NDC E-BIOS (Online) Volume 4, pp 37-46 (2024) ISSN: 2583-6447
DOI: https://doi.org/10.5281/zenodo.15792926

ORIGINAL ARTICLE

DOCUMENTATION OF THE NATIVE DOMINANT MANGROVE VEGETATION AND THE DOMINANT INVASIVE SPECIES FROM JHARKHALI: IMPORTANCE AND IMPLICATIONS

Mitu De*, Priyanka Sen, Asmita Paul, Ripan Chandra Das and Goutam Kumar Pahari

Department of Botany, Gurudas College, Kolkata, West Bengal, 700054, India.
*Correspondence: mitubotany@gmail.com; mitu.botany@gurudas.education

Abstract: *Sundarbans is the largest mangrove forest in the world, a UNESCO World Heritage Site, and is known for its unique ecosystem and rich biodiversity. Jharkhali is a village of the South 24 Parganas district in the Indian state of West Bengal and serves as one of the many gateways to the deltaic region of Sundarban area. The objective of the study deals with the documentation of the native mangrove vegetation as well as the dominating invasive species of the study area. A field study was conducted in Jharkhali in June-July, 2023 from the Department of Botany, Gurudas College, Kolkata. The vegetation was comprised of six key mangrove species (e.g., Heritiera fomes, Excoecaria agallocha, etc.), three associated species (e.g., Aegiceros corniculatum, Nypa fruticans, Phoenix paludosa) and three halophytes (e.g., Suaeda maritima, Salicornia, etc.). Avicennia, Rhizophora and Sonneratia were found to be the present key genera, playing important role in ecology and socio-economic base of the study area, which are being challenged by climate change and anthropogenic activities. It was observed that invasive species like Eichhornia, Mikania, Parthenium hysterophorus, Lantana camara, etc outcompetes the native plant community causing negative effect to biodiversity, environment and natural resources. The observation in present survey may provide valuable insight on environmental protection, biodiversity conservation and socio-economic development as a whole.*

Key words: Mangrove vegetation, Sundarbans, native and invasive species, biodiversity, environment.

Communicated:18.11.2024 Revised: 30.11.2024 Accepted: 01.12.2024

1. INTRODUCTION

The Sundarbans, located in the delta region of the Padma, Meghna, and Brahmaputra rivers, is one of the most biologically diverse ecosystems in the world, particularly noted for its rich and unique floral diversity. The region supports a wide array of plant species that have adapted to the challenging conditions of high salinity, fluctuating water levels, and tidal influences. The region, including the Jharkhali area, is a unique and ecologically significant area known for its rich biodiversity. Jharkhali is a small, picturesque island and a village located in the Sundarbans region of West Bengal, India. The Sundarbans is the largest mangrove forest in the world, a UNESCO World Heritage Site, and is known for its unique ecosystem and rich biodiversity. Jharkhali serves as one of the many gateways to this fascinating deltaic region.

The floral diversity of Jharkhali in the Indian Sundarbans has evolved significantly over time due to both natural and anthropogenic factors, including climate change, sea-level rise, and resource extraction. The Sundarbans' mangrove ecosystem, which supports over 70 species from various families, has seen shifts in species composition and area coverage as environmental pressures intensify.

The detailed account of the plant species found in the Sundarbans, including their taxonomy, ecology, and distribution was recorded by Banerjee *et al*. [1]. There have been several studies on floristic diversity and ecological significance of the Sundarbans region of undivided Bengal, both in India [2] and Bangladesh [3], at present. Mandal and Naskar [2] summarized the diversity and classification of mangrove species in India, with focus on the ecological and economic importance. These observations provide a strong foundation for understanding the plant diversity of the Sundarbans, which is essential for conduction survey the areas in Sundarbans. Rahman and Asaduzzaman [4] provided an analysis of species diversity and the structure of mangrove vegetation in the Sundarbans Reserved Forest in Bangladesh, emphasizing conservation concerns. An in-depth study of the mangrove species in the Indian Sundarbans, discussing their ecology, distribution, and conservation status was conducted by Chaudhuri and Choudhury [5]. A comprehensive information on the floristic composition and phytogeography of mangroves in the Sundarbans, focusing on the diversity and distribution of plant species was depicted by Naskar and Mandal [6]. The biodiversity of the Sundarbans, with a focus on the plant species that form the habitat for wildlife in the region was studied by Islam and Haque [7]. Different workers analyzed the biology of mangroves, with a focus on species diversity, ecological roles, and the effects of environmental changes [8].

