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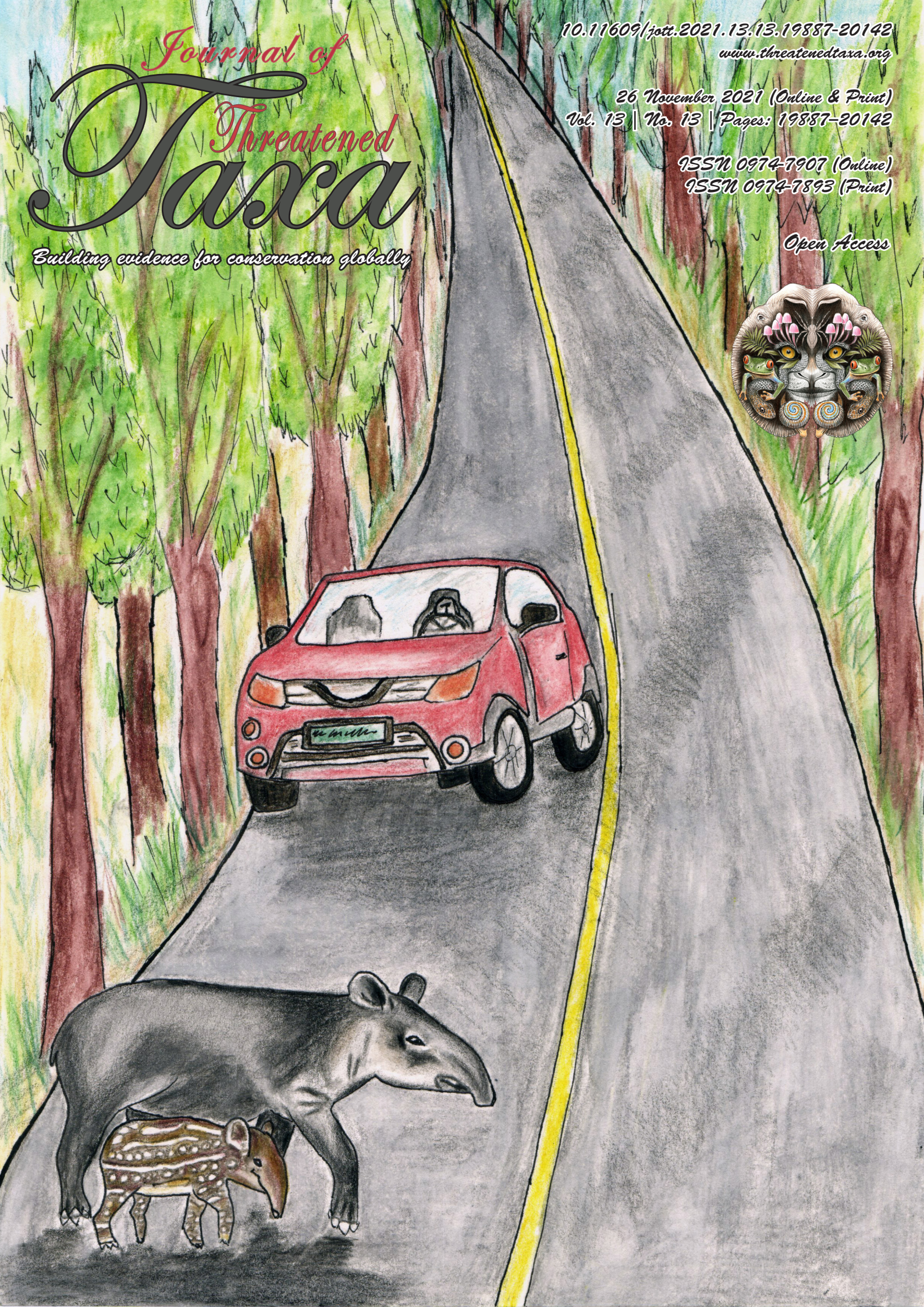

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continued on the back inside cover

Caption: Lowland Tapir *Tapirus terrestris* (Medium—watercolours on watercolour paper) © Aakanksha Komanduri.

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COMMUNICATION

A geographical assessment of Chariganga and Arpara Beel (wetlands) of Nadia, West Bengal as a habitat of wetland birds

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Abstract: The present study attempts to assess the impact of human intervention on the population, distribution, and habitat perspectives of the water birds found in and around Chariganga and Arpara 'Beel' wetlands, leftover channels of the River Bhagirathi. The point count method was adopted during field surveys conducted from April 2019 to March 2020. These wetlands are the natural habitats for 37 species of wetland birds belonging to 18 families and 11 orders, of which 26 species are residents, three are summer migrants, and eight are winter immigrants. The wetlands also harbour 10 bird species whose population is globally declining over the last few decades. Relative Diversity index unveils that among waterfowls Ardeidae is the dominant family. Species richness reaches its peak in winter, and is least during the monsoon. Empirical observation documented one Vulnerable (Greater Adjutant) and one Near Threatened (Black-Headed Ibis) species residing on the banks and adjoining paddy fields. Indiscriminate extraction of wetland products by local people, along with agricultural expansion towards the waterfront of the wetlands, has deteriorated the health of those wetlands and threatened the existence of waterbirds, especially shorebirds. Populations of 22 species living in water edge areas has changed conspicuously owing to cultural and economic activities of neighboring human groups. We suggest improving the ecological balance of the wetlands and restraining further degradation through proper management to preserve avian diversity.

Keywords: Arpara Beel, Avian diversity, Chariganga, relative diversity index, species richness, water birds.

