable availability of water which also contributes to the species endangerment and being extremely vulnerable to risks **(Pilleri *et al*., 1972; Reeves *et al*., 1991)**.Water is a natural source for sustaining and surviving the ecosystem. Obviously, rivers, lakes, and oceans ahave been disregarded and degraded by humans. Hence, every individual should work to conserve water resources **(Vega *et al*., 1998; Jothi *et al*., 2010; Sadia *et al*., 2013)**. The river system is one of the main natural resources of water supply in different countries of the world. At the source of a river, water is relatively pure as it flows downstream. Hence, rivers offer freshwater for aquatic biota, fertile soil, navigation, recreation, and many other essential functions. But, rivers and watersheds are increasingly under threats from ill-planned development. Moreover, the riverine belts of Pakistan are getting contaminated day by day **(Mahessar *et al*., 2019, 2020)**. In this respect, various studies have been conducted to assess the water quality of the Indus

River which exhibits Indus River which is one among the top five most threatened river basins **(Tassaduqe *et al*., 2003; Ali *et al*., 2004; Rahman *et al.,* 2014)**. The Indus River dolphin is commonly found in the deepest river and less common in secondary channels and small braids. The habitat of dolphin mostly preferred includes channel constrictions, confluence, and deep low-velocity water **(Bhatti *et al*., 1980; Pilleri *et al*., 1982; Khuhawar *et al*., 2000)**. During the low water season (October to April), barrages divert almost all river water as water levels drop in winter, dolphins are centered in the remaining deep areas.

Indus dolphin weight ranges from 70 to 110 kg and its maximum length is about 2.5 m (8.2 ft) and males are slightly smaller than females **(Kasuya *et al*., 1975)**. Dolphin swims about 30 to 60 seconds or more on the surface of the water and rotates upright for inhaling air and also rotates again 90 degrees for swimming back to the bottom. This unique swimming behavior is not seen in any other dolphin except the Ganges River dolphin **(Braulik *et al*., 2004)**. There are no direct observations of dolphins moving through the barrage, they often swim through regulator gates into irrigation canals, which although smaller, present a similar obstacle **(Kasuya *et al*., 1972)**. Encounter rates in the farthest downstream subpopulation (between Guddu and Sukkur barrages) are high (about 5 dolphins/km); approaching three and a half times those recorded in similar surveys elsewhere for *Platanista gangetica* **(Braulik *et al*., 2012)**.

The Indus Dolphin Reserve is a natural wetland declared as Reserve for protection of Indus dolphin in 1974 and was later notified as a Ramsar site in May, 2001. Sindh Wildlife Protection Ordinance1972 has set penalties against the offense. Human activity like hunting, shooting and any kind of disturbance to wild animals is not allowed in Indus Dolphin Reserve according to the Sindh Wildlife Protection Ordinance, 1972. The largest sub-population of dolphin, more than 80%of the total in 2001 and 90% of the total in 2006, is concentrated in the Dolphin Reserve between Guddu and Sukkur Barrages. In 2011, the population survey was conducted by Sindh Wildlife Department, which found 918 dolphins between Guddu and Sukkur barrages and 29 between Sukkur and Kotri barrages **(FSRG *et al*., 2011)**. The Indus River Dolphin is a critically endangered obligate freshwater species. Anthropogenic activity is increasing day by day. Given the facts discussed, the current study was carried out to learn about the biological position and current distribution of the Indus River Dolphin in Indus River Sindh, Pakistan, and evaluate the threats to the lives of the Indus River Dolphin.

## MATERIALS AND METHODS

The total length of the Indus River in Sindh is about 864 km, with Guddu-Sukkur reach of 200 km. The study area is located in Sindh Indus river, and the coordinates represent a specific study area with the latitude of $28^{o}$ 25’ 51” N and longitude of $69^{0}$42 50” E of Guddu barrage. The area extends to the altitude of $27^{0}$ 40’ 95” N and longitude $68^{0}$ 50’ 48” E of Sukkur barrage. The study area regarding Indus Dolphin reserve

boundaries covers about a 200 km stretch between Gudduand Sukkur barrages. This area comes under the boundaries of Ghotki, Kashmore, Shikarpurand Sukkur districts. There are two main barrages in the stretch starting from Guddu barrage to Sukkur barrage as shown in Figs. (1 a, b).

