

**Biodiversity status and conservation of Rudrasagar Lake
A Ramsar site in Tripura, India**

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Abstract :

Rudrasagar lake is a Ramsar site located in Northeastern state of India, Tripura. It was designated as a Ramsar Wetland on 8th of November, 2005. The area provides rich biological diversity of waterbirds and aquatic flora and is a perching ground for a large number of migratory birds. During the study, a total of 12 species of birds belonging to 5 families were recorded. All the recorded species were residents. The Shannon biodiversity index for the bird population was estimated at +2.1865, which signifies that the bird population in this lake is moderately diverse. Baer's Pochard, which is a critically endangered diving duck and Three striped roofed turtle, whose IUCN status is critically endangered is also present in this lake. The lake provides many ecosystem services. Related information regarding the health of the lake, decrease in waterfowl population over the years, increase in tourist activities and water pollution were obtained by interviewing a few boat sailors and locals. A few important conservation problems were hydrological regime alteration (hydrological intervention), pollution and disposal of urban sewage, poaching, siltation, excessive fishing, encroachment of invasive species and regime fragmentation by roads leading to habitat alteration. Habitat improvement for waterfowl and the conservation of the rich biodiversity is essential for this Ramsar site.

Keywords :

Rudrasagarlake, wetland, biodiversity, conservation, Ramsar site.

Tripura is one of the North Eastern States of India, which is bounded by latitudes 22°56' N to 24°32' N and longitudes 91°10' to 92°21' E. About two-third of the State is under forest cover where different species of flora, orchards, birds and wildlife are found. Our study area, Rudrasagar Lake (Figure 1) is located in Melaghar of Sepahijala district. The lake is present at a distance of 52 kms from Agartala, the capital city. The lake area is bounded by latitudes 23°28' N to 23°33' N and longitudes 91°16' E to 91°20' E (Barman et al., 2013). It is a natural sedimentation reservoir which receives flow from three perennial streams, viz., Noacherra, Durlavnarayan-cherra and Kamtali-cherra. After offloading the sediment of these flows, fairly clear water discharges into river Gumti through a connective channel named "New - Karchi". The lake bed has been formed by the deposition large amounts of silt. Surrounding hillocks are of soft sediment formation. Due to deforestation and degradation of forest land as well as nine intensive agricultural activities in the catchment of these three cherras and periphery of the water body, there is high silt deposition and piling up of other debris in and around the lake. Due to this reason water-depth of the lake is gradually decreasing. The present water depth varies from 1m to 2m in dry season and about 7m to 8m in peak flood condition. The present water spread area during dry spell is around 100 ha corresponding to lake water level at 9.0m (Barman et al., 2013). This water spread area of the lake ex-

tends to about 1,470 ha corresponding to lake-water-level at 15.0m. The average annual rainfall is of the order of 2,500 mm, bulk of which occurs during four monsoon months from June to September. The soil in the lake area varies from “silty-clay loam” to “loamy”. Lake water is quite fresh, having low to insignificant pollution.

Rudrasagar Lake is also popular for the historical monument “Neermahal”, the Royal Water Palace, which is located in the middle of this lake. Maharaja BirBikram Kishore Manikya, the ruler of Tripura in pre-independent India, constructed the Palace, “Neermahal” at the northern part of the lake and used it as a summer resort. Presently this Palace is maintained by the State Government and has become a major “Tourist Centre”. The Tourism Department has also prepared a Master Plan for Development of “Neermahal Palace-Complex” to attract domestic as well as foreign tourists. This lake attracts a lot of migratory birds annually. An annual boat festival is organized every year during July/August.

The entire area of Rudrasagar Lake is used for fishing purpose by the members of the Co-operative Society. In the year 1952, a group of 1,000 persons (refugee fishermen) were rehabilitated in this area by the Government and fishing rights in the water body was given to them. A Co-operative SamabayaSamity was formed by them for their allround development. It was revealed that RudrasagarUdbastuMatasyaSmabaySamiti (RUMSS) had leased the entire area to local residents for pisciculture, agriculture, for setting brick industry or other related activities.

The aim of this project is to raise awareness about the increasing pollution of the Ramsar site and declining biodiversity as a result of habitat loss.