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Author contributions: MHM, AR, and GS has collectively designed the study and collected the data/information through field investigation in different periods. MHM analyze the data and wrote the paper. AR and GS have also incorporated their inputs to improve the quality of the article. All authors read and approved the final manuscript.

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INTRODUCTION

Natural wetlands benefit nearby human communities and serve natural environments in various ways. Floodplain wetlands are among the most productive and species-rich lacustrine ecosystems (Kingsford et al. 2016). As an ecotone located between terrestrial and aquatic ecosystems, wetlands provide enriched habitat for numerous unique, rare, and threatened species of birds, mammals, fish, amphibians, insects, and plants (Stella et al. 2011; Garg 2015). Therefore, they are often judiciously considered as 'Ecological Hotspots' (Ward & Stanford 1995) or 'Biological Supermarkets' (Chen & Zhang 2001; Chen & Lu 2003). Among the sheltered species, water birds possess an important place because of their crucial ecological roles and very useful ecosystem services to the human communities (Bibi & Ali 2013).

The bird species directly or indirectly dependent upon the permanent or semi-permanent water bodies, either sweet or saline, for feeding, breeding and nesting may be grouped as water birds (Kumar & Gupta 2013). As a natural ally of wetland ecosystems, water birds help sustains the ecological balance of the habitats by performing various key functions (Mistry et al. 2008; Slabbekoorm & Ripmeester 2008). They occupy multiple trophic levels of grazing and aquatic food chain and maintain the diversity of other organisms with commensalism (Sharma & Saini 2014). They also help in pest control, propagule dispersal, and nutrient cycling, retarding potential disease outbreaks in and around the wetlands (Green & Elmberg 2014). Waterbirds have been one of the chief sources of feathers, meat and eggs (Krcmar et al. 2010), and they also contribute to cultural or religious values in different parts of the world (Kear 1990).

The habitat preference of birds depends upon various factors, including depth and quality of water, availability of food, nature of vegetation for shelter, degree of human intervention, and the presence of predators and inter-species competitors (Stewart 2001). Owing to their high mobility, birds react quickly to changes in habitat quality (Puri & Virani 2016), thus they are considered to be useful bio-indicators of ecosystem integrity, quality, health and productivity (Kumar & Gupta 2013; Mazumdar 2017). Recent worldwide loss and degradation of wetlands have conspicuously affected water birds through gradual shrinkage in the area and quality of their habitats.

India hosts diverse and unique waterbird species because of its diversity in topography and climate (Prasad et al. 2002). Several studies (Khan 2010; Rajashekara & Venkatesha 2010; Kumar et al. 2016; Kar & Debata 2018) have searched out in-depth accounts of avian species (especially winter migrants) of different wetlands of the country and also endeavored to trace the impact of human intervention on their abundance, density, distribution, and composition. The floodplain wetlands aligned on both sides of river Bhagirathi over the riparian tract of the lower Gangetic plain of West Bengal are a biologically prolific and rich repository of biological diversity (Mukherjee 2008). Various ornithological works have been carried out in different water bodies interspersed over the southern portion of the Bengal delta. The ecological diversity of two oxbow lakes (floodplain wetlands), located at the southeastern part of the Ganges delta has been comprehensively studied by Khan (2002), while the diversity of waterfowl at SantragachiJheel has been studied by Mazumdar et al. (2005). Further, Mazumdar et al. (2007) also assessed and enumerated the composition and diversity of migratory waterbirds in six different wetlands, namely, Nalban Bheri, Santragachi Jheel, Saheb Badh, Bakreshwar Barrage, Tilpara Barrage, and wetlands inside Ballavpur Wildlife Sanctuary of southern West Bengal. On the other hand, Mukhopadhyay & Mazumdar (2019) nicely presented the habitat-wise distribution of birds species in and around the lower Gangetic delta.

Despite facing immense anthropogenic pressures, these wetlands host a wide variety of 'wetland birds' species, both resident and migratory, throughout the year (Mazumdar & Saha 2016). There is a lack of complete accounts of the biological resources of those wetlands, except for Purbashali Lake (Chupi Beel) on the right bank of the river. As a wintering site for migratory birds, Chupi has drawn attention from scholars, whereas other wetlands, including the Arpara Beel and Chariganga, have failed to do so. The composition, distribution, diversity, abundance and threats of the water birds at Purbasthai Oxbow Lake have been extensively evaluated by various studies (Ganesan & Khan 2008; Chowdhury 2015; Ghosh 2016; Mandal 2017; Debnath et al. 2018; Mandal & Siddique 2018; Mandal et al. 2018). The ecological and economic significance of Arpara Beel and Chariganga wetlands is thus yet to be evaluated properly. This study aims to prepare a comprehensive checklist of the water birds found in and around these wetlands, and to assess bird abundance and the effects of human interventions in their habitat.

MATERIAL AND METHODS

Study area

Arpara Beel and Chariganga, two hook-shaped floodplain wetlands at the left bank of the river Bhagirathi in the moribund part of the Ganga Delta (Bagchi 1944) have been selected as the area under study. Given the administrative location, they are situated in the western part of Nakashipara Block of Nadia District, West Bengal (Figure 1). Given that geomorphological specificity, these wetlands are palaeochannels of river Bhagirathi and have been originated through dynamicity of lateral channel shifting with the simultaneous erosion-accretion process. Though direct connectivity with the Bhagirathi River keeps the Chariganga wetland perennial, its water cover area gets receded at dry seasons. The Arpara Beel, on the other hand, is semi-permanent since most of it dries up during summer. Delinked from the prime course of the river, this abandoned channel normally receives no inflow. Both wetlands achieve their full storage capacity only in the monsoon period, when they receive a massive influx of river water. Such spatiotemporal alterations have obvious impacts upon water birds, as well as on the availability and utility of ecosystem services offered by the lake.