**Survey/Monitoring Methodology**

Partly due to the lack of a better available technique, the usual way to survey the dolphins is by counting them as they surface for air. But, this method is loaded with errors. The main river may extend for several kms wide and dolphins may surface beyond the visual range of the observation, and consequently dolphins that appear in a specific "transect" of the river are generally counted rather than considering the whole river. Nevertheless, the general method has been used in most previous surveys (**Smith & Reeves, 2000)** where possible separate observers count from the front, behind, left and right sides of the boat. Animals are counted as they surface for air; and observers keep an eye on each animal to prevent double counting. Parameters recorded included animal size, relative beak length where possible, dive time (intervals between surfacing), dive distance (distance between surfacing), river depth, width and turbidity. As direct observation is the only available survey method, such inaccuracy can in part, be compensated for by using a correct factor (CF) . According to the method of **Sinha *et al.* (1993),** one dive time probabilities is divided by the sighting probabilities and incorporated into a population to estimate

$$\text{Correction Factor (CF)} = \frac{\text{Dive time probablities}}{\text{Sighting probablities}}$$

Statistics: to determine population density from the transect methodology described above, the following calculation **(Braulik *et al*., 2006)** will be used to calculate the density (D) of animals per $Km^2$ of river.

D = ng/(w) *L, Where n = no of dolphin group observed, g = mean group size, 2w = transect with on either of observer, L = length of transect in river (Km), To convert this to number of dolphins per section of river, the above results are multiplied by A; the area of habitat available in $km^{2.}$

The total population = A * D

If the 2w sighting distance increases to the point where sighting probability falls, then the correction factor mentioned above can be determined and incorporated into a population estimate such that D = DF x ng/2n.

**Methods of Rescue/Capture of Dolphin**

According to **Waqas *et al.* (2012)**, prior to each rescue operation, measurements of the water depth of each depression were taken to be able to move the dolphin in shallow waters. The rescue party then boarded the boats in the canal and the rescue team pulled the nets from both sides of the canal, and a clicking sound is produced in water with depth that

does not exceed 70 cm. The boats and rescue team moved slowly, and when the dolphin reaches the feet of the rescue team it is then captured. The rescue operation in each pool takes 1-2 hours and great care is taken to avoid entanglement and drowning of the dolphin in the nets. Transportation from the place of rescue was achieved through a stretcher carried to a vehicle by two rescue men. The dolphin's body was loosely wrapped with muslin cloth leaving the blowhole uncovered. Prior to wrapping, the body was kept wet by sprinkling water to keep the skin cool and moist. This operation continued throughout the whole journey for providing a required atmosphere to shift into the dolphin's reservation.

**Physico-chemical parameters management**

The pH values were recorded every day and measured using Celsius glass thermometer, conductivity (µs/cm) (Model: MW301), total dissolved solids (Model: MW402), and digital pH mete. While, chloride (mg/L), total hardness (mg/L), sulphate (mg/L) alkalinity (mg/l), and nitrite (mg/ l) were determined every two weeks with chemical methods according to the methods of **APHA (1995)** and **Hassan *et al.* (2021).**

## RESULTS

**Construction and Operation of Barrages**

The serious threat to dolphins at an early stage was the construction of barrages across the Indus River which fragmented the population and reduced the habitat of dolphins. Dolphins sometimes move through barrage gates as shown in Fig. (2). The Indus dolphin seen at u/s of Sukkur barrage is generally assumed as an unidirectional movement downstream through barrages, and the upstream movement is precluded by high gradient, rapid and turbulent flow, and frequently shallow water, and downstream of the gates. Even a low downstream migration could dramatically affect the persistence of upstream sub-populations over time. Downstream migrants would not survive below Kotri Barrage where the Indus River is dried most of the year. For fishing, fishing nets (Fig. 3) are commonly deployed for extended periods of time, including overnight, which can result in dolphin entanglement and mortality, especially as the preferred habitat of the Indus dolphins is often in the same location as the primary fishing grounds. The problem of accidental killing is expected to worsen with increasing fishing intensity. Illegal fishing through the use of pesticides is also creating harmful effects on the Indus dolphin population, both directly and indirectly.

