Study on the diversity of birds in the new abode of wetlands created by the 2004 tsunami in South Andaman

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Abstract: Subsidence and upliftment of landmass were encountered in Andaman & Nicobar Islands due to the 2004 tsunami. The subsided landmass at the coastal front was permanently waterlogged ensuring a conducive new habitat for wetland birds. Pre- and post-tsunami Landsat satellite data products were used to demarcate the permanently waterlogged areas. A total of 63 bird species belonging to nine families comprising of five orders were identified and documented through direct observation technique in six stations of the 2004 post-tsunami-created wetlands in South Andaman. Order Charadriiformes and Anseriformes recorded the highest (47.62%) and least (4.76%) taxonomic composition of wetland birds, respectively. Scolopacidae family recorded the highest (56.67%) species composition. Among the six stations, the highest diversity of birds was observed in Sippighat and Ograbraj stations.

Keywords: Andaman birds, geographic information system (GIS), landmass subsidence, remote sensing, Tsunami-created wetlands (TCW), wetland biodiversity.
INTRODUCTION

The 26 December 2004 (Sumatra-Andaman) was one of the two recent tsunamigenic mega earthquakes that unleashed a tremendous catastrophic impact on the human race and the environment (Malik et al. 2019) which struck near Indonesia with a magnitude of 9.3 on the Richter scale (Stein & Okal 2005; Garay & Diner 2007). The epicenter was situated 80 km west of the coast of northern Sumatra (at approximately 95.85W and 03.41N). The seismic wave thereafter advanced approximately northward rupturing the 1,300-km Andaman-Sunda plate (with an average rupture speed of 2.5 to 3 km/s) in about 8 to 10 minutes (Ammon et al. 2005; Bilham et al. 2005; Lay et al. 2005; Subarya et al. 2006; Malik et al. 2011) resulting in up to ~6 m of bottom subsidence and ~10 m of upliftment parallel to the rupture and about 100–150 km wide across the subduction area (Malik & Murty 2005; Ioualalen et al. 2007; Malik et al. 2011, 2015). Upliftment and subsidence of landmass were caused as a consequence of earthquake elastic rebound, offshore of Banda Aceh, the northern tip of Sumatra (Bilham 2005). The tsunami waves which surged across the ocean with a velocity of 900 km/h and took a devastating wave height of 10 m with a speed of 40 km/h along the coastal frontiers (Bahuguna et al. 2008) resulting in permanent waterlogging in landmass subsided zones (Shankar et al. 2019). These waterlogged areas were called tsunami wreaked Wetlands (TCW) and they became a favorable habitat for the water birds. The avian diversity of ANI is well documented by various studies (Pande et al. 2007; Sivaperuman et al. 2010, 2018). Thus, there is a lack of studies about the diversity of birds post 2004 in the TCW thus created and this study is a first of its kind. The study was initiated to understand the diversity and distribution of birds in the six TCWs of South Andaman (Figure 1).

ANI comprises of nine national parks, 96 sanctuaries, and one biosphere reserve (Rao et al. 2013; FSI 2019).

ANI were the first responders to the 2004 tsunami among other territories of India because of its closest proximity to the epicenter. Due to this tsunamigenic mega-earthquake, the ANI experienced both upliftment and landmass subsidence (Nehru & Balasubramanian 2011, 2018) creating permanently waterlogged areas (Shankar et al. 2019). These waterlogged areas were called tsunami wrecked Wetlands (TCW) and they became a favorable habitat for the water birds. The avian diversity of ANI is well documented by various studies (Pande et al. 2007; Sivaperuman et al. 2010, 2018).

MATERIALS AND METHODS

Pre (2003) and post (2018) tsunami Landsat satellite images, ArcGIS 10.5, Garmin 60 CxS handheld global positioning system (GPS), binocular, and camera were used to comprehend the objective of the present investigation.

