

## Locational Suitability of Paschim Boragaon Landfill Adjacent to Deepor Beel Wetland, Assam

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### Abstract

Deepor Beel, situated in the lower Assam region of Brahmaputra Valley, is a significant wetland that holds immense importance and is classified within the biogeographical region of the Burma monsoon forest. The beel acts as a crucial reservoir for storing water in Guwahati, aiding in mitigating the effects of flash flooding. The beel is endowed with luxuriant aquatic flora and fauna and maintains a well-balanced ecosystem. Nevertheless, the presence of the Paschim Boragaon Landfill in close proximity to the beel has raised concerns about the fragility of the biodiversity and ecosystem. The study was conducted to evaluate the appropriateness of placing a waste disposal site near a wetland and also how effectively did the Paschim Boragaon landfill adhere to the criteria specified in the Central Pollution Control Board (CPCB) and Central Public Health and Environment Engineering Organisation (CPHEEO). The landfill's establishment has disregarded the prescribed regulations imposed by the relevant governing body, posing a significant threat to the soil, water, and environment. This situation flagrantly violates the Wetland Rules of 2010, leading to detrimental effects on the diverse features and biodiversity of the beel. The landfill's close proximity has directly or indirectly disrupted the beel's heterogeneous characteristics. Hence, an urgent relocation of the entire landfill is imperative to protect the beel and uphold the internationally renowned Ramsar wetland's biodiversity.



### Article History

Received: 03 August 2023

Accepted: 20 October 2022

### Keywords

Biodiversity;  
Landfill;  
Proximity;  
Suitability;  
Wetland.

### Introduction


Deepor Beel functions as a vital reservoir for Guwahati, benefiting from interconnected inflow and outflow channels.<sup>1</sup> Being an open basin and freshwater lake, it plays a vital role in reducing the

effects of flash floods.<sup>2-4</sup> It holds immense biological and environmental value, serving as a natural home to diverse avian species,<sup>1,5,6</sup> various aquatic plants, and animals.<sup>7-10</sup> Wetlands provide essential ecological services by contributing to watershed

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Doi: <https://dx.doi.org/10.12944/CWE.18.3.10>

functions such as eliminating pollutants, mitigating floods, replenishing and discharging groundwater, safeguarding coastlines, and preserving wildlife habitats.<sup>11–14</sup> Deepor Beel's water dynamics create diverse habitats year-round, making it a crucial beel within the biogeographic region of Burma's monsoon forest situated in lower Assam Valley.<sup>6</sup>

The beel is situated in close proximity to the Paschim Boragaon garbage dump, which is merely 1.5 km away. The diverse characteristics of the beel is adversely affected by its position adjacent to the landfill.<sup>15–19</sup> The discharge of wastewater from the entire city of Guwahati into the beel has caused a decline in water quality, posing a threat to the aquatic fauna and flora.<sup>20,21</sup> The landfill has been set up in a flood-prone region with varying topography, and the entire area gets inundated during the rainy season. The CPCB and CPHEEO have established stipulated guidelines for the establishment of landfills. However, the landfill site has been set up without adhering to these guidelines, putting the soil, water, and overall environment at risk of pollution.

This study aims to evaluate the appropriateness of the landfill's location near a wetland. Additionally, an examination of the Paschim Boragaon landfill's adherence to the criteria set by CPHEEO and CPCB has been conducted.

### Study Area

Deepor beel, a captivating wetland, showcases its grandeur within the given coordinates of 26°05'25''N to 26°11'26''N latitude and 91°35'39''E to 91°43'25''E longitude. Elevated at an average height of 50–56 m above mean sea level (MSL), this tranquil expanse resides in the southwest region of Guwahati, as depicted in Figure 1. Located next to the southern edge of the mighty Brahmaputra River, it gracefully rests about a distance of approximately 10 km from the heart of the bustling city. Encircled by picturesque hills and mountains, Dakhin Jalukbari, Tetelia, and Paschim Baragoan adorn its eastern boundary, while the alluring Gorbhanga Reserve Forest, Chilla Hill and Chakardew Hill; Kahikuchi and Azara; Rani Reserve Forest, and Meghalaya Hill surround it to the southwest, west, and south respectively. Currently covering an estimated 9.27 sq. km, with the actual water body measuring a modest 4.1 sq. km, the beel reportedly covered a remarkable extent of 40.14 sq. km (4000 hectares) during the monsoon season. The depth of this water wonder fluctuates between 1.5 to 6 m, dependent upon the monsoons or dry spell. Rich in natural bounty, the beel sources its water from the Kalmani and Basistha rivers, complemented by the regional monsoon runoff, ultimately merging with the Brahmaputra via the Khonajan channel.

