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THE RAMSAR SITE OF RAJASTHAN (SAMBHAR): DIVERSITY AND ECOSYSTEM OF WETLAND

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ABSTRACT

As a Ramsar site since 1990, Sambhar Lake in Rajasthan, India, is acknowledged as the nation`s largest inland saline wetland and is of great ecological significance. Many migratory birds use this lake as a vital habitat, especially vast numbers of flamingos and pelicans that come to visit in the winter. Specialised bacteria that flourish in the lake`s salty water sustain in its distinct ecosystem, which is responsible for the lake`s vivid colours and rich biological variety. Wetlands play a vital role in maintaining ecological balance, sustaining and biodiversity, providing essential services to both the environment and human societies. As such, it is crucial to continue efforts to protect and preserve these unique ecosystems for the benefit of present and future generations.

KEY WORDS

Ramsar site, wetland, aquatic fauna, zooplankton diversity, biodiversity, conservation,

INTRODUCTION

Wetland are amongst the most productive ecosystem of the earth. A wetland is an area of land that is saturated with water, either permanently or seasonally, and typically characterized by specific types of vegetation adapted to wet conditions. Wetlands are indeed recognized as unique ecological units with significant contributions to human society and the environment (Prasad et al. 2002). It's common to refer to wetlands as the "kidneys of the landscape (Mahajan, 2022). Wetlands play a crucial role in sustaining human life. Spanning an impressive 12.1 million square kilometers, they contribute to a staggering 40.6% of the total global ecosystem services (ES) value. Their importance cannot be overstated, as they provide essential benefits that support both the environment and human well-being (Costanza et al., 2014). Wetlands are recognised as being both extremely threatened by a variety of human activities and crucial for the supply of ecosystem services (Johnson, 2000a; Mitsch & Gosselink, 2021; Sieben et al., 2018; Xu et al., 2020).Wetlands play crucial roles in the environment, such as filtering water, providing habitat for diverse wildlife, and mitigating floods by absorbing excess water. They can be found in various forms, including marshes, swamps, bogs, and mangroves, each with its own unique characteristics and biodiversity. Conservation and protection of wetlands are essential due to their ecological significance and the services they provide to both wildlife and humans. An estimated 64% of the wetlands on Earth have vanished since 1900 (Sharma et al., 2019). India is a land of diverse migratory and water bird's species, many migratory birds come from Northen Europe country to Asian region (Childress, 2008).Many migratory birds visit India after monsoon season in sambhar lake and different wetland. The *Phoenicopterus* family comprises the primary avifauna that visits India in August-September, stays there through the winter, and then returns in March-April. The International Union for Conservation of Nature has classified flamingos as a least concern species. According to Sea World's census records, there are roughly 1.5 to 2.5 million lesser flamingos worldwide, but the Chilean flamingo population was estimated to be less than 0.2 million (Johnson, 2000b).A vast diversity of faunal group found in this region (Sharma, 2021). Lesser flamingos (Phoenicopterus minor) are amiable, long-lived birds that breed in colonies and are scattered throughout the salt pans, while greater flamingos (Phoenicopterus roseus) are partially

migratory as they reside and breed in this region and are distributed in the brackish saline water bodies (Johnson, 2000b; Sharma et al., 2019). Wetlands play a vital role in maintaining ecological balance, sustaining and biodiversity, providing essential services to both the environment and human societies. As such, it is crucial to continue efforts to protect and preserve these unique ecosystems for the benefit of current and future generations.

Ramsar Convention on Wetland

The Ramsar Convention on Wetlands, also known as the Convention on Wetlands, is an international treaty aimed at the conservation and sustainable use of wetlands worldwide. It is named after the city of Ramsar in Iran, where the treaty was adopted on February 2, 1971 (Davidson, 2018; Hails et al., 1996). The convention came into force on 21 December 1975, and is administered by the Ramsar Convention Secretariat, located in Switzerland (Davidson, 2018; Hails et al., 1996).The main goal of the convention is the conservation and wise use of wetlands to prevent their degradation or loss and maintain their ecological character. This convention defines wetlands broadly, encompassing both man-made and natural wetlands, and extending along ocean shorelines to six meters below low tide. Wetlands of International Importance are found in 1421 locations across the globe, covering almost 124 million hectares (Davidson, 2018). The convention recognizes the ecological functions of wetlands and promotes their sustainable use for the benefit of both present and future generations The convention supports research, monitoring, and exchange of information related to wetlands' ecological character, conservation, and wise use. The Ramsar Convention has been successful in raising awareness about the importance of wetlands in supporting biodiversity, water resources, and human well-being (Hails et al., 1996; Sharma, 2021).

They provide a wide range of goods and services, making them invaluable resources on Earth. These wetlands are rich in biodiversity and are considered essential for maintaining ecological balance and supporting various forms of life (Wurtsbaugh et al., 2017).