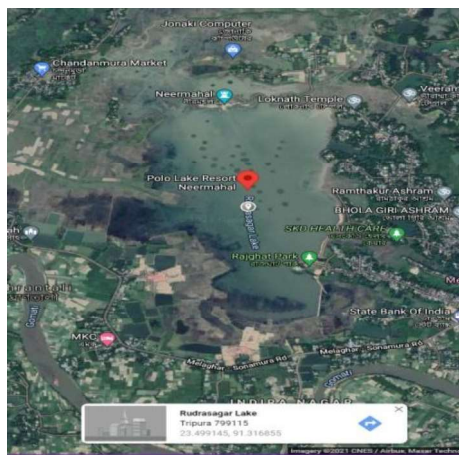


Fig 1: Map of Rudrasagar lake

Rudrasagarlake was recognised as a Ramsar site on 08.11.2005 and the status as a wetland of international importance was received on 29.2.2007. Ramsar Convention, an international agreement for wetlands, signed in 1971, came into force in 1975. It is an intergovernmental treaty, which provides the bodywork for national action and international cooperation for the conservation and shrewd utilization of wetlands and their reservoir, based on several selection

criteria. International network of wetlands is important for conservation of global biological diversity and for sustaining human life through maintenance of their ecosystem components, processes and services. The RSIS [Ramsar site Information Sheet] uploaded by the Ramsar manager of the State to Ramsar website (<https://www.ramsar.org/wetland/india> and www.ramsar.org) periodically monitored and evaluated National River Conservation Directorate [NRCD] under 18 MOEFCC (Ministry of Environment, Forest and Climate Change), New Delhi.

Rudrasagar Wetland needs to maintain and ensure following eight criteria indispensably to retain the Ramsar Status :

1. The site should contain representatives of rare and unique wetland types. [Rudrasagar having a rare bird reported to MOEFCC – Bayer's Pochard (Choudhury, 2010)].
2. Should support vulnerable, endangered, or critically endangered species or threatened ecological communities. [Rudrasagar having a rare turtle reported to MOEFCC – IUCN Red listed three-striped roof turtle, *Kachugadhongoka*].
3. Site should support populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region.
4. Must support plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.
5. The Ramsar site should regularly support 20,000 or more water birds.
6. Also regularly support at least 1% of the individuals in a population of one species or subspecies of water bird.
7. Important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.
8. The site must regularly support 1% of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.

Materials and Methods :

The study was conducted in the month of March 2021 and the bird population was estimated on the basis of number of birds observed. Observations were made on foot and during boat rides, during which several birds were recorded. A few boat sailors and villagers were interviewed during the fieldwork.

Point transect method or point count method was used for measuring the bird population. This method is used to estimate changes in bird population annually and abundance of species at particular locations. For this method of sampling, the observer need to remain in a particular place for a fixed time period and the number of birds are to be recorded accordingly (Cox et al., 1977). Four point counts were conducted during this study at an interval of about 50-100 metres. The study was conducted for four subsequent days in the early morning and the sum total of these four observations has been recorded in Table 2. Tropical waterbirds were counted at aggregations and some others were counted along the watercourse through boat ride (example: herons). Ducks and geese were identified from clumped bird colonies and also individually. The flocks of birds were generally noticeable and they moved around swiftly. Devices used for photography were Nikon z50 and cell phone. Abundance and evenness indices were also calculated from the observed data.

Observations :

Rudrasagar covers a variety of habitats, which sustain rich biological diversity. Rudrasagar supports large congregations of resident and migratory waterbirds. It provides refuge to large number of Ducks and Geese, Coots, Cormorants and Herons. Asian Open Billed Stork, Brahminy Kite, Pygmy Cotton Goose, Painted Stork, Grey Heron, Purple Heron, Night Heron, Large Egret, Intermediate Egret, Little Egret, Cattle Egret, Black Headed Ibis, Little Cormorant, Indian Shag, Large Cormorant, Indian Darter and Eurasian Spoonbill are some species that have been observed in the lake. Besides the fauna, a wide variety of aquatic flora is also being observed in Rudrasagar (Table 1).