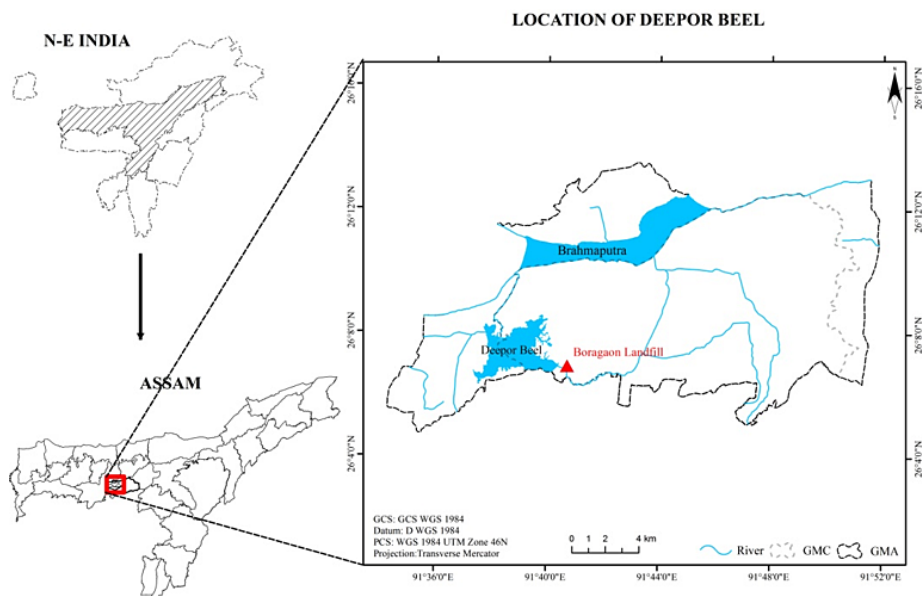


Fig.1: Location map of Deepor Beel

## Results and Discussion

### Deepor Beel as Ramsar Site

The Ramsar Convention is a treaty between governments that establishes guidelines for the preservation and sustainable utilization of wetlands and as well as their resources.<sup>22,23</sup> It is the only international environmental agreement which specifically addresses a specific ecosystem type and applies to all geographical areas. Deepor Beel, designated as Ramsar site no. 1207 on August 19, 2002 (as stated in the Ramsar Wetlands Information Sheet), possesses the necessary characteristics to be internationally recognized as a significant wetland. This wetland holds great ecological, biological, and hydrological value, contributing to habitat preservation while also offering substantial socio-economic and cultural benefits. It is home to rare, vulnerable, and endangered plant and animal species. With 448 plant species, 38 reptile and amphibian species, and 50 fish species, Deepor Beel's biodiversity is remarkable.<sup>24</sup> In addition to its Ramsar status, it holds the designation of a wildlife sanctuary and serves as an essential bird area, identified by Bombay Natural History Society and Birdlife International in 2003 due to its rich bird population. Deepor Beel hosts approximately 219 avian species, including both local wetland birds and migratory birds, making it a significant site for migratory birds in India, particularly during the winter, when large numbers of aquatic birds gather here. There are several IUCN red-listed species, such as *Pelecanus philippensis* (Spot-billed pelican), *Aythya baeri* (Baer's pochard), *Haliaeetus leucogaster* (White-bellied sea eagle), *Leptoptilos javanicus* (Lesser adjutant), *Elephas maximus* (Asian elephant), and *Leptoptilos dubius* (Greater adjutant).<sup>25,26</sup> In a single day, the highest documented count of water birds in Deepor Beel was 19,000.<sup>27</sup> Moreover, this wetland is essential to the local economy and provides a passage and water source for animals in neighbouring forest reserves.<sup>28-30</sup>

### Significant Biodiversity of Deepor Beel

Deepor Beel provides a favorable environment through a range of habitats, both aquatic and terrestrial. It possesses abundant plant and animal diversity and serves as a sanctuary for migratory waterfowl. Moreover, the beel's sprawling wetlands support a delicate ecosystem that sustains a variety of life forms. The tranquil waters teem with

a rich array of aquatic flora, creating a lush habitat for numerous species. Attracted by its bountiful offerings, migratory waterfowl flock to Deepor Beel, seeking refuge during their arduous journeys across vast distances.