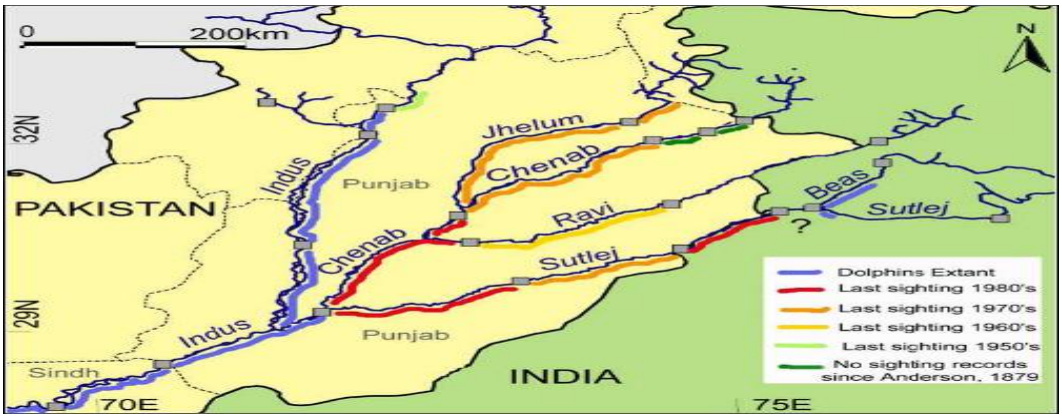


**Fig. 1.** A map showing study areas of Indus River.

**Fig. 2**. Indus Dolphin at u/s of Sukkur barrage.

**Fig. 3.** Fishing at upstream of Sukkur barrage.

**Depletion of Prey Base**

The sustained and heavy exploitation of small fishes within the Indus by the widespread use of small size mesh nets in the river has adversely affected the prey base of the Indus Dolphin. It is currently unknown if the renewal rate of this resource

can keep pace with its decline.

**Poaching**

The Indus dolphins have been sought and killed for favor of oil and meat besides their use in traditional medicine until the early 1970s, when hunting abandonement was brought into law. Although poaching activities have dramatically decreased since the ban, poaching still occurs sporadically water quality and Population Survey of Indus River dolphin. The population of dolphins is distributed in fragmentation due to the construction of barrages so that the Indus dolphin can no longer migrate to long distances across the Indus River. These movement canals oppose a serious threat to the population on the long term, as shown in the results of Indus dolphin's survival rate between Guddu and Sukkur Barrages in Fig. (4).

Fig. (4) shows that the population of Indus river dolphins from 1972 to 2019 witnessed a consecutive increase. The dolphin were counted yearly during the population survey recording numbers of: 132, 138, 290, 429, 368, 387, 398, 443, 458, 725, 1289, 918 and 1419, respectively with the years: 1972, 74, 80, 86, 90, 91, 92, 96, 2001, 2006, 2011 and 2019 as shown in Fig. ( 4).