Aquatic Flora: The plant species which were observed are important for maintaining the healthy habitat of this Ramsar site. Several aquatic plants were identified from Rudrasagar-lake in which some are edible, others have medicinal value and some are also used as fencing and fertilizer(Taran et al., 2017).The detail uses of identified species are mentioned in Table 1. The lake also supports various plant species surrounding it, which are used as timber and fuelwood. Fuelwood is used for cooking food, burning bricks and preparing charcoal. It also contributes to the total revenue of the Rudrasagarlake.

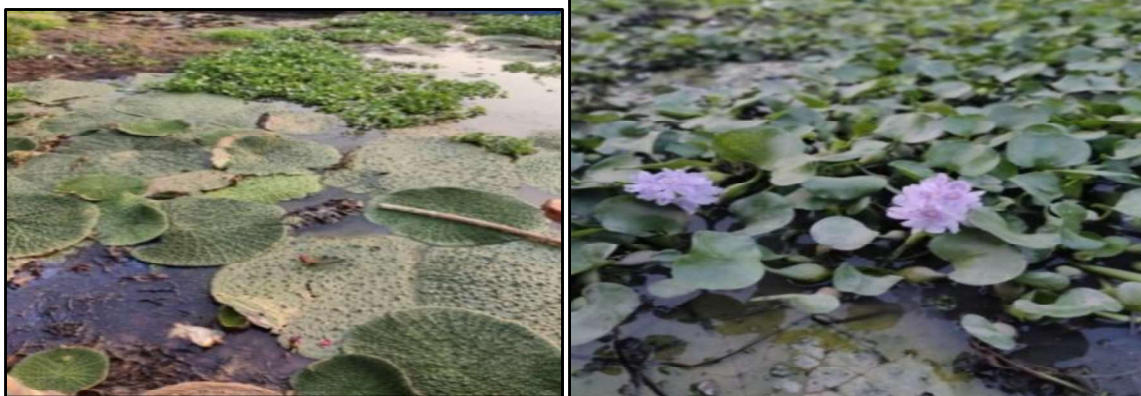


Fig 2: Prickly Water Lily (*Euryale ferox*) Fig 3: Water Hyacinth (*Eichhornia crassipes*)



Fig 4: Large Egret

Fig 5: Asian Open Billed Stork

Fig 6: Cotton Pygmy Goose



Fig 7: Mallard and Lesser Whistling Duck



Fig 8: Black kite

**Table 1: List of Aquatic Plants present in Rudrasagar Lake
(Taran. M and Deb. S., 2017)**

No.	Name of the plants	Family	Uses
1.	<i>Eichhornia crassipes</i> (Mart.) Solms	Pontederiaceae	Used as fertilizer and reduce oil in water.
2.	<i>Enhydra fluctuans</i> Lour.	Asteraceae	Leaves of <i>Enhydra fluctuans</i> are eaten as salad or vegetable.
3.	<i>Euryale ferox</i> Salisb.	Nymphaeaceae	Used as vegetable by some tribal community.
4.	<i>Hydrilla verticillata</i> (L.f.) Royle	Hydrocharitaceae	Used for blood sugar control.
5.	<i>Hygroryza aristata</i> (Retz.) Nees ex. Wright & Arn.	Poaceae	Used to treat urinary diseases.
6.	<i>Ipomoea fistulosa</i> Mart. Ex Choisy.	Convolvulaceae	Stems are used for fencing.
7.	<i>Ludwigia adscendens</i> (L.) H. Hara	Onagraceae	Aerial parts are used for treating skin complaints.
8.	<i>Ludwigia octovalvis</i> subsp. <i>Sessiliflora</i> (Micheli) P. H. Raven	Onagraceae	Decoction of the aerial parts is used as a treatment for dysentery, fever and cough
9.	<i>Nymphoides indica</i> (L.) Kuntze	Menyanthaceae	Used to reduce fever.
10.	<i>Nymphaea micrantha</i> Guill. & Perr.	Nymphaeaceae	Seeds are eaten by local people.
11.	<i>Nymphaea rubra</i> Roxb.	Nymphaeaceae	Young leaves and unopened flower buds can be boiled and served as a vegetable.
12.	<i>Persicaria hydropiper</i> (L.) Delarbre	Polygonaceae	Leaves are used as a vegetable.
13.	<i>Polygonum barbatum</i> L.	Polygonaceae	Roots are used as astringent.
14.	<i>Potamogeton octandrus</i> Poir.	Potamogetonaceae	Young leaves and shoots cooked as vegetable.
15.	<i>Sagittaria guayanensis</i> Kunth	Alismataceae	Used for making fertilizer.
16.	<i>Salvinia cucullata</i> Roxb.	Salviniaceae	Root is suitable for egg laying of fishes.
17.	<i>Trapa natans</i> var. <i>Bispinosa</i> (Roxb.) Makino	Trapaceae	Used as edible fruit.
18.	<i>Utricularia aurea</i> L.	Lentibulariaceae	Edible and used to treat urinary diseases.
19.	<i>Vallisneria spiralis</i> L.	Hydrocharitaceae	The plant is considered to be refrigerant, demulcent and stomachic; used in the treatment of leucorrhoea.