Types of Wetlands

Wetlands come in four primary varieties.

1. Swamps: Rely on groundwater from mineral-rich soils that is rich in nutrients (Zedler & Kercher, 2005).
2. Bogs: Made of accumulated peat, moss is typically the dominant plant. Bogs form in areas where the groundwater is acidic. Bogs are typically created by rainfall (Cowardin, 1979).
3. Marshes: Sites that are periodically or permanently flooded and have water that is rich in nutrients (Rydin et al., 2013).
4. Fens: formed by the buildup of peat. It could be primarily covered in sedge, reeds, shrubs, or trees. Surface or ground water provide the majority of the food for fens (Cowardin, 1979).

Features of Wetlands: Wetlands exhibit several key features, including-

- Occupying a transitional zone between terrestrial and aquatic ecosystems (Kumar, 2019).
- Diverse flora and fauna influenced by factors like origin, location, dominant plants, water regime, and soil properties.
- Dynamics of water loss and replenishment essential for sustainability.
- Biogeochemical activities crucial for ecosystem function.
- These characteristics highlight the ecological significance of wetlands and the need for conservation efforts to protect these vital ecosystems (Arya et al., 2020; Kumar, 2019).

Ramsar sites in India

- India has the greatest number of Ramsar Sites in South Asia as of February 2024, with 82 total, covering 1,332,739 hectares of surface area (The Convention on Wetland; Https://Www.Ramsar.Org/Country-Profile/India, 2024).
- These sites cover diverse ecosystems including freshwater lakes, marshes, mangroves, and high-altitude lakes.
- The Ramsar Sites in India play a critical role in supporting biodiversity, providing habitat for many species of flora and fauna.
- They contribute to water purification, flood control, and climate regulation

Ramsar Sites in Rajasthan

There are two Ramsar site in Rajasthan, state of India, Keoladeo bird sanctuary, Bharatpur and sambhar Salt Lake, Jaipur (Jhajhria, 2020).

1.**Sambhar lake**

Sambhar lake rich in many zooplankton species, algae and many species of migratory and residential birds. The sambhar saline lake has been designated as Ramsar site (Wetland of international importance no.464 march 1990) and important bird and biodiversity area (Jhajhria, 2020). Sambhar Lake, located in the state of

Rajasthan, India, is a significant wetland and holds several distinctions (Singh, 2009). Here are some key characteristics of the lake:

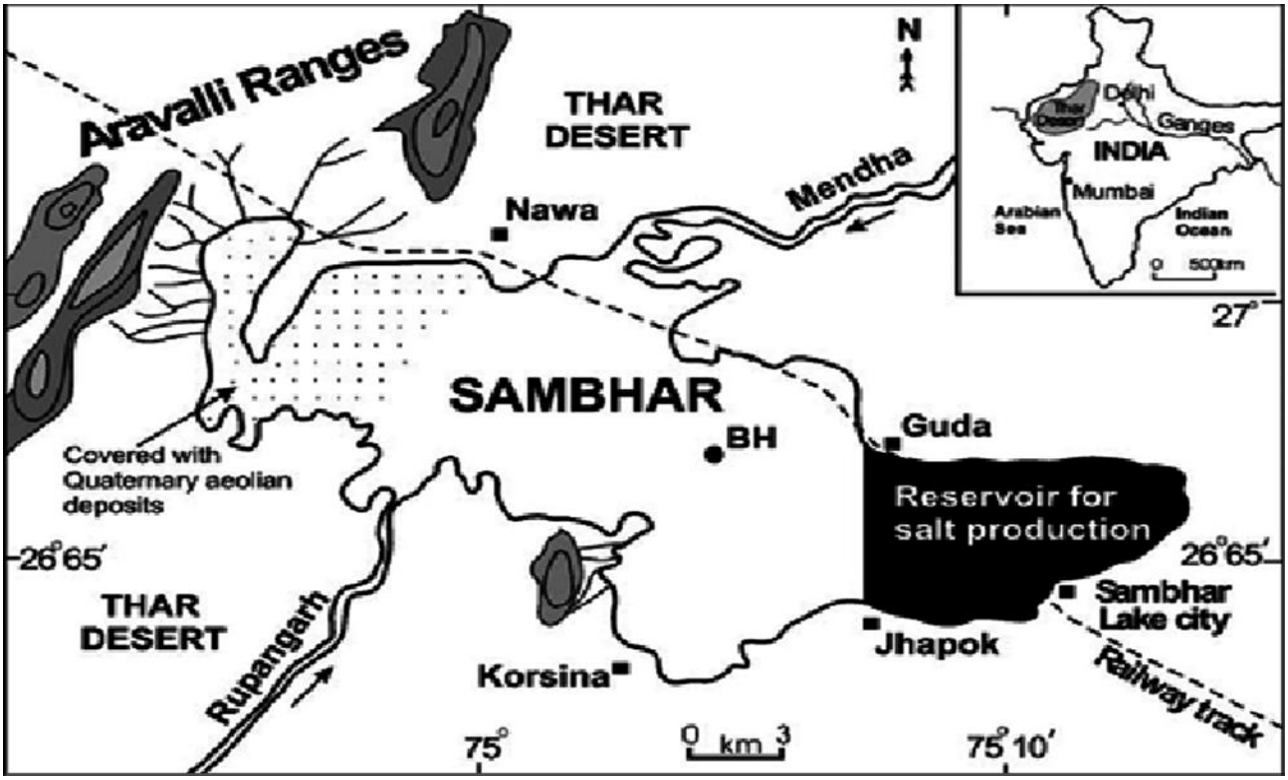

Figure1 Geography of Sambhar Lake (Singh, 2013)

Lake Geography

Size and Location: Sambhar Lake is the largest inland saltwater lake in India (Naik & Sharma, 2022). It covers an area of approximately 230 square kilometres, with a length of 22.5 kilometres and a width ranging from 11.2 to 3.2 kilometres (Jhajhria, 2020; Naik & Sharma, 2022). The lake is situated at an elevation of 360 meters above mean sea level and has an average depth of around 1 meter (Swain et al., 1982).

Closed Sedimentary Basin: Sambhar Lake is a closed sedimentary basin, meaning it does not have any outlets to the sea. It receives water primarily through rainfall and other surface inflows (Naik & Sharma, 2022).

Catchment Area: The lake's catchment area, which is the region contributing water to the lake, covers about 5600 square kilometres (Biswas & Chattopadhyay, 1982).

Semi-arid Climate: Sambhar Lake is situated in a semi-arid climate region with coordinate 26`52` to 27`02` N, 74`54`to 75`14` E (Jhajhria, 2020; Naik & Sharma, 2022; Wurtsbaugh et al., 2017), it receives relatively low levels of rainfall compared to more humid areas.

Ramsar Designation: The lake has been designated as a Ramsar site, which means it holds international importance as a wetland, and conservation efforts are focused on preserving its ecological functions and biodiversity (Hails et al., 1996).

Important Bird and Biodiversity Area (IBA): Sambhar Lake is also recognized as an Important Bird and Biodiversity Area, indicating its significance for supporting various bird species and diverse wildlife (Jhajhria, 2020).

The unique characteristics of Sambhar Lake, including its saline nature, size, and ecological significance, make it a crucial ecosystem that requires conservation measures to protect its biodiversity and maintain its ecological productivity.

The lake basin is divided into two sections by a 5.16 km long stone-earthen dam between the settlements of Jhapok to the south and Gudha in the north. The western part is a natural undisturbed water spread. The eastern part of the lake contains two large reservoirs for salt extraction, canals and saltpans covering an area of 76.8 sq.km (Kumar, 2005). When an optimum degree of salinity required for salt extraction is obtained, the water from the vast lustrous western part of the lake is pumped into the other side via sluice salt gates. 'The saltpans can be approached by the narrow mud bunds that separate them and by indigenously developed rail trolley system, laid by the British for transporting the salt extracted from the saltpans to the processing unit of Sambhar Salt Limited (Figure 2).

Figure 2 Saltpan area of sambhar lake

Figure 3 Trolly Rail line for transportation

2.**Keoladeo national park**

In 1981, India became a member of the Ramsar convention and designated two wetlands as part of the treaty: Keoladeo National Park and Lake Chilika. Afterwards, the list of Indian Ramsar Sites was expanded to include four more wetlands. Unquestionably one of India's oldest and most species-rich parks is Keoladeo National Park, well known for being the only wintering place for a portion of the Siberian crane (*Grus leucogeranus*) population that lives in the west. Since then, it has also been recognised as a World Heritage site. Numerous scientific studies have also been conducted on Keoladeo National Park including a ten-year study conducted by the Bombay Natural History Society's researchers (Middleton, 1989; van der Valk, 1988; Vijayan, 1994).

