**Ecology and Environment of the Indian Sundarbans (West Bengal)**

**Overview**

The Indian Sundarbans—West Bengal's great mangrove delta at the edge of the Bay of Bengal—are not a "forest" in the usual sense. They are a living interface where **tides, rivers, mud, salt, and storms** constantly remake the ground beneath the trees. This chapter offers a field-ecology view of the region: its physical drivers (tides/salinity/sedimentation), plant communities (with a consolidated **24-species true mangrove list**), animal life from microbes to tiger, and the livelihood-linked biodiversity people most directly interact with—**NTFP (honey, beeswax, palms), fish, crabs, prawns/shrimps, and molluscs**. It closes with the ecosystem services the Sundarbans provide and the environmental pressures shaping their future.

A note on "full lists": the Sundarbans hold **hundreds of fish species** and very large multi-taxa biodiversity; complete inventories are typically published as monographs and datasets. For the Indian Sundarbans, the Zoological Survey of India's *Fauna of Sundarban Mangrove Ecosystem* (1989) remains a foundational compilation.

For fish diversity, updated datasets and compilations report roughly **~350 species** in the Sundarban region (species numbers vary by boundary definitions and updates).

Accordingly, this chapter provides (1) a robust ecological synthesis, plus (2) practical "working lists" and annexures that can sit in a 15–25 page book chapter without turning into an encyclopaedia.

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**1. The Indian Sundarbans as an ecosystem: location, boundaries, meaning**

The Sundarbans occupy the seaward fringe of the Ganga–Brahmaputra–Meghna delta, spread across Bangladesh and India. UNESCO describes the Sundarbans mangrove forest as one of the largest such forests in the world, intersected by tidal waterways, mudflats, and salt-tolerant mangrove islands; the Bangladesh World Heritage property lies adjacent to India's Sundarbans World Heritage site (inscribed in 1987).

In West Bengal, "the Indian Sundarbans" is often used in two overlapping senses:

- **The mangrove forest landscape** (tiger reserve/protected forests and adjoining forest divisions).
- **The broader inhabited delta** (a mosaic of embanked islands, rivers, creeks, aquaculture ponds, agriculture, and remnant mangrove patches).

Ecologically, both matter: the forest core is where many processes are most intact, while the inhabited delta is where human–environment interactions are most intense and where many pressures originate.

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**2. The physical template: tides, salinity, sediment, storms**

**2.1 Tidal hydrology and the "breathing" delta**

The Sundarbans are fundamentally **tidal**. Twice-daily tides push saline water inland through a maze of rivers and creeks; during monsoon and upstream freshwater pulses, salinity relaxes and brackish conditions expand. This continual mixing drives nutrient recycling and supports nursery habitats that underpin fisheries productivity (a major reason mangroves are so biologically "rich" despite having relatively few dominant tree types).

**2.2 Salinity gradients structure life**

Salinity is not uniform: it varies by distance from the sea, channel connectivity, monsoon intensity, and local geomorphology. Plant communities respond strongly: some species tolerate a wide salinity range, while others are more restricted. Recent work on Lothian Island, for example, highlights how **Avicennia** species can span lower to higher salinity zones, reflecting changing salinity regimes and/or differences across time and location.

### 2.3 Sedimentation, erosion, and island-making

The Sundarbans are an "unfinished" landscape: silt and clay brought by rivers and moved by tides build mudbanks; currents and storms erode them elsewhere. New land often begins as bare mudflat → colonised by pioneer vegetation → stabilised by mangrove roots → gradually developing a more complex forest structure. This physical dynamism is why mangroves are sometimes described as *geomorphic engineers*—they don't just live on the land; they help create it.

### 2.4 Cyclones and storm surges: disturbance as a normal condition

Extreme events—cyclones, storm surges, embankment breaches—can suddenly change salinity, drown seedlings, open forest edges, and reconfigure channels. From an ecology perspective, the Sundarbans are adapted to disturbance, but the **frequency and intensity** of disturbances can push systems into new states (e.g., more saline conditions favouring certain assemblages, reduced regeneration of sensitive species, stronger erosion fronts). This is one reason long-term monitoring and site-specific restoration choices matter.