Landsat (7 & 8) satellite data products before (2003) and after (2018) tsunami respectively for the study were downloaded from the website (www.earthexplorer.usgs.gov/). The study area is covered by the scene with path (134) and row (52). Mangrove patches and water bodies decipherably picked up very well by band-5 and band-6 by the short-wave infrared (SWIR) sensor of Landsat 7 and 8 satellites respectively from other features like forests and human settlements. six TCWs were chosen for the assessment of wetland avian diversity (Figure 1) using the leads from pre- and post-2004 tsunami satellite images. These six birding locations are Stewartgunj, Ograbraj, Sippighat, Wandoor, Chidiyatapu, and Carbyn’s Cove (Table 1, Image 1,2). Field visits were carried out from November 2018 to March 2020. Each of these six sites was periodically revisited every month on weekends (Saturday and Sunday) at 0600–0900 h during the aforementioned period. Upon reaching the field using binocular the birds were observed directly (Altman 1974) and identified using the identification keys by Ali (2002) and Grimett et al. (2012). Also, the identified birds were cross verified with the checklist of Pande et al. (2007) and Sivaperuman et al. (2018). Thus, the distribution of wetland birds in TCWs of six villages...
Mangrove swamps were the ancestral abode to the wetland birds of the study area (Figure 1). Physical fury, subsidence of landmass, and permanent water logging due to the 2004 tsunami resulted in massive destruction of mangroves (Roy & Krishnan 2005; Nehru & Balasubramanian 2011; 2018; Shankar et al. 2019). Thus, the wetland birds were flushed out of their original habitat and were resilient to adapt to the post-tsunami newly created habitat. All the six study sites’ visual interpretation of pre (2003) and post (2018) tsunami satellite data articulates the loss of mangrove habitat and the areal extent of the TCWs are presented in Table 1. The mangrove swamp at Ograbraj (10.31 ha) was completely wiped out by the 2004 tsunami. On the other hand, the mangrove swamp of Carbyn’s Cove (0.66 ha) was spared, while the subsidence of landmass resulted in the creation of wetland after the tsunami at Stewartgunj. Sippighat mangrove swamps were one of the worst affected habitats in the study area (Roy & Krishnan 2005; Yuvaraj & Dharanirajan 2013; Das et al. 2014; Shankar et al. 2019) as only 37.37 ha (2018) of mangroves survived out of the 130.05 ha (2003). The chosen six birding locations have unique importance, Chidiyatapu is an internationally known birding location in Andaman. While Wandoor is covered under the Mahatma Gandhi Marine National Park (MGMNP). Stewartgunj is situated at the foothills of Mt Harriet National Park. Ograbraj located close to Sippighat (~3 km across the sea), massive mangrove habitat destruction was observed in these two locations.

A total of 63 birds were observed through the direct observation technique and identified using keys by Ali (2002) and Grimett et al. (2012). These 63 wetland birds (Figure 2a) encompassed in five orders, viz., Anseriformes (3 species; 4.76%), Coraciiformes (8 species; 12.70%), Gruiformes (9 species; 14.28%), Charadriiformes (30 species; 47.61%), and Pelecaniformes (13 species; 20.63%). Order Anseriformes, Coraciiformes, Gruiformes, and Pelecaniformes comprise of one family each, viz., Anatidae, Alcedinidae, Rallidae, and Ardeidae. Charadriiformes (Figure 2b) was the most diverse order comprising of five families, viz., Burhinidae (1 species; 3.33%), Charadriidae (7 species; 23.33%), Jacanidae (1 species; 3.33%), Laridae (4 species; 13.33%), and Scolopacidae (17 species; 56.66%). Among the 63 birds only two species, viz., Andaman Crake *Rallina canningi* and Andaman Teal *Anas albogularis* are endemic.

According to IUCN version 3, of the identified 63 wetland birds majority (57 species; 90.47%) are Least Concern (LC), five species (7.93%) are Near Threatened (NT), and one species (1.58%) is Vulnerable (VU) categories. Chinese Egret *Egretta eulophotes* is the only Vulnerable species belonging to the order

**RESULTS AND DISCUSSION**

Table 1. Before and after tsunami areal extent of wetlands (Mangrove stand in ha).