Importance of Wetlands: Wetlands provide enormous goods and services to human society, including resource potential, ecological benefits, and rich biodiversity (Biswas Roy et al., 2016; Hails et al., 1996).
1.Global Extent: The total areal extent of wetlands globally is around 12.1 million km2, and they exhibit diverse characteristics in terms of geographical locations, dominant species, soil-water chemistry, and other factors (Biswas Roy et al., 2016; Hails et al., 1996).
2.Utilization by Rural India: Wetlands can be well-utilized by several landless people in rural India, especially for activities like pisciculture (fish farming), which is a dominant practice in such areas (Hails et al., 1996; Paul & Mormile, 2017a).
3.Environmental Benefits: Wetlands offer several environmental benefits, such as food management, groundwater recharge, water supply, and irrigation activities (Hails et al., 1996).
4.Ramsar Convention: To conserve and enhance the ecological functions of wetlands, the Ramsar Convention on Wetlands was signed in 1971, gaining international importance (Hails et al., 1996).
5.Ramsar Sites in India: In India, total 75 wetlands have been designated as Ramsar sites as of February 2023, indicating their ecological significance and importance in conservation efforts (Ministry of Environment, 2022).
6.Ecosystem Services Provided by Wetlands

i. Provisioning Services: Wetlands supply various natural products, including fish, shellfish, timber, and wild rice. They are crucial for the fishing industry, with many commercially important species relying on wetland habitats for part of their life cycles (Cherry & Aa, 2011; United state environmental protection agency, 2024).
ii. Regulating Services: Water Quality Improvement: Wetlands filter pollutants and improve water quality by retaining sediments and nutrients (Cherry & Aa, 2011; United state environmental protection agency, 2024).
iii. Flood Control: Acting as natural sponges, wetlands absorb excess water during floods and release it slowly, helping to mitigate flood impacts and reduce erosion (Cherry & Aa, 2011; United state environmental protection agency, 2024).
iv. Climate Regulation: Wetlands store carbon, thus playing a role in moderating global climate conditions by reducing greenhouse gas emissions (Cherry & Aa, 2011; United state environmental protection agency, 2024).
v. Cultural Services: Wetlands offer recreational opportunities, aesthetic enjoyment, and spiritual enrichment. They are often sites for ecotourism and contribute to cultural heritage through their biodiversity and beauty (Cherry & Aa, 2011; Mitsch et al., 2015).
vi. Supporting Services: Wetlands contribute to essential ecological processes such as nutrient cycling and primary productivity, which support other ecosystem services (Mitsch et al., 2015).
vii. Economic Value of Wetland Services: The economic value of the services provided by wetlands is immense. Estimates suggest that the global economic worth of wetland ecosystem services could reach up to $15 trillion annually. This value often surpasses the short-term financial gains from converting wetlands to agricultural or urban uses (Cherry & Aa, 2011). For instance, a study highlighted that the storm protection offered by coastal wetlands is valued at approximately $23.2 billion per year in the U.S. alone (Xu et al., 2020).

Wetlands offer humans a multitude of goods and services. Regional wetlands are essential components of wider landscapes; the people who inhabit these landscapes rely on the wetlands' functions and locations. Thus, every wetland has its own ecology. Wetlands serve many important purposes, including recycling nutrients, purifying water, reducing the impact of floods, maintaining stream flow, replenishing ground water, and providing drinking water, fish, fuel, fodder, and habitat for wildlife. They also regulate the rate of runoff into urban areas, protect shorelines from erosion, and provide recreational opportunities for the general public.

The last several decades have seen a significant increase in the connection between humans and wetlands, mostly because of the fast population rise that has been accompanied by increased industrial, commercial, and residential development, which has further exacerbated the pollution of wetlands by domestic, it's common to refer to wetlands as the "kidneys of the landscape" (Mitsch & Wu, 2018). Hydrologic circumstances have the direct power to alter or modify a variety of chemical and physical qualities, including pH, nutrient availability, soil salinity, substrate anoxia, and sediment properties. The biotic response in the marsh is directly impacted by these changes to the physiochemical environment (Gosselink & Turner, 1978). Even little changes in the hydrologic conditions of wetlands can cause significant shifts in the species richness and composition of the biota, as well as in the productivity of the ecosystem. The assessment of water quality and productivity in surface impoundment can be done quickly and cheaply by employing remote sensing data instead of the laborious and expensive traditional limnological approaches.

Importance of Wetland Conservation

Despite their critical importance, wetlands are under threat from human activities such as urban development, agriculture, and pollution. The loss of wetlands can lead to diminished ecosystem services, impacting biodiversity and increasing vulnerability to climate change and natural disasters. Therefore, conservation efforts are vital to maintain these ecosystems and the myriad benefits they provide (Cherry & Aa, 2011; Mccartney et al., 2006; Xu et al., 2020). In summary, wetland ecosystems are invaluable for their diverse services, which support ecological balance and human welfare. Protecting and restoring wetlands is essential for sustaining these benefits in the face of growing environmental pressures.

Avifauna Status of lake

The attention-grabbing sight at Sambhar Lake is none other than the lined population of flamingos that seems as a flame despite the foggy haze in the air. Water birds have a great habitat in Sambhar Lake. Because of its wide expanse of open seas, the majority of aquatic birds settle in flocks and search for adequate room to stay apart and unopposed in the resource market. Spirulina algae blooms and a variety of zooplankton species make it more delightful for birds to feed in the lake for extended periods of time without interruption.