Methods of data collection and analysis

Primary data on bird species in the wetlands were collected via frequent field visits and empirical observations once each month from April 2019 to March 2020. The counting process was carried out in the morning and afternoon (i.e., 0600–1000 h and 0400–0600 h) (Kumar & Sharma 2019) following the point count method (Issa 2019; Volpato et al. 2009). A comprehensive checklist of the birds encompassing their common (local) name, scientific name, taxonomic position (orders, families, and species), dispersal status, habitat location, status according to the International Union for Conservation of Nature and Natural Resources (IUCN), global trends of the population, was prepared, according to the works of Praveen et al. (2016), and Issa (2019). The birds are also classified into four sub-groups like Very Common (VC) (nearly 80–100 % during field visit), Common (Co) (50–79.9%), Fairly Common (FC) (20–49.9%), and Rare (Ra) (< 19.9%) based on the frequency of observation (Khan & Nahar 2009).

The relative abundance of bird species was computed with the help of the formula proposed by Torre-Cuadros et al. (2007):

$$RDi = \frac{n}{N} \times 100$$

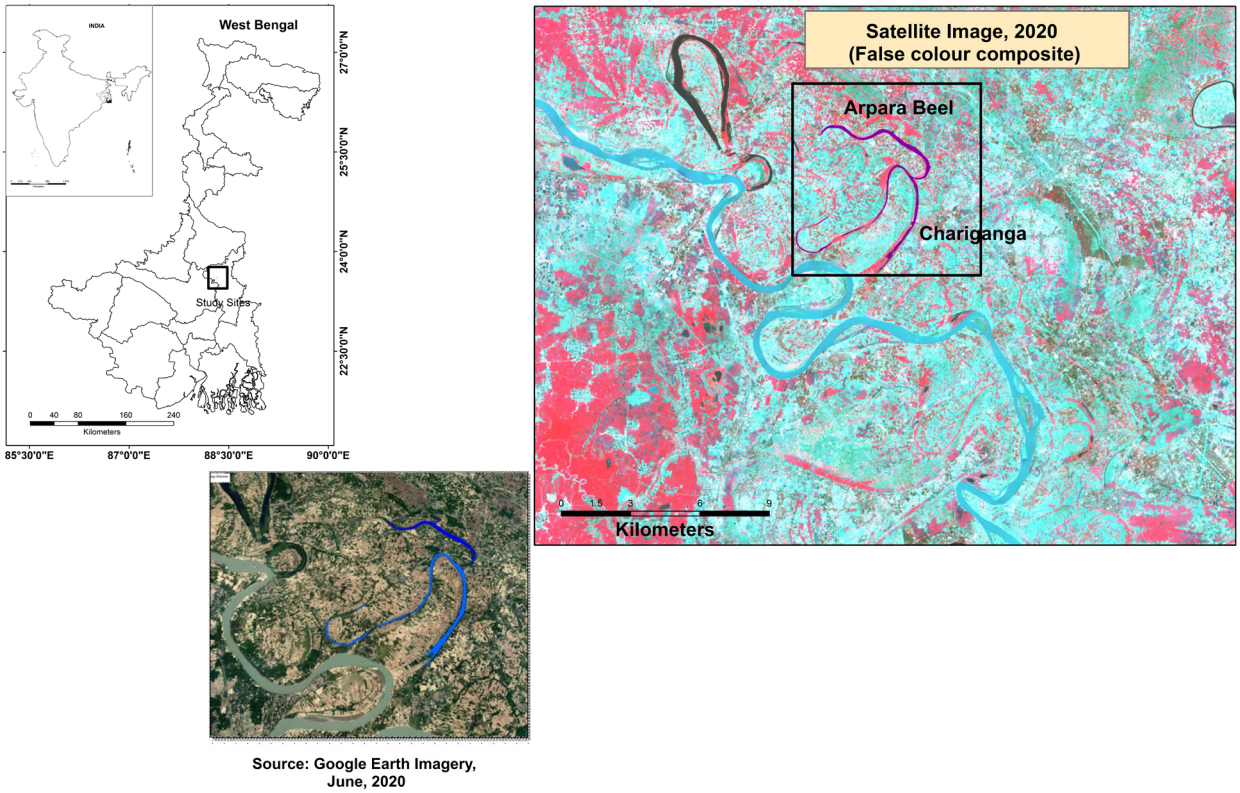

Figure 1. Location of the studied wetlands.

Where, n= Total number of birds in a species, and N= total number of birds across all species

One way ANOVA has been employed to find out the level of seasonal variation in species richness of birds after examining the normality of data through the Shapiro-Wilk test. The entire observation period has been divided into three prominent seasons, i.e., summer or pre-monsoon (April–May), monsoon (June–October), and winter or post-monsoon (November–March) for this purpose.

Subsequently, exhaustive interviews and focus group discussions were also carried out with the nearby people who frequently use these wetlands to assess the degree of people-wetland interdependence and to identify the consequent threats towards the wetlands as a habitat of the wetland birds.