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## 3. Mangrove ecology: what makes a mangrove a mangrove

Mangroves are not a single taxonomic group; they are plants from multiple families that converged on similar solutions to living in **salty, waterlogged, oxygen-poor intertidal soils**. The classic adaptations include:

- **Salt management:** excluding salt at roots, excreting salt through leaves, or storing it in tissues.
- **Aerial roots for oxygen:** pneumatophores (e.g., *Avicennia*), stilt roots (e.g., *Rhizophora*), knee roots (some *Bruguiera*).
- **Vivipary:** seeds germinate on the parent tree; propagules then float and anchor in mud.
- **Detritus-driven productivity:** mangroves export leaf litter and dissolved organic matter, feeding microbes and invertebrates that fuel estuarine food webs.

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## 4. Flora of the Indian Sundarbans: communities and species

### 4.1 A practical way to "read" Sundarbans vegetation

Instead of thinking in terms of one continuous forest, it helps to see a repeating mosaic:

1. **Pioneer fringes and mudbanks** (often *Sonneratia*, *Avicennia*, salt-tolerant grasses).
2. **Creek margins** (root-dense zones with high juvenile fish/crustacean shelter).
3. **Interior mangrove stands** (variable by salinity; mixed true mangroves + associates).
4. **Transitional/embanked edges** (mangrove associates, scrub, palms, human-planted species).
5. **Salt marsh/estuarine grass zones** (important for sediment trapping and shoreline stability).

The Sundarban Tiger Reserve (STR) notes the broader region as home to **300+ plant species**, with many true mangroves listed along with their local names.

### 4.2 The “true mangroves” of the Indian Sundarbans (24 species)

A widely cited revised checklist for the Indian Sundarbans reports **24 species of true mangroves across 9 families**.

These are the core structural species that define mangrove habitat.

You’ll find the consolidated list in **Annex A** (with local names where STR provides them).

### 4.3 Mangrove associates and notable non-tree elements

Beyond true mangroves, the ecology is shaped by:

- **Mangrove associates** (shrubs, climbers, palms) on slightly higher ground.
- **Salt-tolerant grasses and herbs** on mudflats and saline edges.
- **Epiphytes and parasitic plants** in some stands (STR lists examples like mistletoe-type taxa).

Two livelihood-ecology plants deserve special mention:

**Golpata / Nipa palm (*Nypa fruticans*)**

A mangrove palm whose leaves and sap are historically and regionally used for thatching and multiple household products; literature from the Sundarbans context highlights uses ranging from roofing material to fuel and food-related products (noting that use patterns and legality differ by place and time).

**Hental / Hantal (*Phoenix paludosa*)**

A thorny mangrove-associated palm common in the Sundarbans; recent reviews also discuss medicinal potentials documented in the literature.

(From a conservation lens, what matters is: palms contribute to structural diversity and are culturally and economically salient, so governance choices around harvesting can have outsized social impacts.)

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## 5. Fauna: from mudflat micro-life to tiger

### 5.1 Why Sundarbans animal life is so distinctive

The Sundarbans are a place where “land” and “water” are not separate realms. Most animals are either:

- **Amphibious in lifestyle** (crabs, mudskippers, crocodiles),
- **Tide-scheduled** (feeding and moving with tidal cycles), or
- **Edge specialists** (birds, fishing cat, estuarine predators).

For multi-taxa documentation, ZSI’s *Fauna of Sundarban Mangrove Ecosystem* (1989) is a classic baseline.

### 5.2 Flagship mammals and what they indicate ecologically

**Bengal tiger (*Panthera tigris*)**

In the Sundarbans, the tiger functions as apex predator in a fragmented, tidal landscape, where swimming, island-use, and navigating narrow creeks become part of everyday ecology. UNESCO specifically highlights the Sundarbans as an exceptional example of ongoing ecological processes and biodiversity that includes the Bengal tiger.

**Spotted deer/chital (*Axis axis*) and wild boar (*Sus scrofa*)**

These are key herbivore/prey components in many Sundarbans food-web narratives (and are essential for tiger energetics where present).

**Fishing cat (*Prionailurus viverrinus*)**

A wetland carnivore whose presence signals functioning creek-edge prey bases (fish, crabs, small vertebrates).

**5.3 Reptiles, amphibians, and estuarine "top predators"**

**Saltwater crocodile (*Crocodylus porosus*)** is an emblematic estuarine predator in the Sundarbans system and a key risk factor for resource collectors. UNESCO's biodiversity framing includes such large fauna as part of the exceptional ecosystem value.

**5.4 Birds: the visible biodiversity**

The Sundarbans' river edges, mudflats, and forest margins support large bird assemblages—herons/egrets, kingfishers, raptors, shorebirds, and migratory visitors. Bird diversity is often used as a rapid indicator of wetland complexity because birds integrate signals from fish abundance, mudflat invertebrates, and habitat heterogeneity.