Two bird counts were carried out on January 11, 2019, and January 6, and 7, 2020. 29 and 32 bird species, totalling 1124 and 43,445 birds, were identified from the survey in the corresponding years. In 2019 observed rise in bird counts due to good rains. Ten different bird species, including the Common Sandpiper, Black-crowned Night Heron, Greater and Lesser Flamingos, Gadwall, Little Ringed Plover, Kentish Plover, Red Wattled Lapwing, Black Winged Stilt, and Pier Avocet are drawn to Lake by their great predilection for saline and alkaline waters. Notably, certain species that consume invertebrates include the Common Grebe, Graylag Goose, Bar-Headed Goose, and Little Grebe, Great Stone Plover, Northern Shoveller, and Teal Black-Tailed Godwit, White-Tailed Lapwing, Little Stint, Marsh Sandpiper, Wood Sandpiper, Curlew Sandpiper, Common Redshank, found in and around Lake are Temmick's Stint, Ruff, White Wagtail, Grey Wagtail, Pin-tailed Snipe, and Yellow Wattled Lapwing. According to a species-by-species thorough bird census, 83 waterfowls in all were counted (Singh Sangha, 2009). There were 8,500 lesser flamingos on the lake in 1994, but no greater flamingos were discovered; 5,000 lesser flamingos were noted in 1995, but no greater flamingos were visible; and 20,000 birds were sighted in 2001, 10,000 of which were smaller and 5,000 of which were greater flamingos (Naik & Sharma, 2022).

Table 1 Wetland birds' number and comparison (Naik & Sharma, 2022)

S.No.	Common and scientific name	2020	2019
1	Brown-headed Gull *L. brunnicephalus*	1	NF
2	Common Teal *A. crecca*	NF	9
3	Gadwall *A. strepera*	NF	10
4	Greylag Goose *Anser anser*	NF	6
5	Barheaded Goose *A. indicus*	NF	18
6	Common Pochard *Aythya ferina*	3	NF
7	Greater Flamingo *Phoeniconaias*	12,046	331
8	Lesser Flamingo	24,414	128
9	Cattle Egret *Bubulcus ibis*	5	NF
10	Indian Pond Heron *Ardeola grayii*	1	NF
11	Black-crowned Night Heron *Nycticorax nycticorax*	NF	3
12	Little Grebe *Tachybaptus ruficollis*	NF	9
13	Great Stone Plover *Esacus recurvirostris*	NF	1
14	Little-ringed plover *C. dubius*	25	4
15	Yellow lapwing	NF	1
16	Common Redshank *T. totanus*	25	3
17	Common Greenshank *T. nebularia*	5	NF
18	Eurasian Curlew *N. arquata*	1	NF
19	Black-tailed Godwit *Limosa limosa*	2	2
20	Pied Avocet *Recurvirostra avosetta*	422	34
21	Black-winged Stilt *Himantopus himantopus*	112	16
22	White-tailed Lapwing *V. leucurus*	2	1
23	Red-wattled Lapwing *V. indicus*	16	12
24	Kentish Plover *C. alexandrinus*	47	4
25	Pacific Golden Plover	1	NF
26	Western Marsh-Harrier *Circus aeruginosus*	1	NF
27	White-breasted Kingfisher *H. smyrnens*	3	NF
28	Ruff Philomachus pugnax	441	140
29	Temminck's Stint *C. Temminckii*	9	17
30	Little Stint C. minuta	110	8
31	Common Sandpiper *Actitis hypoleucos*	15	2
32	Wood Sandpiper *T. glareola*	7	5
33	Marsh Sandpiper *T. stagnatilis*	2	1
34	Curlew Sandpiper *C. ferruginea*	NF	26
35	Raptor	3	NF
36	Crested Lark	5	NF
37	Greater Coual	1	NF
38	Pintailed Snipe	NF	5
39	Pacific Golden Plover	1	NF
40	Grey Wagtail *M. cinerea*	NF	1
41	White-browed Wagtail *M. maderaspatensis*	1	NF
42	White Wagtail *Motacilla alba*	3	2
43	Green Sandpiper *T. ochropus*	2	NF
44	Eurasian Curlew *N. arquata*	1	NF
45	Undefined	422	NF
	Total count	43,445	1124

	Total species no.	32	29

Table 2 Physicochemical parameter of Sambhar Lake (Bhat & Sharma, 2015)