RESULTS

Composition and relative abundance of water birds

Both the selected floodplain wetlands harbour diverse species of plants (hydrophytes) and animals, especially avifauna. These sweet water storages assure ample food and adequate shelter which attract a wide variety of resident waterbird species to settle here throughout the year. Besides, they provide favorable feeding ground to the migratory bird species, especially in the winter season. A total of 37 avian species from 18 families and 11 orders were observed and documented during the survey period, though distinctive variations in species composition between these two wetlands were also documented. All 37 species are found at Chariganga, while 21 species from 14 families were sighted in Arpara Beel. Several common water birds like Little Grebe, Grey Heron, Cotton Pygmy Goose, Yellow Bittern, Indian Black Ibis, Purple Swamphen (or Western Swamphen), White-breasted Waterhen, Indian (Common) Moorhen, and Common Snipe are noticeably less in number in the concerned wetland; moreover, the surveyors couldn't find any member of avian families like Podicipedidae, Rallidae, Scolopacidae, and Hirundinidae in Arpara Beel.

A checklist comprising the order, family, local name, scientific name, dispersal status, habitat location, abundance, IUCN status (2017) and the global trend of populations of the identified bird species is tabulated in Table 1.

The relative diversity of bird families found in both the wetlands is depicted in Figure 2. It has been found that Ardeidae is the most common and abundant family (RDi value: 21.62) which comprises eight species (three types of heron, four types of egrets, and one type of bittern). Followed by Rallidae and Alcedinidae with four species each, with an RDi value of 10.81). It is noticeable that the members of the Rallidae family were not found in and around Arpara Beel. Nearly nine avian families like Podicipedidae, Charidriidae, Scolopacidae, Accipitridae, Hirundinidae, Cisticolidae, Apodidae, Pandionidae, and Meropidae having only one species each have shown the least diversity (RDi value: 2.70) whereas six families' (i.e., Anatidae, Ciconidae, Jacanidae, Threskiornithidae, Phalacrocoracidae, and Motacillidae) represent moderate abundance with RDi value of 5.41 (Figure 2).

Status of water birds

The water birds identified at the selected wetlands have been categorized based on four criteria: A. dispersal status, B. habitat location, C. local abundance, D. trend of the global population, and E. IUCN conservation status.

Most of the wetlands in India provide shelters to a large variety of resident birds (Mukhopadhyay & Mazumdar 2017). The wetlands represent the same status as 3/4th of the avifauna found in the area is resident. Among the 37 bird species, the number of winter migrant species are eight (21.62%) at Chariganga and 5 (13.51%) at Arpara Beel, whereas the three summer migrant species (8.11%) and two (5.41%) at Chariganga and Arpara Beel respectively. Common Snipe, Large Egret, White Wagtail, Citrine Wagtail are the common winter migrants found in the selected area. On the contrary, Lesser Whistling Duck and Cotton Pygmy-goose generally come during the summer season. Nowadays, they have even been reported in the winter season too. Besides, Egrets, Kingfishers, Pond Herons, Black-headed Ibis, Little Grebe, Bronze-winged Jacana, etc are the resident birds of the wetlands and they have frequently been seen during the field survey. The resident avian species comprises nearly 70.28% and 37.84% of the observed avifaunaat Chariganga and Arpara Beel, respectively (Figure 3).

Nearly 59.46% of bird species of Chariganga and 32.43% of Arpara Beel prefers to live in the banks of water bodies. Primarily, long-legged waders and shorebirds (like Asian Openbill, Grey Heron, Black-headed Ibis) have been found to wade in the muddy or sandy bank areas in search of food. Often, they have been observed in the adjoining paddy fields too. On contrary, almost 13.51% and 5.41% of avian species (like Lesser Whistling Duck, Cotton Pygmy-goose, Little Grebe, Indian Cormorant, and Little Cormorant), respectively, in Chariganga and Arpara Beel have been recorded in open water. Remaining birds species (like Palm Swift and various Kingfishers) generally reside in the nearby trees and shrubs, which constitute

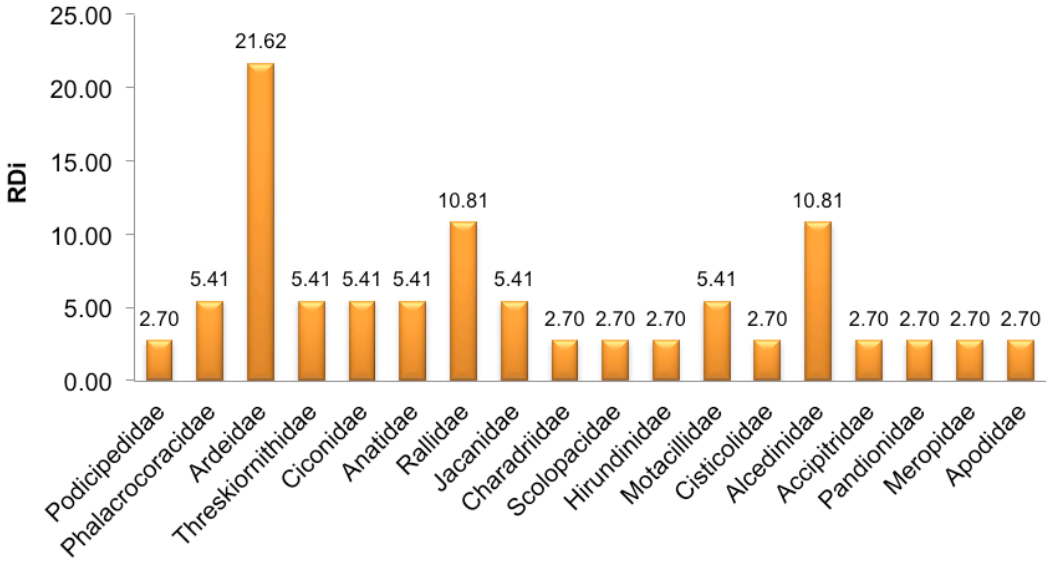

Figure 2. Relative diversity of the bird families recorded in and around Chariganga and ArparaBeel during April 2019 to March 2020.