**5.5 Invertebrates: the engine room of the mangroves**

If mangroves are powered by detritus, then **crabs, molluscs, and microbes** are the converters—turning leaves into animal biomass and recycled nutrients. This is where ecology meets livelihoods most directly: many of these invertebrates are harvested and sold, and harvesting pressure can alter leaf-litter processing and sediment structure.

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**6. Fish, crab, prawn/shrimp, molluscs: the edible biodiversity of the Sundarbans**

**6.1 Mangroves as fisheries nurseries**

Mangrove root networks provide refuge for juveniles; tidal creeks concentrate food; and leaf litter fuels planktonic and benthic pathways. This is why mangrove health is tightly coupled to fishery productivity.

**6.2 Fish diversity: "hundreds of species," plus what is practically important**

Fish inventories and datasets for the Sundarban region commonly report **around ~350 species** (numbers vary by time and boundary definitions).

That is too large for a readable chapter table—so below is a **market-relevant edible list** for the Indian Sundarbans estuarine context, anchored in fisheries literature that explicitly names key commercial taxa.

**Selected high-value/commonly cited edible fish (with scientific names)**

- **Hilsa** — *Tenualosa ilisha* (a premium clupeid; detailed life history work exists for the Sundarban estuary).
- **Asian seabass / Bhetki** — *Lates calcarifer* (major estuarine commercial fish).
- **Mullets** — *Liza parsia*, *Liza tade* (important brackishwater fishes in Sundarban-linked aquaculture and capture contexts).
- **Threadfins (Polynemids)** — *Eleutheronema tetradactylum*, *Polynemus indicus* (listed among valued estuarine fishes in Sundarbans fishery assessments).
- **Pomfret** — *Pampus argenteus* (noted for market value in estuary-linked resource assessments).

**How to use this in a book chapter:** Keep this as the main-text "edible list," and attach a separate appendix referencing a dataset/monograph for full inventories (see Annex C note at the end).

**6.3 Prawns/shrimps: capture + culture**

Shrimp are central to Sundarbans livelihoods and brackishwater aquaculture history. A Springer synthesis on brackishwater aquaculture in India explicitly notes the Sundarbans' traditional **bheri** systems and the role of **tiger shrimp (*Penaeus monodon*)** farming from the early 1990s, with later introduction of **Pacific white shrimp (*P. vannamei*)** in India (contextually relevant for regional aquaculture transitions).

**Practical edible shrimp/prawn list commonly cited in Sundarbans-linked assessments**

- **Tiger shrimp** — *Penaeus monodon*
- **Indian white shrimp** — *Penaeus indicus* (often treated under older genus usage; widely cited in Indian shrimp resources)
- **Indian prawn** — *Metapenaeus monoceros*
- **Acetes shrimp** — *Acetes indicus* (small shrimp, often dried/used locally)

### 6.4 Crabs: mud crabs and beyond

Mud crab fisheries and fattening are important in the Indian Sundarbans. Recent aquaculture-facing syntheses specifically discuss **orange mud crab (*Scylla olivacea*)** farming in the Indian Sundarbans and note its dominance in local fishery/culture contexts.

Taxonomically, the genus **Scylla** is commonly treated as four globally recognised species (*S. serrata, S. olivacea, S. paramamosain, S. tranquebarica*) in the scientific literature.

Additional edible crab taxa are also named in Sundarbans fishery assessments (e.g., *Portunus pelagicus*).

### 6.5 Molluscs and other edible estuarine resources

Edible oysters and bivalves appear in Sundarbans aquaculture research contexts. For instance, an IMTA model tested in the Indian Sundarban includes **estuarine oyster (*Crassostrea cuttackensis*)** alongside mullets and tiger shrimp.

**Ecological note:** molluscs are also water-quality mediators (filter feeding), and their abundance can reflect changes in salinity, pollution, and habitat stability.

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## 7. NTFP in the Sundarbans: livelihoods on the forest edge

### 7.1 What counts as NTFP here?

In official protected-area terminology, "NTFP" often refers to legally recognised minor forest produce. In everyday Sundarbans reality, people also treat many aquatic resources (fish/crab/prawn) as forest-linked nature products because access, risk, and regulation are intertwined with the mangrove landscape.