S.No.	Parameters	Unit	G-1	G-2	G-3	G-4	G-5	G-6	G-7	G-8
1.	pH (at 25 ^{0}C)	--	7.90	8.42	8.26	7.49	8.68	7.42	7.47	7.96
2.	ElectricalConductivity	µs/cm	4398	14000	2954	3550	1723	23400	6650	4600
3.	Total Hardness as CaCO3	mg/l	1345.40	2798.00	603.90	698.00	402.00	3657.00	1512.00	1432.00
4.	Calcium as Ca	mg/l	309.98	897.00	145.43	186.01	103.21	943.43	498.79	254.56
5.	Alkalinity as CaCO3	mg/l	389.87	454.33	392.30	389.29	309.69	496.92	473.56	327.69
6.	Chloride as Cl	mg/l	1472.00	5879.00	848.92	1096.50	543.00	9926.00	1995.54	1432.03
7.	Magnesium as Mg	mg/l	139.00	136.08	58.58	56.84	35.11	316.66	65.01	193.64
8.	Total Dissolved Solids	mg/l	2844	8924	1803	2264	1175	14900	4190	3003
9.	Sulphate as SO4	mg/l	123.32	387.69	143.21	194.98	117.69	943.98	321.29	198.93
10.	Fluoride as F	mg/l	1.21	1.34	0.98	0.87	0.69	2.01	1.43	1.38
11	Nitrate as NO3-N	mg/l	19.23	25.98	18.21	22.54	7.69	28.45	24.92	25.98
12	Iron as Fe	mg/l	0.34	0.42	0.23	0.19	0.25	0.21	0.23	0.28
13.	Boron	mg/l	0.98	1.95	0.87	0.76	0.87	1.98	1.56	0.98
14.	Zinc as Zn	mg/l	0.87	0.89	0. 48	0.23	0.11	1.01	0.45	0.97
15.	Chromium as Cr	mg/l	0.021	0.033	BDL	0.012	BDL	0.021	0.031	0.028
16.	Copper as Cu	mg/l	0.051	0.043	BDL	BDL	BDL	0.065	0.037	0.063
17.	Manganese as Mn	mg/l	0.11	0.19	0.11	0.13	BDL	0.97	0.18	0.21
18.	Lead as Pb	mg/l	0.011	0.014	BDL	0.014	BDL	0.12	0.019	0.026
19.	Sodium as Na	mg/l	534.0	1238.0	312.0	463.0	67.0	2312.0	1127.0	675.0
20.	Potassium as K	mg/l	4.30	12.4	3.40	4.39	4.30	18.90	10.23	6.90

*BDL- Below Detection Limit

Zooplankton Diversity

Zooplankton are small microscopic organism that drift in the water Colum of lakes, ponds, and other water bodies. They are an essential component of aquatic ecosystem and serve a critical link in the food web. Sambhar lake, a large saline lake in Rajasthan, India, hosts a variety of zooplankton species with the major representative being Protozoa, Rotifer, and Crustaceans. The zooplankton community in sambhar lake is likely to be diverse with various species contributing to the ecological balance of the lake ecosystem. These tiny organisms play a crucial role in nutrient cycle, energy transfer and providing a food source for higher trophic levels such as fish and other aquatic organism. Hemiptera were also recorder from lake water, The chironomid density was as high as 1845/m^2. The number increased after the monsoon when the lake is freshly inundated and chloride values drops down, the chironomids were the most predominant among the dipteran larvae (Kumar, 2005). Such type of dominance of benthic chironomid and formation of swarms is well-marked phenomenon of Chironomidae and was also reported in high altitude lakes of the northwest Himalaya (Kumar, 2005). Sambhar lake is highly productive due to low water transparency. The physico-chemical characteristics of sambhar lake play a significant role in shaping the zooplankton community. The reduce transparency might be caused by suspended particle and dissolved substance in the water. This condition can support the growth of phytoplankton which serve as a food source for zooplankton, leading to their increased abundance and productivity (Sharma, 1980). A few zooplanktons such as *Cladocera, Copepoda, Branchianus, Cyclops*, and Diaptomus were seen during rainy seasons when the salinity is very low (Gopal & Sharma, 1994). Baid reported two species of protozoan. A few *Cyclops, Miona*, and *Cladocera* observed during the rainy season of 2008 which disappeared as the salinity of the lake water increased in October 2008 (Kulshreshtha et al., 2013). Invertebrate such as *Berosus indicus*, *Ephydra malellia*, and *Eristalis* and shells of *Indoplanorbis*

exustus and *Gabbia orula* were collected from dry margins of the lake (Gopal & Sharma, 1994). A brine shrimp *Artemia salina* was reported which disappeared during the floods of 1970s (Baid, 1958). After that, attempts to introduce and culture brine shrimp failed possibly due to low oxygen levels of the salt pans (Bhargava et al., 1987). Catchment area has some common insect species like *Schistocerca* (locust), Agrian, and Petalura (dragon flies) while Vespa and Polistes sp. (wasp) were present on the dry margins of the lake (Kulshreshtha & Sharma, 2008).