In terms of phytoplankton 18 genera of species which includes genus such as *Anacystis*, *Volvox*, *Oscillatoria*, *Ulothrix*, *Spirogyra*, *Ceratium*, *Diatom*, *Selenastrum*, *Anabaena*, *Microcystis*, *Zygnema*, *Tribonema*, *Hydrodictyon*, *Closterium*, *Navicula*, *Synedra*, *Chlorella*, and *Melosira*. The free-floating species are *Azolla pinnate* (Feathered mosquitofern), *Eicchornia crassipes* (Common water hyacinth), *Lemna major* (Spirodella polyrhiza), *Lemna minor* (Common Duckweed), *Pistia stratiotes* (Water lettuce) and *Spirodela polkyrrhiza* (Greater Duckweed).<sup>31,32</sup> Zooplankton constitutes altogether 171 species from 21 genera, of which the most dominant species falls under the genera of Copepod, Cladoceran, Protozoans and Rotifers.<sup>10,27</sup> The benthic fauna includes *Nais* sp., *Tubifex* sp., *Pheritima* sp., *Limnodrillus* sp., *Dero* sp., *Chironomus* sp., *Chaoborus* sp., *Bortia* sp., *Bellemya* sp., *Culicoids* sp., *Chaoborous* sp., stone fly larvae, Dragon fly larvae, Cybister larvae, Unio sp., Pila globose., etc.<sup>1</sup>

Chetry<sup>27</sup> has identified different fish species such as *Botia dario* (Botia Dari), *Chitala chitala* (Chitala), *Notopterus notopterus* (Bronze featherback), *Gadusia chapra* (Indian river shad), *Lepidocephalichthys guntea* (Peppered Loach), *Sperata seenghala* (Giant river-catfish), *Mystus vitatus* (Striped dwarf catfish), *Anabus testudineus* (Climbing perch), *Amblyphraygodon mola* (Mola carplet), *Aspidoparia morar* (Cabdio morar), *Mystus tengra* (Tengra fish), *Ompok pabo* (Pabo catfish), *Pethia ticto* (Ticto barb), *Wallago attu* (Helicopter catfish), *Puntius sophore* (Pool barb), *Systemus sarana* (Olive barb), *Ailia colia* (Gangetic ailia), *Clarias batrachus* (Walking catfish), *Heteropneustes fossilis* (Asian stinging catfish), *Pethia conchonius* (Rosy Barb), *Parambassis ranga* (Indian glassy fish), *Catla catla* (Catla), *Labeo rohita* (Rohu), *Monopterus cuchia* (Cuchia), *Xenentodon cancila* (Freshwater garfish), *Chanda nama* (Elongate glassy perchlet), *Labeo gonius* (Kuria labeo), *Glossogobius giuris* (Tank goby), *Channa punctata* (Spotted snakehead), *Trichogaster fasciata* (Striped gourami), *Cirrhinus reba* (Reba carp), *Channa marulius* (Great

snakehead), *Ctenopharyngodon idella* (Grass carp), *Hypophthalmichthys molitrix* (Silver carp), *Cirrhinus mrigala* (Mrigal carp), *Cyprinus carpio* (Common carp), *Channa striata* (Striped snakehead), *Channa gachua* (Dwarf snakehead), *Mastacembalus armatus* (Zig-zag eel), *Channa orientalis* (Ceylon

snakehead), *Salmophasia bacaila* (Large razorbelly minnow), *Rasbora daniconius* (Slender rasbora), *Barilius barila* (Boroli fish), *Macragnathus aculeatus* (Lesser spiny eel), *Tetraodon cutcutia* (Leiodon), and *Lepidocephalichthys guntea* (Guntea loach).

**Table 1: Some of the few bird species in the IUCN Red List**

Sl. No.	Common/local name	Scientific name	IUCN status
1	Greater adjutant stork	<i>Leptoptilos dubius</i>	Endangered
2	Lesser adjutant stork	<i>Leptoptilos javanicus</i>	Vulnerable
3	Spot-billed pelican	<i>Pelecanus philippensis</i>	Near Threatened
4	Baer's pochard	<i>Aythya baeri</i>	Critically Endangered
5	Ferruginous duck	<i>Aythya nyroca</i>	Near Threatened
6	Black-necked stork	<i>Ephippiorhynchus asiaticus</i>	Near Threatened
7	White-rumped vulture	<i>Gyps bengalensis</i>	Critically Endangered
8	Slender-billed vulture	<i>Gyps tenuirostris</i>	Critically Endangered
9	White-bellied sea eagle	<i>Haliaeetus leucogaster</i>	Least Concern
10	Spot-billed pelican	<i>Pelecanus philippensis</i>	Near Threatened
11	Red-headed vulture	<i>Sarcogyps calvus</i>	Critically Endangered
12	black-headed ibis	<i>Threskiornis melanocephalus</i>	Near Threatened