The floral diversity of Jharkhali in the Indian Sundarbans, which has evolved significantly over time due to both natural and anthropogenic factors, including climate change, sea-level rise, and resource extraction. The Sundarbans' mangrove ecosystem, which supports over 70 species from various families, has seen shifts in species composition and area coverage as environmental pressures intensify.

Since the 1970s, satellite data indicates considerable changes in the area of mangrove forests. A study of the larger Sundarbans area found that forest coverage initially increased but began to decline after the 1990s, partly due to the decreased sediment deposition from rivers and rising water levels. Significant losses of native mangrove species such as *Heritiera fomes* and expansions of waterlogged areas have altered the ecosystem's structure, reducing overall plant diversity in certain zones. Giri *et al* [9] used satellite data to monitor changes in mangrove forest cover and biodiversity in the Sundarbans over several decades providing insights into the dynamics of plant diversity along with comparative analyses of mangrove forests of the world using earth observation satellite data [10]. It was found that the threat to mangroves plants mostly due to climatic changes as well as anthropogenic pressure [11, 12]. Based on the analytical studies, Duke [13] emphasized on what the world would be, if there were no mangroves with a futuristic approach. In the last decade, the importance of community-based management initiatives, leading to the sustainable use and conservation of mangrove plant species are being highlighted [14].

With a focus on the changing floristic diversity, the present study also observed the anthropogenic pressures on the land ecosystem of Sundarban area. The basic objective of the investigation was laid on the documentation of the dominant mangrove vegetation as well as the dominant invasive species, causing habitat depletion for native plant species.

2. MATERIALS AND METHODS

Study Area

Jharkhali is a serene village under the gram panchayat within the jurisdiction of the Basanti police station in

the Basanti CD block in the Canning subdivision of the South 24 Parganas district in the Indian state of West Bengal (Figure 1).

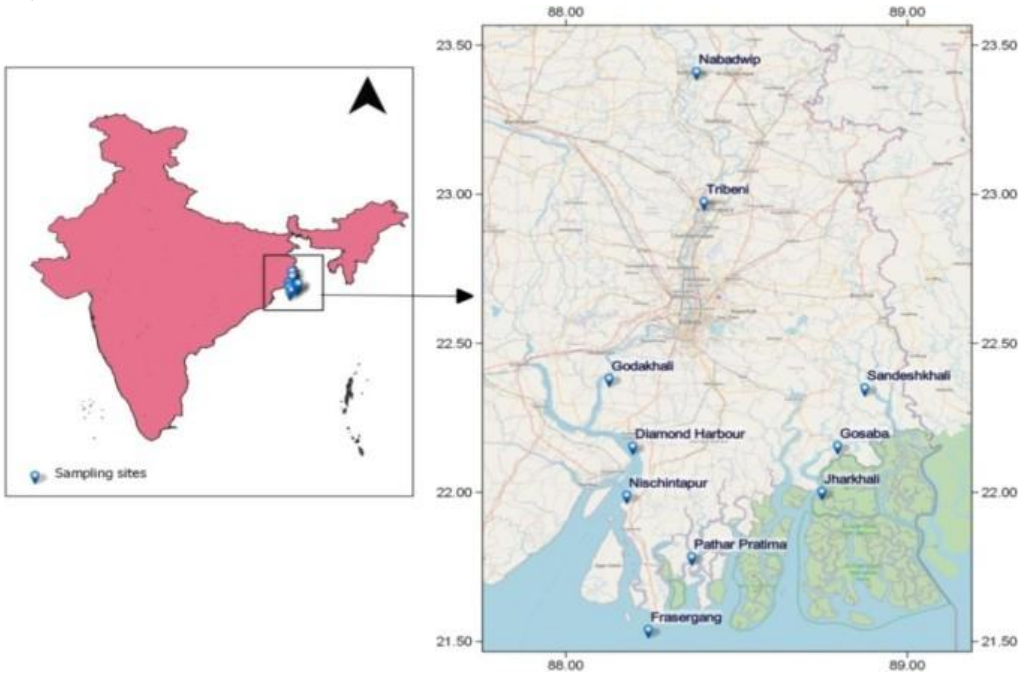

Figure 1. Location map of study area at Jharkhali, Sundarbans, West Bengal, India.