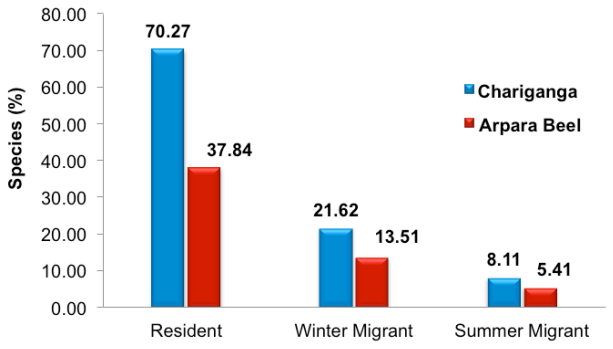

Figure 3. Dispersal Status of the wetlands' birds found in and around Chariganga and ArparaBeel during April 2019 to March 2020.

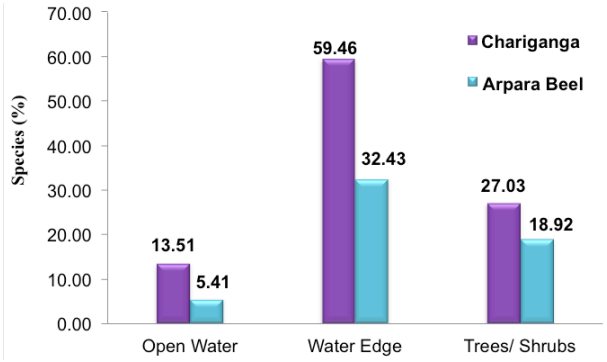

Figure 4. Habitat location of the wetlands' birds found in and around Chariganga and Arpara Beel during April 2019 to March 2020.

nearly 27.03% and 18.92% of identified species of the selected wetlands respectively (Figure 4).

Figure 5 shows the abundance status of recorded species. The proportion of birds in four abundance categories at Chariganga are: 30% Very Common, 13% Common, 30% Fairly Common, and 27% Rare. In Arpara Beel the distribution among these categories was 19%, 11%, 11%, and 16%, respectively, while 43% of available birds were rarely seen during the survey.

Among recorded species 27% of birds at Chariganga and 16% at Arpara Beel have shown negative trends in global population, whereas 11% and 5.4% of birds in the wetlands have shown a positive trend worldwide. Ten species found in the area have shown a gradual decrease in their global population over the past years. Therefore, the importance of the wetlands is irrefutable as the abode of globally declining species. Further, it is worth mentioning that the growth trends of the population are still unspecified at the global level, which is 57% and 30% of the birds at Chariganga and Arpara Beel, respectively (Figure 6).

As stated earlier, the studied wetlands harbor various unique as well as endangered avian species. One classic example is Greater Adjutant, found at both the wetlands, and which has been enlisted as Vulnerable by the IUCN in 2017. The Black-headed Ibis, fall under the Near Threatened category of IUCN (2017), which has also been observed at both of the wetlands.

Temporal variation of bird species

The acquired result of One way ANOVA has depicted highly significant variation (p-value <0.001 at 0.05 significance level) in the seasonal species richness for both the wetlands. The month-wise variation of

Table 1. Checklist of bird species found in and around the studied wetlands during April 2019 to March 2020.