Aquatic Beetles*: Cybister tripunctatus asiaticus*, *Eretes sticticus* and *Hyphoporous severini* were reported (Baid, 1958). Twenty-two species of aquatic beetles belonging to the family Dytiscidae in a 16-km radius covering Naraina, Phulera, Bahadurpur, and Koni villages (Jakher et al., 1990). Some of 16 species of beetles were found in 2009, namely, *Cybister tripunctatus asiaticus, Eretes sticticus, Hyphoporous severini, Canthydrus lactablis, Laccophilus chinesis inefficiens, L. parvulus* (found at Phulera*), L. flexuosus and L. sharpii* (both found at Gudha), *Hyphydrus flavicans, H. musicus, Guignotus flammulatus, G. pusillus, Hyphoporous severini, H. kempi, Rhantaticus sp., and Sandrauoltus dejaeni* (Kulshreshtha & Sharma, 2008).

Vertebrate Fauna: Several freshwater fishes have been reported to enter the lake with the incoming streams during rainy season and die out due to its high salinity (Gopal & Sharma, 1994). Common amphibians such as *Euphlyctis hexadactylus* and *Bufo* species are generally seen in the catchment. A variety of reptiles like *Geochelone elegans, Hemidactylus flaviviridis, H. brookii, Crossobamon orientalis, Chamaeleon zeylanicus, Varanus bengalensis, Eryx johnli, Ptyas mucosa, Coluber gracilis, Spalerosophis arnarius, Bungarus caeruleus, Naja oxiana* etc. have also been observed in the catchment area (Kulshreshtha et al., 2013; Paul & Mormile, 2017b). The harsh and saline conditions of the lake do not attract mammals, although some common species of small mammals like *Suncus murinus, Paraechinus micropus, Funambulus pennantii, Tatera indica, Rattus rattus, Mus musculus* and *Mus booduga* inhabit the catchment area (Banerjee et al., 2023). Bluebull or Nilgai *Boselaphus tragocamelus* is a common pest in the crop fields situated on the periphery of Sambhar town. The wildlife includes Leopard *Panthera pardus*, Striped Hyena, Golden Jackal *(Canis aureus),* Hanuman Langur *(Semnopithecus entellus),* Rhesus Monkey *(Macaca mullatta),* Bengal Fox (Vulpes bengalensis), Indian Grey Mongoose *(Herpestes edwardsii)* and Indian Hare *(lepus nigricollis)* (Kulshreshtha et al., 2013). Domestic animals of this area are estimated to be 7.5 million including dogs, house cat, pig, cattle, sheep, buffalo, camel, goat, donkey, and horse which are confined to the catchment. Grazing by herds of sheep by Rebari or Raika community is a very common sight (Banerjee et al., 2023).

Potential Threats to Sambhar Lake:

The Sambhar Lake faces multiple conservation-related challenges, and involvement of a large number of stakeholders has made effective protection measure difficult to implement. If the issue persists, the lake may suffer a fate similar to Didwana lake, which has completely disappeared (Kulshreshtha & Sharma, 2008).

The major threats to the already diminishing ecology of sambhar lake are as follows:

1. Shrinkage of water spread: The formation of large number of anicuts on the inflowing rivers by the state irrigation department, combined with harsh climatic condition has significantly reduced the water spread of the lake (Kulshreshtha, 2017).
2. Siltation and disturbances in the lake bed: The main lake bed have been badly exploited for procuring soil by the villagers in the southwest part toward Nawa in Nagour district. Due to change in the nature of lake bed, a large amount of silt blows into the lake and deposits at the bottom. It reduces the brine level and ground water level causing both shrinkage of the lake size and capacity (Goswami, 2021).
3. Altered land use pattern: Eroded land of the Sambhar catchment area has increased during past seven years since agricultural land as well is being used illegally for salt extraction (Kulshreshtha, 2017). These altered land use patterns are mainly due to various anthropogenic pressures which have intensified the process of desertification of Sambhar area by increase in eroded land making it a serious issue of the entire Indian arid zone (Dhabariya, 1984).
4. Deforestation: Forest covers are mostly confined to the dissected rocky and hilly areas in a much-degraded form. Overgrazing and large-scale tree-cutting of the residual dry forest of Acacia and Prosopis in the watershed have further led to siltation and sedimentation of the lake. Human settlements of Sambhar and Phulera towns are also fast extending, and urbanization is taking place on a large scale, resulting in a considerably thin forest cover (Goswami, 2021).
5. Anthropogenic activities. The most devastating anthropogenic action has been the construction of 12.4-km road from Nawa to Khakarki village near Korsina in the southwest of the lake, dividing the lake bed into two unequal parts. This may severely affect the population of the migratory avifauna (Kulshreshtha et al., 2013). In addition, the tourists often visit the lake, being unaware of the ethics of bird-watching, disturb flamingos, and create panic among the flocks even making them leave the place sometimes. Poaching of flamingos and other birds by local hunters, tribes, and villagers continues as a common and age-old malpractice. Recently,

there was shocking news of about 20000 Greater Flamingo are found dead in this lake in 2020. Sambhar Salts Ltd. officials are devoted to their primary job of salt extraction with no unit deployed to take care of the conservation aspects of the lake (Sharma et al., 2019). The salt industry tries to get rid of the algae present in the brine of reservoirs in their efforts to produce quality salt despite the fact that the algae make the favourite food for flamingos (Sharma et al., 2017).