### 7.2 Honey and beeswax: the iconic Sundarbans NTFP

The STR explicitly identifies **honey and beeswax** as minor forest produce collected during **April–May**, with permits issued annually; collected honey is deposited at tiger reserve godowns and handled through West Bengal Forest Development Corporation Limited.

Ethnographic and livelihood literature emphasises the danger and traditional knowledge involved in honey/wax collection, including exposure to tiger risk and dependence on wild bee ecology (e.g., *Apis dorsata*).

**Ecology–livelihood connection:** honey collection depends on flowering phenology, forest patch quality, and the integrity of creek-edge vegetation where bees forage. Over-disturbance can reduce floral resources; climate variability can shift flowering windows and honey yields.

### 7.3 Golpata and Hental: historically important, socially sensitive

STR notes that **earlier** Golpata (*Nypa*) and Hental (*Phoenix*) were extracted by fringe villages, but those operations were discontinued in the protected-area management history described on the STR site. Separately, broader Sundarbans-region literature documents extensive household uses of *Nypa fruticans* leaves for thatching and other products, underlining why governance and access questions carry livelihood weight.

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## 8. Ecosystem services: what the Sundarbans *do* for society and nature

UNESCO's framing emphasises the Sundarbans as an outstanding example of ongoing ecological processes (delta formation, tidal influence, plant colonisation) and exceptional biodiversity.
Building from that, key ecosystem services include:

1. **Coastal protection:** mangrove belts attenuate wave energy, reduce erosion, and buffer storm surges—most effectively when belts are wide, continuous, and structurally diverse.
2. **Fisheries production:** nursery function supporting regional food security and income (fish, shrimp, crab).
3. **Carbon storage ("blue carbon"):** mangroves store carbon in biomass and, crucially, in deep organic-rich soils (often the largest pool).
4. **Water quality mediation:** sediment trapping, nutrient cycling, and (where present) shellfish filtration.
5. **Cultural services:** identity, folklore, spiritual landscapes (Bonbibi tradition), and lived "risk ecologies" that shape community institutions.

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## 9. Environmental pressures and emerging ecological risks

### 9.1 Salinity shifts and vegetation change

Salinity increases and altered freshwater flows can change species composition and regeneration success. This can favour tolerant taxa (often *Avicennia* in certain contexts) and stress others, leading to functional changes in habitat complexity.

### 9.2 Erosion, channel migration, and habitat loss

Erosion removes forest edge; accretion creates new mudbanks. The risk emerges when erosion outpaces regrowth, or when embankments and human infrastructure prevent landward migration of mangroves ("coastal squeeze").

### 9.3 Overharvesting and unsustainable extraction

- **Honey/wax:** pressure can disrupt hive cycles and harm collector safety if governance fails.
- **Crab and shrimp:** heavy extraction of juveniles and broodstock can destabilise populations; destructive gear can damage benthic habitat.
- **Fish:** targeted overfishing of high-value species (e.g., hilsa) requires careful management of breeding seasons and mesh regulations.

### 9.4 Aquaculture intensification and water-quality stress

Sundarbans brackishwater aquaculture has a long history, but intensification can drive disease risk, chemical inputs, and water-quality degradation if not managed.

Promising directions include **polyculture/IMTA approaches** that recycle nutrients (e.g., shrimp + mullet + oyster systems demonstrated in Indian Sundarban contexts).

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## 10. Conservation and management: what a "Sundarbans strategy" must respect

### 10.1 Protected areas are necessary—but not sufficient

Protected areas conserve core habitats, but many drivers (freshwater flow, pollution, fishing pressure, cyclone impacts) operate at landscape and seascape scales. A practical conservation strategy must integrate:

- **Hydrological thinking** (connectivity, salinity regimes),
- **Livelihood realism** (what people need and when),
- **Restoration ecology** (species-site matching; pioneer vs interior restoration),
- **Monitoring and adaptive governance**.

### 10.2 Restoration: "planting mangroves" isn't one action

Effective restoration depends on **site conditions**:

- On freshly accreted mudbanks, pioneer species may establish naturally if hydrology is right.
- In saline-stressed interiors, planting the wrong species can fail repeatedly.
- In eroding edges, bioengineering and sediment-trapping may be prerequisites before trees can survive.

### 10.3 Knowledge priorities

For a book chapter aimed at both general and professional readers, a clean set of "research-to-action" priorities includes:

- Long-term salinity and vegetation monitoring at representative islands,
- Fish/crustacean nursery mapping (where are the juvenile hotspots?),
- Sustainable harvest calendars linked to breeding seasons and flowering phenology,
- Community safety protocols and benefit-sharing for high-risk NTFP (honey).