Order	Family	Species/ Common name	Scientific name	Chariganga	Arpara Beel	Dispersal Status	Habitat Location	Abund-ance	IUCN status	Global Population Trend
Podicipediformes	**Podicipedidae**	Little Grebe	*Tachybaptus ruficollis*	√	X	R	OW	VC	LC	↓
Pelecaniformes	**Phalacrocoracidae**	Indian Shag	*Phalacrocorax fuscicollis*	√	√	WM	OW	C	LC	?
		Little Cormorant	*Microcabro niger*	√	X	R	OW	VC	LC	?
	Ardeidae	Grey Heron	*Ardea cinerea*	√	X	R	WE	FC	LC	?
		Indian Pond Heron	*Ardeola grayii*	√	√	R	WE	VC	LC	?
		Night Heron	*Nycticorax nycticorax*	√	√	R	WE	FC	LC	↓
		Cattle Egret	*Bubulcus ibis*	√	√	R	WE	VC	LC	↑
		Intermediate Egret	*Ardea intermedia*	√	√	WM	WE	C	LC	↓
		Great Egret	*Ardea alba*	√	X	WM	WE	FC	LC	?
		Little Egret	*Egretta garzetta*	√	X	R	WE	VC	LC	↑
		Yellow Bittern	*Ixobrychus sinensis*	√	X	R	WE	FC	LC	?
	Threskiornithidae	Indian Black Ibis	*Pseudibis papillosa*	√	X	R	WE	R	LC	↓
		Black-headed Ibis	*Threskiornis melanocephalus*	√	√	R	WE	R	NT	↓
Ciconformes	**Ciconidae**	Asian Openbill Stork	*Anastomus oscitans*	√	√	WM	WE	VC	LC	?
		Lesser Adjutant	*Leptoptilos javanicus*	√	√	R	WE	R	VU	↓
Anseriformes	**Anatidae**	Cotton Pigmy-goose	*Nettapus coromandelianus*	√	X	SM	OW	C	LC	?
		Lesser Whistling Duck	*Dendrocygna javanica*	√	√	SM	OW	VC	LC	↓
Gruiformes	**Rallidae**	Water Cock	*Gallicrex cinerea*	√	X	R	WE	FC	LC	?
		Purple Swamphen	*Porphyrio porphyrio*	√	X	R	WE	R	LC	?
		White-breasted Waterhen	*Amaurornis phoenicurus*	√	X	R	WE	FC	LC	?
		Indian Moorhen	*Gallinula chloropus*	√	X	WM	WE	R	LC	?
Charadriifofmes	**Jacanidae**	Bronze-winged Jacana	*Metopidius indicus*	√	√	R	WE	VC	LC	?
		Pheasant-tailed Jacana	*Hydrophasianus chirurgus*	√	√	SM	WE	C	LC	↓
	Charadriidae	Red-wattled Lapwing	*Vanellus indicus*	√	√	R	WE	R	LC	?
	Scolopacidae	Common Snipe	*Gallinago gallinago*	√	X	WM	WE	FC	LC	?
Passeriformes	**Hirundinidae**	Barn Swallow	*Hirundorustica*	√	X	R	T	FC	LC	↓
	Motacillidae	White Wagtail	*Motacilla alba*	√	√	WM	WE	FC	LC	→
		Citrine Wagtail	*Motacilla citreola*	√	√	WM	WE	R	LC	↑
	Cisticolidae	Plain Prinia	*Prinia inornata*	√	√	R	T	C	LC	?
Coraciiformes	**Alcedinidae**	Pied Kingfisher	*Ceryle rudis*	√	√	R	T	VC	LC	?
		Common Kingfisher	*Alcedo atthis*	√	√	R	T	VC	LC	?
		Stork-billed Kingfisher	*Pelargopsis capensis*	√	X	R	T	R	LC	↓
		White-breasted kingfisher	*Halcyon smyrnensis*	√	X	R	T	VC	LC	↑
Accipitriformes	**Accipitridae**	Indian Shikra	*Accipiter badius*	√	√	R	T	R	LC	→
	Pandionidae	Osprey	*Pandion haliaetus*	√	√	R	T	R	LC	?
Coraciiformes	**Meropidae**	Green Bee-eater	*Merops orientalis*	√	√	R	T	FC	LC	?
Apodiformes	**Apodidae**	Asian Palm Swift	*Cypsiurus balasiensis*	√	√	R	T	FC	LC	?

Dispersal status: R—Resident | SM—Summer Migrant | WM—Winter Migrant | Habitat Location: OW—Open Water | WE—Water Edge | T—Trees and Shrubs | Abundance: VC—Very Common | C—Common | FC—Fairly Common | R—Rare | IUCN Status: LC—Least Concern | NT—Near Threatened | VU—Vulnerable | Trend: ?—Unknown | ↑—Increasing | ↓—Decreasing | →—Stable.

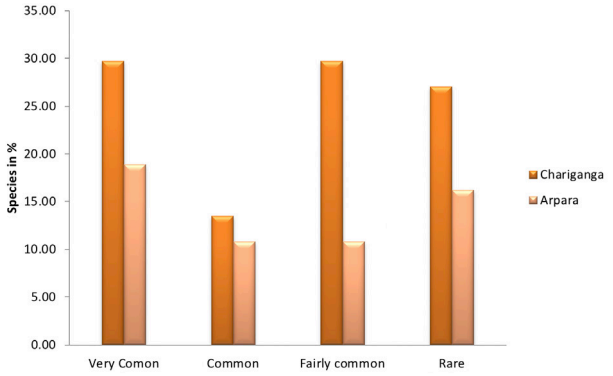

Figure 5. Local abundance status of the wetlands' birds found in and around Chariganga and Arpara Beel during April 2019 to March 2020.

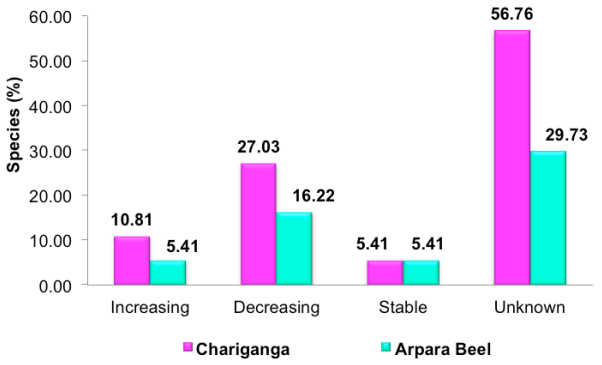

Figure 6. Global trend of population of the wetlands' birds found in and around Chariganga and Arpara Beel during April 2019 to March 2020.

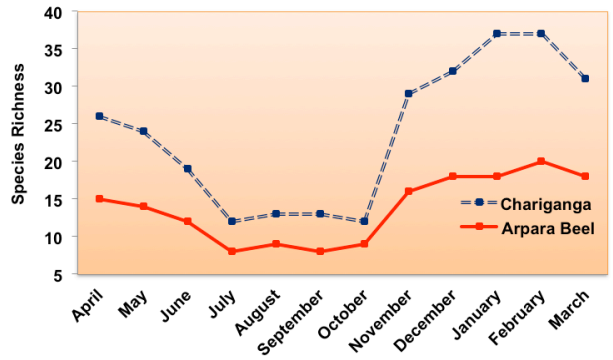

Figure 7. Month wise Variation of Species Richness of the wetlands' birds found in and around Chariganga and Arpara Beel during April 2019 to March 2020.