Source: Bhattacharjya et al (2021)<sup>10</sup>

There have been documented 219 different species of birds, of which 70 species are waterfowl.<sup>33,34</sup> These species includes *Podiceps cristatus* (Great crested grebe), *Tachybaptus ruficollis* (Little grebe), *Microcarbo niger* (Little Cormorant), *Phalacrocorax fuscicollis* (Indian Shag), *Phalacrocorax carbo* (Large cormorant), *Podiceps nigricollis* (Black-necked grebe), *Pelecanus philippensis* (Spot-billed pelican), *Ardea cinerea* (Grey Heron), *Ardea goliath* (Giant Heron), *Ardeola* (Pond Herons), *Egretta garzetta* (Little Egret), *Ixobrychus cinnamomeus* (Cinamon Bittern), *Ardea intermedia* (Intermediate Egret), *Bubulcus ibis* (Cattle Egret), *Ardea alba* (Great Egret), *Ardea purpurea* (Purple Heron), *Ixobrychus flavicollis* (Black Bittern), *Ixobrychus sinensis* (Yellow Bittern), *Anastomus oscitans* (Asian Openbill Stork), *Leptoptilos dubius* (Greater Adjutant), *Nycticorax nycticorax* (Black-Crowned Night-Heron), *Leptoptilos javanicus* (Lesser Adjutant), *Dendrocygna javanica* (Lesser Whistling Duck), *Ephippiorhynchus asiaticus* (Black-necked Stork), *Anser indicus* (Bar-headed Geese), *Dendrocygna bicolor* (Fulvous whistling duck), *Tadorna ferruginea* (Ruddy Shelduck), *Mareca penelope* (Eurasia

Wigeon), *Nettapus coromandelianus* (Cotton pygmy goose), *Mareca strepera* (Gadwall), *Anas crecca* (Common Teal), *Spatula querquedula* (Garganey), *Anas platyrhynchos* (Mallard), *Aythya nyroca* (Ferruginous Duck), *Spatula clypeata* (Northern Shoveler), *Anas poecilorhyncha* (Indian spot-billed duck), *Anas acuta* (Northern Pintail), *Aythya baeri* (Baer's Pochard), *Aythya fuligula* (Tufted Duck), *Aythya ferina* (Common Pochard), *Netta rufina* (Red Crested Pochard), *Porphyrio porphyrio* (Purple Swamphen), *Rallus aquaticus* (Water Rail), *Gallinix cinerea* (Watercock), *Hydrophasianus chirurgus* (Pheasant Tail Jacana), *Fulica atra* (Common Coot), *Metopidius indicus* (Bronze Winged Jacana), *Glareola maldivarum* (Oriental Partincole), *Vanellus indicus* (Red-Wattled lapwing), *Rostratulidae* (Painted Snip), *Vanellus vanellus* (Northern Lapwing), *Amaurornis phoenicurus* (White breasted Waterhen), *Tringa ochropus* (Green Sandpiper), *Tringa erythropus* (Spotted redshank), *Vanellus cinereus* (Grey-headed lapwing), *Actitis hypoleucos* (Common sandpiper), *Pluvialis fulva* (Asiatic Golden Plover), *Tringa stagnatilis* (Marsh Sandpiper), *Charadrius dubius* (Little Ringed

Plover), *Tringa nebularia* (Common greenshank), *Calidris pygmaea* (Spoon-billed sandpiper), *Chlidonias hybrida* (Whiskered tern), *Gallinago gallinago* (Common snip), *Gallinago stenura* (Pin-tailed snip), *Chroicocephalus ridibundus* (Black-headed gull), *Tringa glareola* (Wood sandpiper), *Gallinago solitaria* (Solitary snip), *Sterna acuticauda* (Black-bellied tern), *Sterna aurantia* (Indian River tern) and *Calidris minuta* (Little stint). The *Elephas maximus* are among the mammals found in the reserve forest of Rani and Garbhanga which visit the beel in search of water and food.<sup>26</sup>

### Impact of Landfill on Deepor Beel

Deepor Beel is vulnerable due to its proximity to the Paschim Boragaon landfill. Although the wetland is 1.5 km away from the landfill, being situated within the floodplain exacerbates the issue over monsoon season when the level of water reaches the landfill's edge. The presence of a nearby landfill has significantly impacted the surrounding areas,<sup>16,35,36</sup> giving rise to a range of concerns—from the visual appeal of the site to public disputes and water contamination. Dumping waste in close proximity has led to alarming levels of pollution in the wetland, compromising biodiversity and drastically affecting the survival of various organisms in the marsh.