Aquatic Fauna:

Table 2: Distribution of observed bird species at Rudrasagar Lake

SL. No.	Family	Common name	Scientific name	Acronym	Number observed
1.	Ciconiidae	Asian open billed stork	<i>Anastomusoscitans</i>	AOS	1
2.	Accipitridae	Brahminy Kite	<i>Halliastrurindus</i>	HIN	1
3.	Accipitridae	Black kite	<i>Milvusmigrans</i>	MMI	2
4.	Ardeidae	Purple heron	<i>Ardeapurpurea</i>	APU	1
5.	Ardeidae	Large egret	<i>Ardea alba</i>	AAL	3
6.	Ardeidae	Little egret	<i>Egretta garzetta</i>	EGA	2
7.	Phalacrocoracidae	Little cormorant	<i>Phalacrocoraxniger</i>	PNI	1
8.	Anatidae	Lesser whistling duck	<i>Dendrocygnajavanica</i>	DJA	9
9.	Anatidae	White pekin	<i>Anasplatyrhynchos</i>	APL	5
10.	Anatidae	Cotton pygmy goose	<i>Nettapuscoromandelianus</i>	NCO	4
11.	Anatidae	Common Pochard	<i>Aythyaferina</i>	AFE	2
12.	Anatidae	Fulvous whistling duck	<i>Dendrocygna bicolor</i>	DBI	1

Results

The total number of observed birds were noted down and the biodiversity index was then calculated (Table 3).

Table 3: Calculation for estimation of Shannon biodiversity index

SL. No.	Species acronym	Abundance(A)	P_i	$\ln P_i$	$P_i * \ln P_i$
1.	AOS	1	0.031	-3.474	-0.1077
2.	HIN	1	0.031	-3.474	-0.1077
3.	MMI	2	0.062	-2.772	-0.1733
4.	APU	1	0.031	-3.474	-0.1077
5.	AAL	3	0.094	-2.368	-0.2218
6.	EGA	2	0.062	-2.772	-0.1733
7.	PNI	1	0.031	-3.474	-0.1077
8.	DJA	9	0.281	-1.268	-0.3564
9.	APL	5	0.156	-1.856	-0.2900
10.	NCO	4	0.125	-2.079	-0.2599
11.	AFE	2	0.062	-2.772	-0.1733
12.	DBI	1	0.031	-3.474	-0.1077
		Total = 32			$\sum P_i * \ln P_i = -2.1865$

Shannon-Wiener Biodiversity Index (H') For Abundance(A) = $-(\sum P_i * \ln P_i)$

$$= -(-2.1865) = +2.1865$$

Total number of species (S) observed = 12

$$H_{\max} = \ln(S) = \ln * 12 ;$$

$$\text{therefore, } H_{\max} = 2.485$$

$$\text{Evenness Index (E)} = H' / H_{\max} = +2.1865/2.485 = +0.8798$$

Discussion :

The Shannon diversity index generally ranges from 1.5 to 3.5 and very rarely reaches 4.5. According to Shannon-Wiener Biodiversity Index, the bird population in this lake is moderately diverse because the value resides between 1.5 and 3.5. Evenness index varies between 0 and 1. It compares the similarity of the population size of each of the species present in the study area. If all species have similar distribution, then evenness is high. A value for the evenness index approaching zero indicates large differences in abundance of species, whereas an evenness index of 1 means all species are equally abundant. Thus, the calculated values of Shannon diversity index (2.1865) and that of evenness index (0.8798) indicate that the aquatic bird population of Rudrasagarlake is moderately diverse and are evenly distributed.