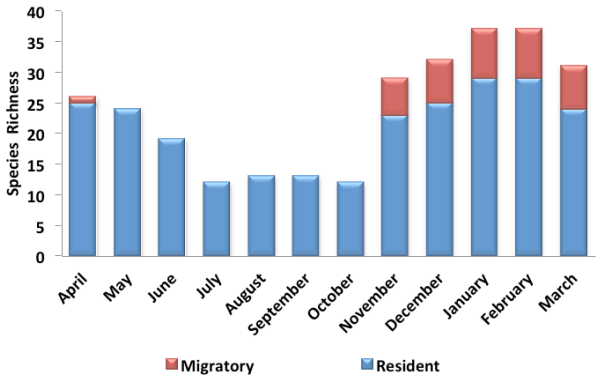

Figure 8. Influence of Winter Migrants in Species Richness of the wetlands' birds found in and around Chariganga and Arpara Beel during April 2019 to March 2020.

abundance of birds species in both the wetlands has been shown in Figure 7. It reveals that the species richness of both the wetlands is comparatively higher during the winter season (November to February), which declines during the monsoon period. A mild but fair inflow of winter migratory birds naturally enhances the species affluence as well as the birds' population (Figure 8). The species richness in Chariganga reaches its crest (N= 37) during January and February, whereas the least richness (N= 12) has been recorded in July and October. Similarly, the maximum and minimum abundance of birds' species at Arpara Beel has been observed in February (N= 20) and months of July and September (N= 8), respectively.

DISCUSSION

The availability of food, preference of habitat location, area of food collection and wading, depth and quality of water, presence of hydrophytes, and nature of the habitat have determined the temporal variation of abundance as well as species richness (Saygili et al. 2011) in and around the lakes under study. The waterfowls of the Anatidae family prefer deep, open water areas clear from submerged/floating hydrophytes (Benoit & Askins 1999; Kumar & Sharma 2019), while the Jacanidae family requires plenty of floating vegetation for food and shelter (Grimmet et al. 2011). Naturally, their occurrences are less and spatially more confined within the habitat. Thus the relative abundance of some birds' families, i.e., Ardeidae, Rallidae, and Alcedinidae is comparatively higher than others in both of the wetlands. Moreover, human activities adversely affect and restrict the abundance of some families like Charidriidae, Scolopacidae, Motacillidaeetc (Mandal & Siddique 2018). The abundance of Swamphens, wagtails and waders is controlled by the availability of food at the nearby agricultural fields (Ringelman 1990). As the average depth in most parts of these wetlands decreases the availability of invertebrates increases (Murkin &

Kadlec 1986), which attracts various birds like egrets and herons of the Ardeidae family, for which the family has recorded its higher abundance. The abundance of Common Moorhen and White-breasted Waterhen birds of the Rallidae family is high at Chariganga because a large part of the water body is covered with dense water hyacinth, water lily, and various types of weeds that attract those birds. But, in the case of Arpara Beel, the Rallidae family is absent, as the maximum part of the wetland either contains shallow water or has been altered into the land (Image 1).

The species richness in both of the wetlands reached its maximum in the winter season due to the arrival of migratory birds. Generally, the winter migrants came into the area in November and some of the species reside here till the end of April. The following diagram (Figure 8) illustrates how the species richness gets influenced by thewinter migrants. But, the utilization of the wetlands for 'boro' (winter paddy) production significantly interrupts the arrival of migratory birds (Image 2).

The massive influx of river water and precipitation in the monsoon helps the full storage condition of the water bodies. Even the low lands, agricultural fields, and shallow surface depressions in and around the selected wetlands often get inundated under stagnant water. Thus, the habitat area of the resident bird's species has seasonally expanded due to the creation of new/ alternative living spaces. The bird's species spread over the vast areas, which has naturally reduced their density in the concerned lake areas. Therefore least species richness has been enumerated during the monsoon months (June to October). On the contrary, the majority of smaller wetlands become dried up in summer, and various birds species gather at the larger wetlands. The water areas become confined in some definite spots (portions) of the wetlands during dry spells (summer and winter) of the year. Under such peculiar circumstances, the gathering of birds' species becomes restricted near the water dots of the wetlands. During this period, summer migrants like Lesser Whistling Duck, Cotton Pygmy Goose, and Pheasant-tailed Jacanas arrive in these wetlands.

Nearly half of the world's wetlands have been lost in the 20th century, and the remaining face serious threats by anthropogenic interventions (Fraser & Keddy 2005). Such loss and degradation have negatively affected the population and distribution of water birds, as they greatly depend upon the wetland habitats for survival (Ma et al. 2010). Since their origin, the concerned wetlands have been rapidly modified by the diverse socio-economic activities of the nearby human group. Focus group discussions and field surveys unveil that these wetlands provide an array of ecosystem services, from provisioning material resources to intangible cultural services, which put a significant impact on the economic and cultural livelihood patterns of the local people. Mandal et al. (2020) have identified 33 ecosystem services (encompassing eight provisioning, 10 regulating, five cultural, and 11 supportive services), extended by these selected wetlands. The local people interact with the wetlands in 13 ways to collect the benefits of the ecosystem services. They have acquired various wetland products like green leafy vegetables, fish, freshwater, forage, fuel, medicinal herbs, humus, and mud. The agrarian community of the area utilizes the wetlands as chief sources of irrigation and often uses the shallow bank areas as crop fields or seedbeds. As a result the collection and extraction of wetland ecosystem services by local people adversely affect the wetlands as the habitat of water birds. But the utilization pattern has shown distinctive changes during the dry and wet spell of the year with the seasonal transformation of the lakes. Both the wetlands have turned into the rich fishing ground during monsoon days with the significant influx of water from the river Bhagirathi, while maximum portions of these two lakes become dried up during dry spells of the year. In such a situation, the local farmers have temporarily altered a considerable proportion of these wetlands into agricultural fields by encroaching and reclaiming the area of the wetlands. Such man-made seasonal transformation destroys the ecological setting of the habitat and has posed serious threats to the existence of the floral and faunal community, especially the avifauna (Image 3).