The village is known for its lush mangrove forests, wildlife, and the picturesque view of the Matla River on one side and the Bidya River on the other side (Figure 2).

Figure 2. Location of Jharkhali with the two rivers on each side.

The Coordinates of Jharkhali are viz Latitude: 22.0197° N and Longitude: 88.7662° E The satellite map is shown in Figure 3.

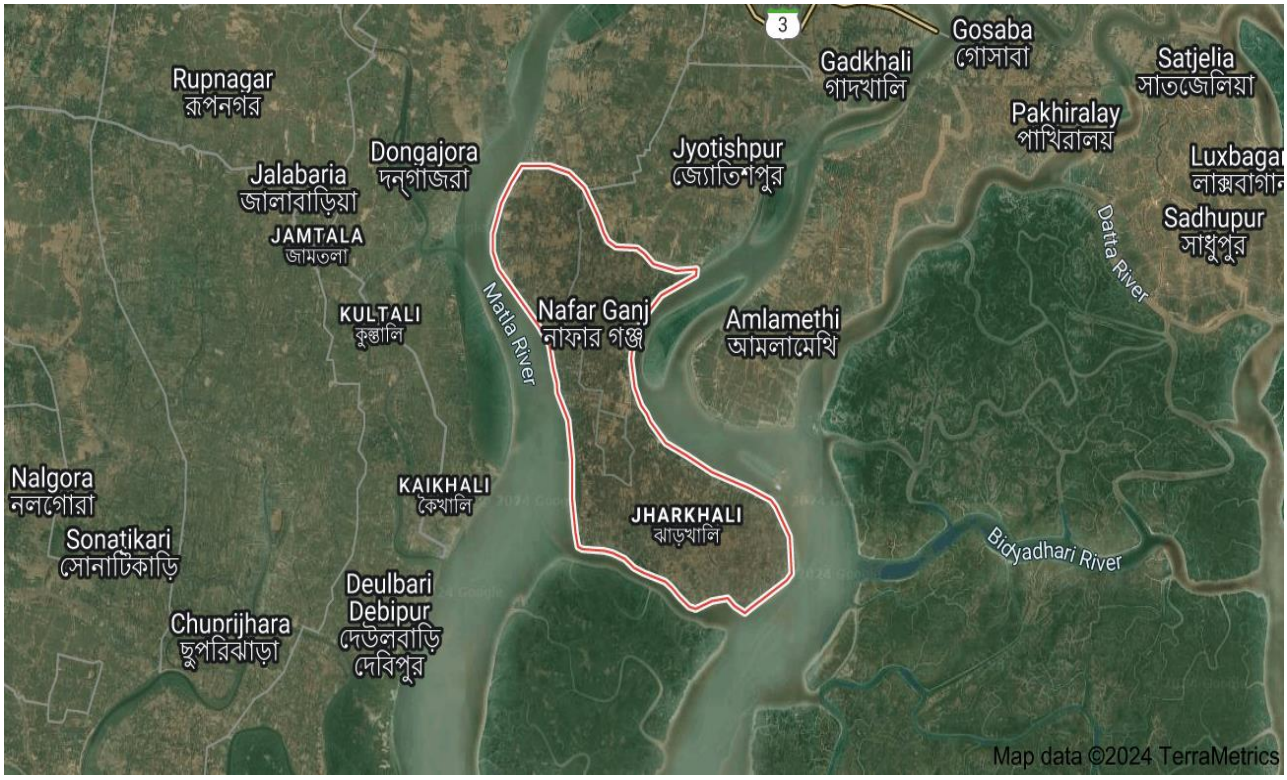

Figure 3. Satellite image of the study area at Jharkhali,

A field study was conducted in June - July, 2023 to Jharkhali, from the Department of Botany, Gurudas College, Kolkata.