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## 11. Conclusion: the Sundarbans as a living boundary

The Indian Sundarbans are best understood not as a static forest, but as a **moving, tidal boundary**: land becoming water and water becoming land, constantly. Their ecological richness arises from that dynamism—mudbanks colonised, creeks reshaped, leaf litter converted into fish and crab, and apex predators riding the productivity of the system. Their vulnerability arises from the same logic: when hydrology, sediment balance, and governance break down, the system can flip quickly.

A chapter-length takeaway is simple: **protect processes, not just patches**—tides, freshwater pulses, sediment flows, nursery creeks, and community institutions that govern risk and harvest. UNESCO's emphasis on ongoing ecological processes is not a poetic phrase; it is the core management truth of the Sundarbans.

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**Annex A. True mangroves of the Indian Sundarbans (24 species) + local names (where available)**

**Source of the 24-species true mangrove list:** revised checklist for Indian Sundarbans (true mangroves, 9 families).

**Local names below are added where STR explicitly provides them.**

**Rhizophoraceae**

1. *Bruguiera cylindrica* — “Son Champa” (STR)
2. *Bruguiera gymnorhiza* — “Kankra” (STR)
3. *Bruguiera parviflora* — “Bakul Kankra” (STR)
4. *Bruguiera sexangula* — (true mangrove list)
5. *Ceriops decandra* — “Jhamti/Jele Garan” (STR)
6. *Ceriops tagal* — “Jat Garan” (STR)
7. *Rhizophora apiculata* — “Garjan” (STR)
8. *Rhizophora mucronata* — “Bhara” (STR spelling variation noted)
9. *Kandelia candel* — “Goria” (STR)

**Sonneratiaceae**

10. *Sonneratia apetala* — “Tak Keora” (STR)
11. *Sonneratia caseolaris* — “Chak Keora” (STR)
12. *Sonneratia griffithii* — (true mangrove list)

**Combretaceae**

13. *Lumnitzera racemosa* — “Kripa” (STR)

**Meliaceae**

14. *Xylocarpus granatum* — (true mangrove list)
15. *Xylocarpus mekongensis* — “Pashur” (STR)
16. *Aglaia cucullata* — (true mangrove list)

**Avicenniaceae**

17. *Avicennia alba* — “Kalo Baine” (STR)
18. *Avicennia marina* — “Peara Baine” (STR)
19. *Avicennia officinalis* — “Jat Baine” (STR)

**Plumbaginaceae**

20. *Aegialitis rotundifolia* — “Tora” (STR)

**Malvaceae s.l. (Sterculiaceae in older usage)**

21. *Heritiera fomes* — “Sundari” (STR)

**Myrsinaceae/Primulaceae**

22. *Aegiceras corniculatum* — “Khalsi” (STR)

**Arecaceae**

23. *Nypa fruticans* — “Golpata” (STR)
24. *Phoenix paludosa* — “Hental/Hantal” (STR)

**Annex B. Edible biodiversity: practical Sundarbans lists (chapter-friendly)**

**B1. Fish (selected high-value/common)**

- *Tenualosa ilisha* (Hilsa)
- *Lates calcarifer* (Asian seabass/Bhetki)
- *Liza parsia*, *Liza tade* (mullets)
- *Eleutheronema tetradactylum*, *Polynemus indicus* (threadfins)
- *Pampus argenteus* (pomfret)

**B2. Shrimps/prawns (selected)**

- *Penaeus monodon* (tiger shrimp)
- *Penaeus indicus* (Indian white shrimp)
- *Metapenaeus monoceros* (Indian prawn)
- *Acetes indicus* (small shrimp)

**B3. Crabs (selected)**

- *Scylla olivacea* (orange mud crab; prominent in Indian Sundarbans farming)
- *Scylla serrata* (mud crab; commonly referenced in fishery assessments)
- *Portunus pelagicus* (swimming crab; referenced in assessments)

**B4. Oysters/molluscs (example from IMTA work)**

- *Crassostrea cuttackensis* (estuarine oyster; tested in Indian Sundarban IMTA systems)

**Bibliography / References (Sundarbans—Indian part, with a few key transboundary sources)**

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2. **UNESCO World Heritage Centre.** *The Sundarbans (Bangladesh) (WH property no. 798): Description & documents.*
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**Books / monographs / faunal surveys**

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**Optional "context" sources you may also want in the chapter bibliography**

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