<table>
<thead>
<tr>
<th>Village name</th>
<th>Before Tsunami</th>
<th>After Tsunami</th>
<th>Area of TCW (ha)</th>
<th>Before tsunami land use apart from Mangrove</th>
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<td>Chidiyatapu</td>
<td>18.42</td>
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<td>Sippighat</td>
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<td>37.37</td>
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<td>Carbyn’s Cove</td>
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<td>0.66</td>
<td>4.20</td>
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<td>Stewartgunj</td>
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</table>

Figure 1. Study area map.
Pelecaniformes. Whereas, Andaman Teal \textit{Anas albogularis}, Curlew Sandpiper \textit{Calidris ferruginea}, Eurasian Curlew \textit{Numenius arquata}, Bar-tailed Godwit \textit{Limosa lapponica}, and Beach Thick-Knee \textit{Esacus magnirostris} are Near Threatened. The complete list of birds is in Table 2, Image 3. According to the Indian Wildlife (Protection) Act, 1972, one species (Andaman Teal) was listed under Schedule I; and all the 63 species were included in Schedule IV.

Wards cluster analysis (Figure 2c) articulates two distinct clusters. Cluster 1 comprises Wandoor and Carbyn’s Cove. Eleven and 18 wetland birds were identified from two sites of Wandoor and Carbyn’s Cove. The species diversity was found to be low in these two sites when compared to the other four locations. Low levels of species diversity in Carbyn’s Cove and Wandoor are probably due to the frequent movement of tourist vehicles and fishing boats in these two sites. In addition to tourism, the movement of vehicles and the closest proximity of human settlements around the wetlands has threatened the birds in Carbyn’s Cove. Cluster 2 is further classified into two sub-groups. Ograbraj and Sippighat exhibit a high degree of species diversity. These two stations comprise 53 and 54 wetland birds, respectively. Before the 2004 tsunami, Sippighat was the abode for wetland birds. The massive mangrove habitat loss (80%) in Sippighat (Roy & Krishnan 2005) and a complete wipe of the mangrove swamp in Ograbraj (Shankar et al. 2019) flushed the wetland birds to the newly created habitat of TCW. The vast expanse of permanent waterlogging with suitable prey base availability in these sites would have the wetland birds adapt to the new environment. We assume this could be the reason for the high diversity observed in both Sippighat and Ograbraj sites. Stewartgunj and Chidiyatapu form another subgroup of cluster 2. A retrospection of pre-and post-tsunami satellite data products (Image 1) articulates that the shoreline has migrated inwards to Stewartgunj due to the subsidence of landmass thus responsible for the migration of wetland birds to the new habitat.

Before the 2004 tsunami impact, agriculture was extensively practiced on the coastal plains of Sippighat and Ograbraj (Rajan & Pramod 2017). The loss of natural habitat due to tsunami had led to the migration of the wetland birds to the new habitat (permanently waterlogged subsided landmass).
### Table 2. wetland-wise avian diversity.

<table>
<thead>
<tr>
<th>Order</th>
<th>Family</th>
<th>Common name</th>
<th>Scientific name</th>
<th>Status</th>
<th>IUCN Red List status</th>
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Diversity of birds in wetlands created by 2004 tsunami

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CONCLUSION

The present study is the first of its kind to document the diversity of wetland birds in the last two decades. This study contributes to the rich bird diversity recorded in earlier studies of the Andaman & Nicobar Islands. Various tools like GIS, remote sensing, and on-field direct observation were comprehended to achieve the objective of the present investigation in pre and post-tsunami bird diversity and TCW. Land reclamation from these newly created wetlands is on the rise since it is in private ownership thus threatening the diversity of these wetland birds. A conservation drive is recommended for the conservation of these wetland birds.

REFERENCES


**Table:**

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Image 3. Field photos of wetland birds. a—Common Moorhen | b—Purple Swamphen | c—Andaman Teal | d—Striated Heron | e—Lesser Whistling Duck | f—Pheasant-tailed Jacana.
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