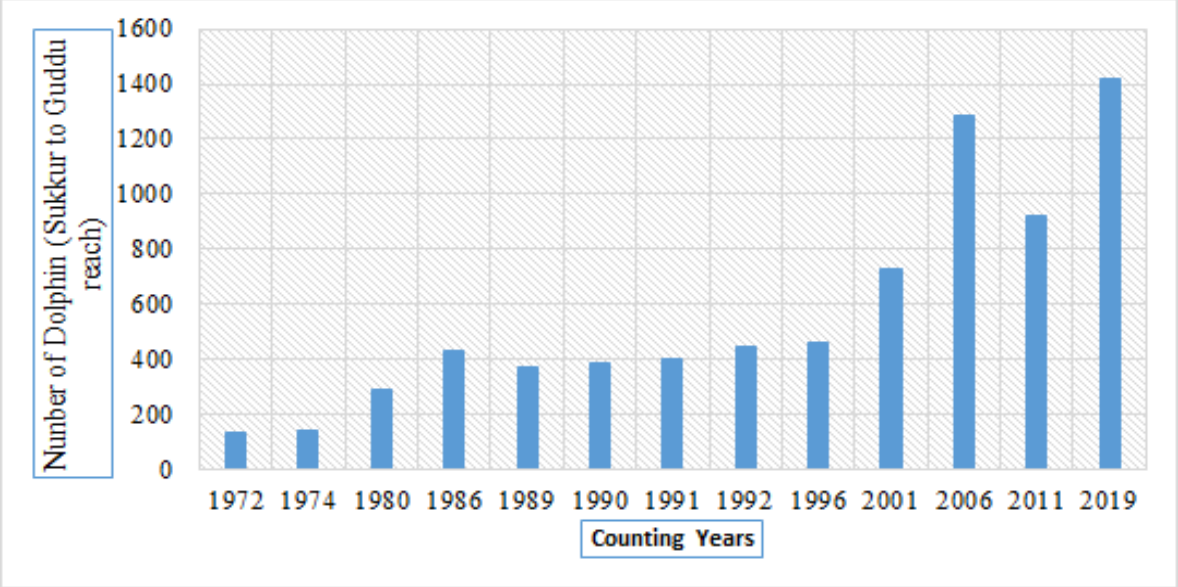


**Fig. 4.** Indus Dolphin population survey from Guddu to Sukkur reaches.

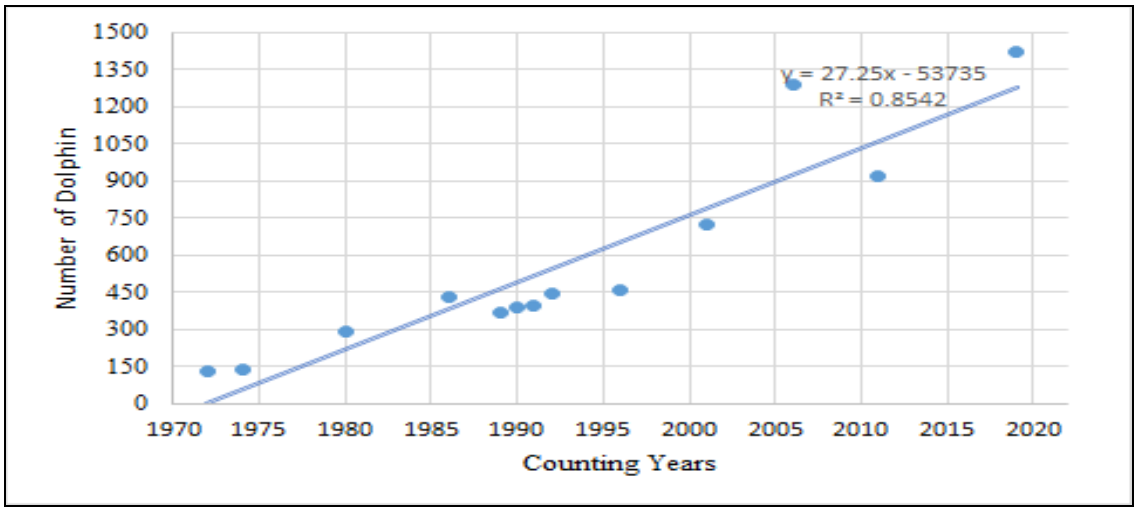


**Fig 5.** Linear relationship b/w counting years and number of Dolphins found

This shows that the Dolphin number in Guddu to Sukkur stretch is increasing gradually year by year, instead of common threats from various activities.

**Fig. (5)** exhibits the linear correlation of the Indus dolphin population survey conducted on the area between Sukkur to Guddu barrage. Statistical analysis was made and R2 recorded value was 0.854. Hence, there is a good linear correlation between Guddu to Sukkur dolphin survey. Regarding the dolphin mortality in the irrigation canals, since the mid-1990s there have been reports of dolphins becoming trapped in irrigation canals. It is believed that dolphins enter the canals while hunting for prey. Dolphins may remain in deeper portions of the canal until annual canal closures where water levels reduce, resulting in dolphin mortality unless these dolphins are rescued. The rescuing centers of Indus dolphin have been established at Sukkur and Guddu barrages to rescue the stranded Indus dolphins from canals barrages. Table (1) shows that Indus dolphins have been rescued by the dolphin rescue team, Sindh Wildlife Department from canals. The number of rescued Indus dolphins was 03, 07, 02, 04, 03, 08, 14, and 02 in years 2012, 2013, 2014, 2015, 2016, 2019, and 2020, respectively. In addition, the construction of cofferdams during the rehabilitation of barrages is another major threat to the dolphins (Fig. 7). The sediment load developed from the construction of the cofferdam also affects the blind dolphin (Fig. 5). A linear relationship b/w counting years and number of dolphins found