Leachate is a liquid substance that escapes from the confines of a landfill and infiltrates the surrounding environment. It possesses the potential to pollute soil, groundwater reservoirs, and residential or natural areas in general.<sup>37–39</sup> Leachate arises when liquid substances come into contact with waste, particularly household waste.<sup>40</sup> It extracts substances from the waste that can dissolve inorganic components, which in turn dissolve alongside organic waste materials like paper, cardboard, and food. These substances are broken down by microbial activity into simpler compounds. As water permeates through the landfill, its quality typically degrades. The color shifts from light brown to black, emitting a sweet and nauseating smell. If the construction and upkeep of sediment barriers are inadequate, contaminated sediments can flow into the adjacent wetland. This influx, along with an increase in sediment content, can disrupt the aquatic life within the wetland. Consequently, liquid waste from the landfill may find its way into the wetland, resulting in modifications to the wetland ecosystem.

Sayed Ali, Singh, and Kalamdhad<sup>41</sup> conducted a study and disclosed that the different water quality parameters within Deepor Beel have been undergoing variations in both time and location. Choudhury and Gupta,<sup>15</sup> applied biological monitoring scores in different sites and seasons of the beel, which indicated critical to moderate water quality, along with frequent alterations in water quality near the landfill due to leachate.<sup>15</sup> The landfill significantly modifies the hydrology of surface and groundwater in the area, affecting the water balance of the nearby wetland in an adverse manner. A decrease in dissolved oxygen levels and an increase in concentrations of hazardous organic compounds (e.g., phenol) lead to changes in the composition and abundance of the biological community. Fluctuations in the biological oxygen demand, presence of heavy metals and faecal coliforms are unsuitable for aquatic plants and animals and also for the domestic utility.<sup>35</sup> The disturbance in water balance for a wetland can have detrimental effects on the reproduction of fish and other aquatic organisms. Consequently, the coexistence of wetlands and landfills poses an ecological risk and threat.

### Stipulated Standards in Citing a Landfill

Sanitary landfills are purposefully designed and constructed to minimize the environmental impact associated with the land-based disposal of solid waste. The Solid Waste Management (SMW) Rules of 2016 govern the location, design, and operation of these landfills. In compliance with these parameters, a modern landfill is a multifaceted facility incorporating various equipment.

#### Solid Waste Management Rules of 2016 - Regarding Landfills<sup>42</sup>

- Avoid dumping of mixed waste;
- The rejects and residues from waste treatment facilities which are non-usable, non-biodegradable, non-recyclable and non-combustible to be disposed of in a sanitary landfill.
- The appropriate actions should be performed to bio-mine or bio-remediate the locations. Additionally, an investigation and analysis of all former open dumpsites and existing dumpsites should be carried out to determine their potential for bio-mining and bioremediation, if feasible.
- If bio-mining and bio-remediation cease



to be practised in the dumpsite, it should be scientifically capped to prevent further environmental harm.

- Avoiding building landfills on slopes is one of the special provisions for hilly areas. Instead, a transfer station should be set up in a suitable, enclosed area to gather inert trash and leftover garbage from processing units. Finding suitable land in plain areas, downhill and within a 25 km proximity is crucial for building sanitary landfills. Only the leftover material from the transfer station should be dumped in the landfill.
- A regional landfill for non-hazardous waste to be setup when in circumstances where such land is not accessible.

#### **Waste Suitable for Landfilling**

As per the SWM Rules of 2016, certain conditions and waste compositions are regulated for dumping of waste material in a municipal sanitary landfill. The following types of waste are considered suitable.

- i. Waste that is inert and non-biodegradable (either naturally or following pre-treatment).
- ii. Garbage that has been combined together and is declared unfit for waste-treatment.
- iii. Materials produced by before and after processing operations in waste-treatment units.
- iv. Garbage that isn't harmful and can't be processed or recycled.