3. RESULTS AND DISCUSSION

The study area is located in Sundarbans, which is primarily known for its extensive mangrove forests. The key mangrove species in the study area included:

I. Key Species:

i. Heritiera fomes Buch. Ham. (Sundari in Bangla language): The most dominant and economically valuable species, known for its hard wood. The Sundarbans derive its name from this dominant flora known as Sundari by the local people.

ii. *Excoecaria agallocha* L. (Gewa in Bangla): A common species with toxic latex, used traditionally for medicinal purposes.

iii. *Avicennia alba* Blume, *Avicennia marina* (Forsk.) Vierh., *Avicennia officinalis* L. (White mangroves): These species are among the first colonizers in newly formed mudflats, known for their pneumatophores (breathing roots). Commonly *Avicennia* sp. is known as 'Kala Baine" in Bangla language

iv. Rhizophora mucronata Lam, *Rhizophora apiculate* Blume (Red mangroves): Known for their stilt roots, which provide stability and aid in gas exchange. It is known as Garjan in Bangla.

v. Ceriops decandra (Griff.) Ding Hou (Goran in Bangla): Another important species, which is often found in the higher salinity zones of the Sundarbans.

vi. Sonneratia apetala Buch (Keora in Bangla): Commonly found along river banks and tidal flats, playing a crucial role in sediment trapping.

4. **Associated Vegetation:**
    i. Aegiceros *corniculatum* (L.) Blanco (River Mangrove): Found in slightly less saline areas, often alongside true mangrove species. Known as Khalshi in Bangla.
    ii. *Nypa fruticans* Wurmb. (Nipa Palm): Common in brackish water areas, it is the only palm species in the mangrove forest. known as Golpatta in Bangla.
    iii. *Phoenix paludosa* Roxb. (Mangrove Date Palm): A species of palm found in the Sundarbans, contributing to the structural diversity of the mangrove ecosystem.

5. **Halophytes and Salt Marsh Plants:**
    i. *Suaeda maritima* (L.) Dumort.: A salt-tolerant shrub found in the upper intertidal zones, often on saline mudflats.
    ii. *Salicornia brachiata* Roxb.: A succulent halophyte found in high salinity areas, known for its ability to thrive in extremely salty conditions.
    iii. *Atriplex repanda* Phil: Another halophyte contributing to the unique vegetation of the Sundarbans.

Heritiera fomes Buch. Ham. or the Sundari tree from which the name of the Sundarbans was derived is slowly declining. *Avicennia* sp, *Rhizophora* sp, and *Sonneratia* sp are now the three key genera of mangrove plants that play a vital role in the ecology, economy, and community resilience of areas like Jharkhali in the Sundarbans. Their significance lies in their ability to sustain biodiversity, protect the environment, and support local livelihoods.
The specific contributions of these genera recorded are as following:

1. **Environmental Importance**

a. Shoreline Protection

- These mangroves act as natural barriers against coastal erosion and storm surges.
- Their complex root systems stabilize sediments and reduce wave energy, crucial for protecting the fragile Sundarbans delta.

b. Climate Mitigation

- *Avicennia, Rhizophora,* and *Sonneratia* are highly efficient in carbon sequestration, storing large amounts of carbon in their biomass and soil.
- They help combat climate change by acting as a carbon sink.

c. Habitat for Biodiversity

- The mangroves provide a safe habitat for a variety of species, including:
    - Fish and crustaceans (breeding and nursery grounds).
    - Birds, reptiles, and amphibians.
    - Iconic species like the Royal Bengal Tiger and the Irrawaddy dolphin.

d. Water Quality

- Their roots filter pollutants, sediments, and nutrients, improving the water quality of the estuarine ecosystem.

2. Economic Importance

a. Fisheries and Livelihood

- Local communities rely on the mangroves for sustainable fishing practices, as they serve as nurseries for commercially valuable species.
- Honey collection and crab farming also depend on the mangrove ecosystem.

b. Wood and Non-Timber Products

- *Avicennia* sp and *Rhizophora* sp. provides wood and tannins, though these activities are regulated to prevent overexploitation.

c. Ecotourism

- Jharkhali is emerging as a tourist destination, with its mangroves attracting visitors interested in the unique biodiversity and scenic beauty of the Sundarbans.

3. Species-Specific Roles

a. *Avicennia* (Example: *Avicennia marina*)

- Pioneer species that tolerate high salinity and aid in reclaiming degraded lands.
- Act as a buffer against saline water intrusion.

b. *Rhizophora* (Example: *Rhizophora mucronata*)

- Known for their prop roots, which trap sediments and create land over time.
- Provide robust protection against tidal waves and storm surges.

c. *Sonneratia* (Example: *Sonneratia alba*)

- Important for pneumatophores (aerial roots) that enhance oxygenation of waterlogged soils.
- Support biodiversity, especially for aquatic species.