The Rudrasagarlake is the largest natural lake in Tripura, which plays a significant role as the main corridor in the North-eastern region serving as the staging ground for a large number of migratory waterfowls during winters (Choudhury 2010). The lake supports the waterfowl in adverse conditions by providing refuge areas. The wetland also has a unique habitat type creating a number of ecotones suitable for a variety of wildlife. During the dry periods, it is the congregation point of a large number of waterfowl and amphibians (Taran et al., 2017).

The Rudrasagarlake provides several values and benefits to mankind ranging from sources of freshwater for domestic and irrigation purpose, fisheries, acting as a repository for medicinal and ornamental resources and also helping out to buffer flood (Taran et al., 2017). But this waterbody is under several threats being imposed due to anthropogenic activities like pollution, urban sewage disposal, encroachment, regime fragmentation by roads and introduction of invasive species (Deka, 2010). Threats are also being perceived due to some natural causes like hydrological regime alteration, siltation, etc. This area is also under the threat of over-fishing, forest clearance for settlements, very rapid growth of human population, pollution and poaching of birds and turtles (Choudhury 2010).

Long-term decline in waterfowl populations is a warning sign for degradation of the lake habitat, which need to be restored. Therefore, appropriate conservation measures are to be developed for conserving, managing, and restoring wetland habitats that support wintering waterfowl populations. Assuming that foraging habitat is limited for waterfowl in the winter, we need to assess the energy needs of waterfowl, mortality rates, length of the winter period, and the energy available in various foraging habitats. For migrating birds, an approximate estimation of foraging need, determining habitat requirements like earthen mounds, dykes, roosting

places, perching areas specific to different species may be considered. Maintaining a good water quality of the lake will enhance more planktons and influence fish diversity and eventually ensure food niche of birds. Plantations in the catchment areas, vegetation management, regulation of tourism activities, dredging pattern, protection from poaching and pollution are some other conservation measures (Choudhury 2010).

Conclusion :

Rudrasagar Lake is a natural wetland which provides shelter to a huge number of residential and migratory water birds. It should be protected by all means to conserve its rich biodiversity. Critically endangered animals like Baer's Pochard, three striped roofed turtle, and other migratory birds present in this lake should be protected and conserved. Environment awareness programmes should be conducted in villages, annual waterfowl census should be estimated and poaching and encroachment should be checked regularly for the protection of such areas.

Acknowledgement :

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References :

1. Agenda note on Neermahal. 2007. Ministry of Forest, Fishery Dept., Govt. of Tripura Annual Report.
2. Barman, D., Mandal, S. C., Bhattacharjee, P., and Datta, S. P. 2013. Status of Rudrasagar Lake (Ramsar site) in Tripura, India. *Environment and Ecology*, Vol.31 No.3 pp.1320-1325.
3. Choudhury, A. 2010. Recent ornithological records from Tripura, north-eastern India, with an annotated checklist. *Indian Birds*, 6 (3): 66-74.
4. Cox, George W., Ricklefs, Robert E. 1977. Species diversity and ecological release in Caribbean land bird faunas. *Oikos*, 28: 113-122.
5. Deka, S. 2010 Conserving Lake Ecosystem - A case study of Rudrasagar Lake (Ramsar Site), Tripura. (http://aquafind.com/articles/Rudrasagar_lake.php)
<https://www.ramsar.org/wetland/india>
6. Integrated Management Plan Rudrasagar Wetland Melaghar Tripura Compiled by Wetland Authority of Tripura, AranyaBhavan, Office of PCCF, Tripura, Agartala.
7. Restoration of Ecosystem Services by Community involvement in Rudrasagar Lake of Tripura, Department of Forestry & Biodiversity Tripura University Suryamaninagar, Tripura. Progress Report July 2017-March, 2018.
8. Taran.M and Deb. S. 2017. valuation of provisional and cultural services of a Ramsar site: a preliminary study on Rudrasagar lake, Tripura, northeast India. *Journal of Wetlands Environmental Management* Vol 5, No 1 : 37 – 4