**Fig 6.** Construction of Coffer-Dam

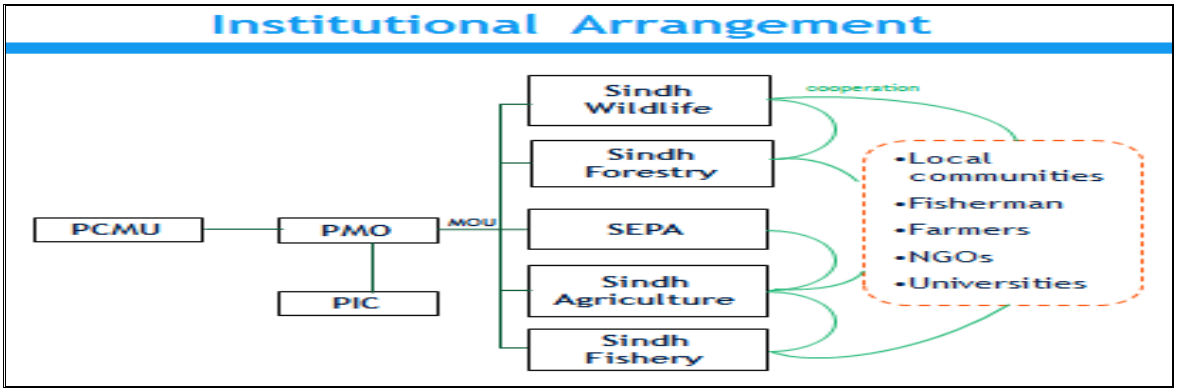


**Fig 7**. Institutional arrangement for conservation of dolphins.

Fig. (7) shows that heavy machinery is used for the construction of cofferdams which create adverse impact directly on dolphins. Therefore, in the rehabilitation works of the barrage, only bulkhead gates have been used instead of the construction of cofferdams for averting the negative environmental impacts on dolphins and biotic life. Pollutions suspected to inhibit the population increase of the Indus dolphin, a phenomenon likely to be exacter bated by the absence of strong water flow. Furthermore, untreated sewage especially from major towns along the Indus River is directly contributing to this pollution, as do other domestic, agricultural and industrial pollutions.

**K. Water Quality:** The water samples at upstream, downstream, Lansdowne Bridge, left and right pockets of Sukkur barrages were collected and analyzed as shown in Table (2). These results revealed that all the tested parameters ( the pH, Cond, TDS; Cl, TH, Alk, SO4, and NO2) were within the permissible limits of drinking water quality as per standards NEQS and WHO as shown in Table (2). Table (4) exhibits the correlation matrix of all parameters of collected samples. The pH has a very strong correlation with NO2 and SO4 and has a strong relation with conductivity and total hardness and alkalinity. While, an almost weak correlation among other parameters was detected. Changes in the environment and climate and natural disasters

are also significant threats to the survival of *Platanista gangetica*. Pollution, heavy siltation, habitat loss, water contamination with industrial, agricultural, or domestic waste, constriction of dams, barrages, irrigation channel, sprays of pesticides, global warming, fertilizers, and pathogens all threaten the current of aquatic biota.