4. **Cultural and Social Importance**

- Mangroves hold cultural significance for the communities of Jharkhali and the Sundarbans, symbolizing resilience and interdependence with nature.
- Their preservation is deeply tied to local traditions of living sustainably with the environment.

There are the following challenges, which are faced by the vegetation of the study area:

i. Deforestation, rising sea levels, and climate change are threats to these critical mangroves.
ii. Initiatives like reforestation, community-based conservation, and sustainable tourism are essential to ensure their survival and benefits.

Figure 4. Detailed location map of Jharkhali showing stretches of land converted to agricultural fields

It was observed that, *Avicennia* sp, *Rhizophora* sp, and *Sonneratia* sp are lifelines for the Jharkhali region of the Sundarbans, providing ecological stability, economic resources, and protection for both the environment and the

communities dependent on them.

However, there is heavy anthropogenic pressure in Jharkhali. The mangrove vegetation has been wiped away in several places and converted into crop fields (Figure 4).

Dominant Invasive species in Jharkhali

Invasive plant species are non-native plants that spread rapidly and can cause significant ecological disruption, often outcompeting native flora and altering habitats. In the Sundarbans, including Jharkhali, the presence of invasive species poses a threat to the delicate balance of this unique ecosystem [15-17]. Some of the invasive plant species that have been observed in the study area are:

1. *Pontederia crassipes* Mart. (formerly known as *Eichhornia crassipes* (Mart.) Solms., belonging to the family Pontederiaceae, commonly known as common water hyacinth, is an aquatic invasive plant.
    - Origin: Native to South America.
    - Impact: This aquatic plant is highly invasive and forms dense mats on the surface of water bodies, blocking sunlight, reducing oxygen levels, and disrupting aquatic ecosystems. It can hinder the growth of native aquatic plants, affect fish populations, and clog waterways, impacting local communities' livelihoods.

2. *Mikania micrantha* Kunth (Bitter vine/Mile-a-Minute Weed) belonging to the family Asteraceae.
    - Origin: Native to Central and South America.
    - Impact: Known for its rapid growth, this vine can smother native vegetation, including mangroves, by forming dense, impenetrable thickets. It competes with native species for light and nutrients, leading to a reduction in biodiversity.

3. *Lantana camara* L. belonging to the family Verbenaceae
    - Origin: Native to Central and South America.
    - Impact: *Lantana* is a shrub that invades disturbed areas, forming dense thickets that suppress native plants. Its allelopathic properties inhibit the growth of other species. In the Sundarbans, it can alter the structure of mangrove forests and reduce habitat quality for wildlife.

4. *Parthenium hysterophorus* L. (congress grass) belonging to the family Asteraceae.
    - Origin: Native to the Americas.
    - Impact: *Parthenium hysterophorus* L. is an aggressive invader of open lands, including disturbed areas in the Sundarbans. It can outcompete native grasses and herbs, leading to a decline in plant diversity. Its pollen and volatile oils are also known to cause allergic reactions in humans and animals.

5. *Chromolaena odorata* (L.) R.M. King & H. Rob. (siam weed) belonging to the family Asteraceae.
    - Origin: Native to Central and South America.
    - Impact: This fast-growing shrub invades forest edges and open areas, forming dense stands that outcompete native species. In the Sundarbans, it can encroach on mangrove areas, reducing biodiversity and altering habitat structure.

6. *Ipomoea carnea* Jacq. (Pink Morning Glory) belonging to the family Convolvulaceae
    - Origin: Native to South America.
    - Impact: *Ipomoea carnea* Jacq. is a woody, herbaceous shrub that invades wetlands and riverbanks. It forms dense thickets that can outcompete native vegetation, particularly in disturbed areas of the Sundarbans. It is toxic to livestock and can disrupt local agricultural practices.