**Table 2: Evaluation of the site for placing a sanitary landfill at Paschim Boragaon**

Sl. No.	Place	Minimum distance for sitting	Status of the site
1	Wetland, important habitat areas, delicate eco-fragile areas, coastal regulation, and flood plains	Restrictions on establishing sanitary dump sites in these designated locations	The landfill site is a wetland
2	Rivers	100 m away	A small stream passes through the site
3	Pond, lakes, water bodies	200 m away	Deepor Beel is 1.5 km away
4	Highway or railway line	200 m away from the centre line	NH 37, 1 km away
5	Water supply/ wells	500 m away	The vicinity lacks any schemes or wells.
6	Habitat	500 m away	Habitats seen within 500 metres of the site.
9	Flood-prone area	Prohibited	Within the floodplain
10	Water table	The landfill's bottom liner ought to be more than 2 metres above the highest water table.	At ground level
11	Airport	No landfill within 20 km**	Guwahati airport – 10 km

\*\* A landfill site can be established within a distance of 10 to 20 km from the airport or airfield, but only if there is a no objection certificate from the civil aviation authority or air force, as applicable. This exception would be allowed in special circumstances.

Source: GWMCP<sup>43</sup> and CPHEEO<sup>42</sup>

### Waste not Suitable for Landfilling

The kinds of waste considered unsuitable for sanitary landfilling are as follows.

- i. Garden waste or biodegradable garbage, preferably composted.
- ii. Recyclables that are dry and ideally recycled.
- iii. Hazardous waste (needs unique containment facilities for disposal).

### CPCB and CPHEEO's Guidelines

CPCB and CPHEEO have established guidelines for the placement of sanitary landfills. It is imperative to strictly avoid constructing sanitary landfills for municipal waste in restricted zones, as outlined in Table 1. The waste management system overseen by Guwahati Municipal Corporation in Guwahati has failed to meet these prescribed standards. Deficiencies were identified not only in the primary and secondary waste collection, but also in the transportation and final dumping of waste. The existing waste management system in Guwahati is inadequate, necessitating the adoption of proper measures to address the mismanagement and growing waste generated by the city's expanding population. With reference to Guwahati Waste Management Company Private Limited (GWMCP) Boragaon landfill location has been examined and highlighted the violations committed by GMC during the selection of the landfill site, posing risks of air, water, and environmental pollution.

### Conclusion

Deepor Beel is a natural wetland with a self-contained ecosystem that supports a wide range of living and nonliving species. The beel holds significant ecological, economic, social, and commercial value, providing sustenance to local communities. Any disruption in the food chain within the wetland ecosystem would result in a disturbance of the entire system. Over time, Deepor Beel has lost its originality, primarily due to the deterioration of water and soil quality, as well as the loss of habitats and ecological balance. The beel is also undergoing changes in size due to human

activities like urbanization, illegal settlements, and industrial growth.<sup>44</sup> The construction of railroads through the wetland poses a threat to Asiatic Elephants, leading to frequent collisions with trains.<sup>45</sup> Moreover, there has been a significant decline in aquatic species, particularly a 26% decrease in fish varieties, mainly caused by rising temperatures.<sup>46</sup> The survival conditions for these species have been compromised due to continuous pollution from sewage disposal and waste dumping near the beel. Therefore, it is crucial to urgently relocate the dumping grounds, as this violates the regulations outlined by CPHEEO and CPCB, contravening the Wetland Rules of 2010. In line with these standards, Hazarika and Saikia (2020) conducted an analysis using geospatial technologies to identify suitable landfill sites for Guwahati city and proposed several locations.<sup>4</sup> To combat habitat loss and preserve the importance of Deepor Beel, the following actions and sustainable measures are recommended: conducting environmental awareness programs for local residents, regularly monitoring water and soil quality, implementing government policies, promoting afforestation initiatives, minimizing unauthorized encroachments, enforcing restrictions on illegal fishing and poaching, ensuring unobstructed animal movement paths to mitigate human-animal conflicts, and reducing the use of pesticides and fertilizers in agricultural areas.

### Acknowledgement

The author would like to acknowledge the support of Gauhati University and my work place institution.

### Funding

The author received no financial support for the research, authorship, and/or publication of this article.

### Conflict of Interest

The author doesn't have any conflict of interest in the article of research "Locational Suitability of Paschim Boragaon Landfill adjacent to Deepor Beel Wetland, Assam"

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