**Table 1.** Population status compared to previous study of the Indus River dolphin at Indus River.

| Rescue of Indus Dolphin | | | | |
|---|---|---|---|---|
| **S. No.** | **Year** | **No of Dolphin Rescued** | **Live Successful** | **Dead** |
| 1 | 2012 | 03 | 03 | 00 |
| 2 | 2013 | 07 | 6 | 01 |
| 3 | 2014 | 02 | 02 | 00 |
| 4 | 2015 | 04 | 03 | 01 |
| 5 | 2016 | 03 | 03 | 00 |
| 6 | 2019 | 14 | 13 | 01 |
| 7 | 2020 | 02 | 02 | 00 |

**Table 2.** Hydrological parameters recorded at different sampling sites during experimental period.

| | **Sampling sites** | **Parameters** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **pH** | **Cond** ***µs/cm*** | **TD** ***mg/L*** | **Cl** ***mg/L*** | **TH** ***mg/L*** | **Alk** ***mg/L*** | **$SO_4$** ***mg/L*** | **$NO_2\mu$** ***g/L*** |
| 1 | Guddu upstream | 8.33 | 492 | 314 | 35 | 60 | 100 | 28 | 1.13 |
| 2 | Guddu downstream | 8.3 | 480 | 307 | 35 | 80 | 100 | 24 | 1.01 |
| 3 | Lans down bridge | 8.38 | 484 | 309 | 28 | 60 | 100 | 26 | 2.14 |
| 4 | Left Pocket of Sukkur barrage | 8.34 | 483 | 309 | 21 | 60 | 100 | 26 | 1.61 |
| 5 | Right Pocket of Sukkur barrage | 8.37 | 494 | 316 | 21 | 70 | 100 | 27 | 2.01 |
| 6 | WHO limits | 6.5-8.5 | 1600 | 500-1000 | 250 | 300 | 300 | 250 | 5 |

**Table 3.** Water quality parameters (Mean±SD) of the Indus River during the experimental period.

| Parameters | Minimum | Maximum | Mean | Standard Deviation |
|---|---|---|---|---|
| Ph | 8.3 | 8.38 | 8.34 | 0.03 |
| Conductivity (µs/cm) | 480 | 494 | 486.7 | 6.1 |
| Total dissolved solids (mg/L) | 307 | 316 | 311.1 | 3.81 |
| Chloride (mg/L) | 21 | 35 | 28 | 7 |
| Total hardness (mg/L) | 60 | 80 | 67.14 | 8.94 |
| Alkalinity (mg/L) | 100 | 100 | 100 | 0 |
| Sulphate (mg/L) | 24 | 28 | 26.14 | 1.48 |
| Nitrite (µg/L) | 1.01 | 2.14 | 1.58 | 0.51 |

## DISCUSSION

The Indus River represents one of the major water distribution systems of South East Asia and the most important river of Pakistan **(Perveen *et al.*, 2011)**. The Indus River, in Pakistan, is one of the world's largest rivers in terms of drainage basin area (970,000 km), discharge, and sediment load. The loss of freshwater inputs and the release of industrial and domestic waste are probably the most serious ecological threats. Indus River carried a lot of silt and suspended solids, which push high total residues and fixed residues reported similar observations **(Braulik *et al.*, 2015)**. Vertebrate diversity is severely affected due to increased anthropogenic activities in aquatic and terrestrial habitats. Ecosystem changes result in changes to the habitats of vertebrate species and to water quality parameters **(Abro *et al.*, 2020; Hassan *et al.*, 2020)**. Changes in the environment and climate and natural disasters are also significant threats to the survival of vertebrate biodiversity. Pollution, water contamination with industrial, agricultural, or domestic waste, sprays of pesticides, fertilizers, global warming, accidental killing during fishing-operations habitat-loss, population-fragmentation and pathogens decline food tropical level affected directly and indirectly the *Platanista gangetica* minor, hence the dolphins became in an endangered condition. A similar finding was detected in the studies of **Braulik *et al.* (2006)**, **Qadir *et al.* (2007)**, **Perveen *et al.* (2011)** and **Hassan *et al.* (2020a)**. The major threats also affect certain factors of the Indus River dolphins including habitat conditions, their early life, feeding, fish fatness, development pattern, overall health, degree of stomach completeness, sexual category, size range, and physical condition. The highest mortality was recorded in 2015 and 2019 compared to other years **(Reeves & Chaudhry, 1998; Moreno, 2004)**. This holistic approach of cleaning the environment to the benefit of all river users could have a positive effect on the dolphin