Over extraction of provisioning, resources have intensified the human pressure, which has diminished the suitability of those lakes as the abode of the birds. As a large part of the ArparaBeel dries up in summer, every exposed and accessible part of the wetland is used for cultivation and grazing purposes. Similarly, a significant part of the submerged bank Chariganga has now been reclaimed and is used by the locals for cropping. Even, a remarkable portion of these two wetlands has been transformed into agricultural and pastoral land perpetually and the water areas have gradually been shrunk. For example, the water cover area of Chariganga has been reduced from 1.45 km^2 in 2010 to 1.05 km^2 in 2020, whereas the areal coverage of Arpara Beel has been reduced from 0.69 km^2 to 0.52 km^2 in 2020 due to anthropogenic interventions.

Such human-induced artificial alteration of the transitional areas has damaged the ecological niche of

Image 1. A & B showing habitat status of Chariganga, filled with water hyacinth and weeds, helps birds to settle, whereas C & D showing habitat status of Arpara Beel, used as pasture land and agricultural filed. © Authors.

the water birds, especially of the waders. It has brought profound adverse effects on the population and species diversity of the bird community. Once, Arpara Beel served the local people with various ecosystem services. Human intervention to grab that service led to serious damage to the wetland. As a result Arpara Beel now does not produce many resources for human beings except agricultural land and pastoral ground. Moreover, it has lost its quality as a habitat of avifauna thus the species richness of waterbirds is less in comparison to Chariganga Beel. In a similar way jute retting, wetland agriculture, the transformation of parts of Chariganga as pasture land, acting as garbage disposal center, pollution from pesticides coming from surrounded crop fields,etc are major threats to Chariganga Wetland. Local people have opined that the abundance of birds has gradually declined over time in the case of Chariganga also. The numbers of diverse bird species seen in winter are also reduced in number for enhanced human intervention, compared to the earlier phases of evolution of the concerned wetland. Though species richness is higher at Chariganga, it is now under tremendous pressure of human intervention which should be controlled otherwise Chariganga wetland will be a lost habitat for water birds.

CONCLUSION

The present study highlights the importance of the two selected wetlands as a habitat of residents as well as migratory birds species. But, fragmentation of the habitat by human encroachment and pressures has threatened the existence of the local birds. Recent agricultural extension, as well as arbitrary extraction of wetland resources, is instrumental to the tremendous degradation of those wetlands, which has posed a conspicuous impact upon the size, richness, and distribution of the birds' species. Predominantly, the bank areas have now been altered into the zone of

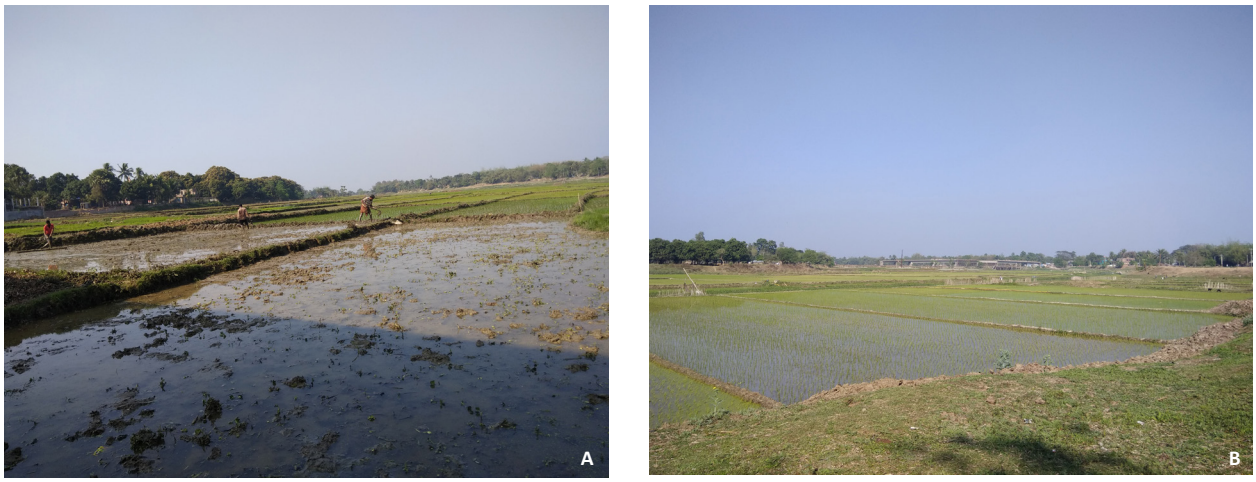

Image 2. A & B *Boro* cultivation at Arpara Beel. © Authors.

Image 3. Human encroachment and habitat alteration at both the wetlands in the dry period: A & B Arpara Beel; C & D Chariganga Beel. © Authors.

human-birds conflict. Thus the ecological setup of such areas has been disrupted which has directly been consequent upon the avian species. The importance of the resident birds in maintaining local ecological equilibrium should not be denied rather appreciated. Thus their habitat needs to be conserved essentially with a sustainable management plan that would benefit both the birds and the other stakeholders of the wetlands.

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