Ecological Impact of Invasive Species on the ecosystem of the study area:

i. Displacement of native species: Invasive species often outcompete native plants, leading to a decline in native biodiversity. This can alter the structure and function of the ecosystem, making it less resilient to environmental changes.
ii. Alteration of habitat: Invasive species can change the physical structure of habitats, such as altering the hydrology of wetlands or the light availability in forests, which can have cascading effects on the entire ecosystem.
iii. Impact on wildlife: The spread of invasive plants reduces the availability of food and habitat for native wildlife (viz., Bengal tiger, deer, and various bird species), that rely on native flora.
iv. Economic consequences: Invasive plants can impact local communities by reducing the availability of natural resources, such as fish and honey, which are vital for livelihoods.

Significance of the study of the floral diversity of Jharkhali

The study of plant diversity at Jharkhali in the Sundarbans is of significant importance due to the unique ecological, environmental, and socio-economic roles that this region plays. The Sundarbans is a UNESCO World Heritage Site and one of the most biodiverse regions in the world, with its intricate mangrove ecosystems providing numerous benefits. Jharkhali, as a part of the Sundarbans, contributes to this diversity and warrants detailed study for several reasons:

1. Biodiversity conservation

- Unique Flora: Jharkhali hosts a variety of plant species, including several that are endemic or rare. Studying this diversity helps in understanding the complex ecological interactions and the specific roles that each species plays in the ecosystem. This knowledge is crucial for the conservation of these species, many of which may be threatened by climate change, habitat loss, and human activities.
- Genetic Reservoir: The plant species in Jharkhali act as a genetic reservoir, which is vital for maintaining biodiversity. This genetic diversity can be important for breeding programs, especially in the face of changing environmental conditions.

2. Ecological significance

- Mangrove Ecosystem: The Sundarbans is the largest mangrove forest in the world, and Jharkhali is a key part of this ecosystem. Mangroves are critical for coastal protection, acting as natural barriers against storms, cyclones, and tidal surges. Understanding the plant diversity in Jharkhali helps in maintaining the health of these mangroves, which in turn supports a wide range of marine and terrestrial life.
- Carbon Sequestration: Mangrove forests are known for their ability to sequester carbon at high rates. The plant diversity in Jharkhali contributes to this process, helping mitigate climate change. Detailed studies can quantify this role and enhance conservation efforts aimed at climate change mitigation.

3. Environmental monitoring

- Indicator of Ecosystem Health: The diversity and health of plant species can serve as indicators of the overall health of the Sundarbans ecosystem. Monitoring changes in plant diversity at Jharkhali can provide early warnings of ecological imbalances or environmental degradation, allowing for timely interventions.
- Impact of Climate Change: The Sundarbans is highly vulnerable to the impacts of climate change, including rising sea levels, increased salinity, and changing precipitation patterns. Studying the plant diversity at

Jharkhali helps in understanding how these changes affect local ecosystems and guides adaptive management strategies.

4. Socio-Economic importance

- Livelihoods and Local Communities: Many local communities in Jharkhali and the broader Sundarbans region depend on the diverse plant life for their livelihoods, including fishing, honey collection, and traditional medicine. Understanding plant diversity helps in the sustainable management of these resources, ensuring that local populations can continue to benefit from them.
- Ecotourism: Jharkhali is an emerging destination for ecotourism. Knowledge of plant diversity enhances the ecotourism experience, as visitors can be educated about the ecological importance and unique characteristics of the local flora, thereby promoting conservation awareness and generating revenue for local communities.

5. Scientific research and education

- Baseline Data for Research: Detailed studies of plant diversity at Jharkhali provide baseline data that is essential for further scientific research. This data can be used to study ecological dynamics, evolutionary processes, and the effects of environmental changes on biodiversity.
- Educational Value: Jharkhali serves as an excellent field site for education in ecology, botany, and environmental science. Understanding its plant diversity allows for better educational programs that can inspire future generations of conservationists and scientists.

4. CONCLUSION

Informed decision-making is an important factor in the conservation of biodiversity as well as for sustainability of this unique yet fragile ecosystem. Accurate knowledge of plant diversity (native as well as the invasive species) is essential for conservation and management decisions. It helps to identify the key species and habitats that require protection, the development of restoration programs, and the creation of policies that balance conservation with sustainable development. In the areas, where plant diversity has been degraded, studies provide the necessary information to guide restoration efforts, ensuring that the reintroduction of native species is done in a scientifically sound manner.