population by controlling pollution in the food chain **(Waqas *et al*., 2012)**. Growth of the Indus River dolphin showed significant relation with the pH level that recorded a very strong correlation with NO2 and SO4 and a strong relation with conductivity and total hardness and alkalinity. There is an almost weak correlation among other parameters. The DO, conductivity (µs/cm) total dissolved solids (mg/L) chloride (mg/L) total hardness (mg/L) alkalinity (mg/L) Sulphate (mg/L), and the pH values in this study are compatible to grow the Indus River dolphin according to the study of **Gachal *et al*. (2006)** who stated that *Platanista gangetica* minor is a homoeothermic animal. The highest rainfall was observed in October and no precipitation occurred in the month of December. Rainfall doesn't show any relation with growth. Remarkably, the DO is considered the most vital parameter due to its necessity for aerobic metabolism (**Gachal *et al*., 2006; Hasan *et al*., 2020)**. Both the DO and the pH also revealed a correlation with growth. According to **Biswas and Panigrahi (2015)** the desired level of the DO is 5.0 to 15.0 mg/l. At least 3.0-5.0 mg/l of DO is needed for survival. Similarly, the pH value is also considered crucial for any aquatic ecosystem. If the pH value of any aquatic ecosystem is more acidic (pH < 4.5) or more alkaline (pH > 9.5) for a long time, growth and reproduction would be diminished **(Ndubuisi *et al*., 2015)**. In the current study, the pH level ranged from 8.3 to 8.38 indicating a suitable habitat for freshwater resources in the Indus River. The area is also valuable as fuel resources and as a wetland for wildlife. This holistic approach of cleaning the environment to the benefit of all river users could have a positive effect on the dolphin population by controlling pollution in the food chain. The fluctuations in the Indus River dolphin are due to the increased, anthropogenic activities, habitat loss, industrial effluents, and illegal hunting

## CONCLUSION AND RECOMMENDATIONS

To satisfy our desire, the biodiversity of the riverine ecosystem is being adversely affected. As a result, we must implement the best management strategies and take stringent corrective measures against debtors in order to save the organisms until they become extinct in the ecosystem. In this regard, the government and non-governmental organizations (NGOs) must take the lead in promoting Indus River dolphin conservation policies. It is concluded from discussed the common threats to endangered Indus blind dolphin frequent face. Therefore, for addressing these threats, it requires to prepare integrated conservation and management plan for Indus dolphin through taking on board Government departments and related stakeholders. The implementation activities of dolphin conservation and management consisted of periodic dolphin population surveys, identify core dolphin habitat, and establish a permanent dolphin rescue team at Sukkur and Guddu barrages.

**Rehabilitation works of the barrage**

The rehabilitation works of barrages is carried out by replacing gates, repair of civil works, and electro-mechanic for operating of gates of barrage and head regulators. Although the work area became dry, any spilled contaminant enters in to the mainstream when the temporary bulk headgates are removed and the work area flooded such pollutants include spills of oil or grease during the removal, replacement of gates of barrage and head regulators. The major risk to dolphins in this category is due to the relatively high-speed movement of motorboats which are used for transport, fuel, and smaller construction materials. Severity of impact between a dolphin and boat is increased due to high speeds of such plant.

**Mitigation Measures for Dolphin conservation**

Changes in the environment and climate and natural disasters are also significant threats to the survival of Platanista gangetica. Pollution, heavy siltation, habitat loss, water contamination with industrial, agricultural, or domestic waste, constriction of dams, barrages, irrigation channel, sprays of pesticides, global warming, fertilizers, and pathogens all threaten the current of aquatic biota. For successful conservation detect and find out all these major threats to conserve and improve the management of the riverine ecosystems and aquatic resources within the designated Ramsar site between the Guddu and Sukkur Barrage. This objective can be achieved through enhancing ecological values of the riverine ecosystem by conservation and improved management of Indus river dolphin. In this regard minimize (detect) threats and establishing riverine forests, sustainable fishing practices, technical studies; pollution reduction, monitoring water quality parameters, enforcing environmental regulations, and promoting sustainable agriculture, and education and awareness-raising of the general public regarding the importance of the riverine ecosystem.

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