To conserve sambhar lake and its ecology there is an urgent need for cooperation and coordinated efforts among all stakeholders, including govt. authorities, local communities and industries. Implementing effective protection measure, enforcement regulation on salt extraction and land use and promoting responsible tourism are essential step towards healthy lake ecosystem and preserving its biodiversity.

Suggestions for Conservation of Sambhar Salt Lake:

Conserving the Sambhar Wetland requires a comprehensive approach involving various stakeholders and addressing multiple threats. Here are some suggestions for the conservation of Sambhar Wetland

Strict Enforcement of Regulations: The first step is to enforce existing regulations related to water use, salt extraction, and land use. Strict enforcement will help control illegal activities that are harming the wetland's ecology.

Integrated Water Management: Implement integrated water management strategies to ensure a sustainable balance between water supply and demand. This includes efficient water use in agriculture, industries, and urban areas to minimize the impact on the wetland.

Restoration of Lake Bed: Efforts should be made to restore the lake bed and prevent further siltation caused by soil extraction. Reforestation and soil conservation practices can help stabilize the soil and reduce sediment inflow.

Awareness and Education: Create awareness among local communities, industries, and tourists about the importance of the wetland's conservation. Education programs can promote responsible tourism and discourage harmful activities.

Community Participation: Involve local communities in the conservation efforts. Engage them in sustainable livelihood activities that do not harm the wetland, and encourage their active participation in monitoring and protection.

Research and Monitoring: Conduct regular scientific research and monitoring to understand the wetland's ecosystem dynamics and assess the effectiveness of conservation measures.

Collaboration with NGOs and Experts: Collaborate with non-governmental organizations (NGOs) and experts in wetland conservation to benefit from their knowledge and experience.

Sustainable Tourism: Promote sustainable and eco-friendly tourism practices. Develop bird-watching and nature tourism activities that do not disturb the wildlife and its habitats.

Restoration and Enhancement of Wetland Habitats: Undertake restoration projects to enhance wetland habitats, such as creating additional shallow water areas and providing nesting sites for birds.

Incentives for Conservation: Offer incentives and rewards to individuals or organizations actively contributing to the conservation of the wetland. This can encourage more people to get involved in preservation efforts.

By implementing these conservation strategies and fostering cooperation among different stakeholders, it is possible to protect and restore the delicate ecology of Sambhar Wetland and ensure its sustainability for future generations.

CONCLUSION

The biological and environment significance of Rajasthan, India`s sambhar Salt Lake makes it an important Ramsar site. Approximately 80 kilometres southwest of Jaipur, this sizable Salt Lake is notable for its salinity as well as its essential ecological features. Sambhar lake is home to a wide variety of plants and animals. It is especially important for flamingos, which utilise the lake as a breeding and feeding place, as well as other migratory bird species. because of the salinity of the lake, specialised organisms like bacteria and algae may survive and contribute to the ecosystem that makes the lake special. A variety of ecological niches are supported by the lake`s varied habitats, which include saline pools and mudflats, due to the seasonal fluctuations in water levels. The health of the wetland and the balance of the surrounding ecosystem depend on this dynamic environment. sambhar lake`s important role in sustaining biodiversity and upholding ecological balance is highlighted by its status as a Ramsar site. This special wetland needs to be protected and managed in a way that balances cultural, economic and ecological values. We can contribute to ensuring that sambhar lake survives as an essential biological asset and a resource for coming generations by tackling conservations issues and putting sustainable practices into place.

Sambhar lake was highly diversified and habitat for most beautiful creature flamingo, in present situation this lake was diminished and need to protect for its faunal group and migratory birds. Our study focuses on the

diversity of zooplankton and their status in present scenario so our study analysis the physicochemical status of lake water and help to establish the healthy food web in lake ecosystem.

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AUTHORE CONTRIBUTIONS

Dr. Subhash Chandra supervised the research process and provided the guidance in critically reviewing the literature and edited the manuscript. The guidance and encouragement from colleagues have been invaluable throughout the work.

CONFLICT OF INTEREST STATEMENT

The author declares no conflict of interest.

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