The study of plant diversity at Jharkhali in the Sundarbans is crucial for conserving biodiversity, protecting the environment, supporting local livelihoods, and enhancing scientific understanding. The present work is an attempt to study only the major mangrove plants as well as the invasive species. The importance of these species is depicted here, to get an overall comprehensive view. As environmental pressures increase, the insights gained from such studies will be vital in ensuring the long-term sustainability

5. CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this work.

6. ACKNOWLEDGEMENTS

The authors would like to express sincere thanks to the Principal of Gurudas College for providing necessary infrastructure to conduct this study as a student project. Thanks are due to the Head of the Botany Department for organizing this excursion. The authors would also like to thank the other departmental faculty members of Gurudas

College for their encouragement and support.

7. REFERENCES

1. *Banerjee, L.K., Mukherjee, S.K., and Pal, D.C., "Flora of the Sundarbans mangals", Botanical Survey of India, (1989).*
2. *Mandal, R.N. and Naskar, K. R., "Diversity and classification of Indian mangroves: a review", Tropical Ecology, vol 49(2), (2008), pp 131-146.*
3. *Zaman, S. and Siddiqui, M. Z., "Plant Diversity in the Sundarbans ecosystem of Bangladesh", Journal of Tropical Forest Science, vol 7(2), (1995), pp 222-226.*
4. *Rahman, M. M. and Asaduzzaman, M., "Mangrove species diversity and vegetation structure of the Sundarbans reserved forest, Bangladesh", Frontiers of Earth Science, vol 7(4), (2013), pp 469-486.*
5. *Chaudhuri, A. B. and Choudhury, A., "Mangroves of the Sundarbans", Volume 1: India. IUCN. (1994).*
6. *Naskar, K. R. and Mandal, R. N., "Ecology and biodiversity of Indian mangroves", vol 2: Floristic composition and phytogeography. (1999), Daya Publishing House.*
7. *Islam, M. S. and Haque, M., "The mangrove forests of Sundarbans: a natural habitat for wild animals", Pakistan Journal of Biological Sciences, vol 7(10), (2004), pp 1821-1829.*
8. *Kathiresan, K. and Bingham, B. L., "Biology of mangroves and mangrove ecosystems", Advances in Marine Biology, vol 40, (2001), pp 81-251.*
9. *Giri, C., Pengra, B., Zhu, Z., Singh, A. and Tieszen, L. L., "Monitoring mangrove forest dynamics of the Sundarbans in Bangladesh and India using multi-temporal satellite data from 1973 to 2000", Journal of Estuarine, Coastal and Shelf Science, vol 73(1-2), (2007), pp 91-100.*
10. *Giri, C., Ochieng, E., Tieszen, L. L., Zhu, Z., Singh, A., Loveland, T., Masek, J. and Duke, N., "Status and distribution of mangrove forests of the world using earth observation satellite data", Glob Ecol Biogeogr, vol 20, (2011), pp 154–159.*
11. *Gilman, E., Ellison, J., Duke, N. C. and Field, C., "Threats to mangroves from climate change and adaptation options: a review", Aquat Bot, vol 89, (2008), pp 237–250.*
12. *Giri, C., Long, J., Abbas, S., Murali, R. M., Qamer, F. M., Pengra, B. and Thau, D., "Distribution and dynamics of mangrove forests of South Asia", J Environ Manage, vol 100, (2014), pp 1–11.*
13. *Duke, N. C., Meynecke, J. O., Dittmann, S., Ellison, A. M., Anger, K., Berger, U., Cannicci, S., Diele, K., Ewel, K. C. and Field, C. D. A world without mangroves?", Science, vol 317, (2007), pp 41–42.*
14. *Datta, D., Chattopadhyay, R. N. and Guha, P., "Community-based mangrove management: a review on status and sustainability", Journal of Environmental Management, vol 107, (2012), pp 84-95.*
15. *Mandal, S. and Naskar, K. R., "An updated inventory of invasive plants of Sundarbans", West Bengal Biodiversity Board. (2010).*
16. *Pasha, M. K., Rahman, M. M. and Islam, M. S., "Impact of exotic invasive weeds on the ecosystem of Sundarbans mangrove forest, Bangladesh", Journal of Forestry Research, vol 15(4), (2004), pp 270-276.*
17. *Saha, S., Chattopadhyay, S. and Mitra, A., "Invasive alien species of Sundarbans mangrove ecosystem and their impact on forest health", International Journal of Environmental Sciences, vol 8(3), (2018), pp 227-235.*
