The Sundarbans

2025 Conservation Outlook Assessment

SITE INFORMATION

Country: Bangladesh
Inscribed in: 1997
Criteria: (ix) (x)

The Sundarbans mangrove forest, one of the largest such forests in the world (140,000 ha), lies on the delta of the Ganges, Brahmaputra and Meghna rivers on the Bay of Bengal. It is adjacent to the border of India's Sundarbans World Heritage site inscribed in 1987. The site is intersected by a complex network of tidal waterways, mudflats and small islands of salt-tolerant mangrove forests, and presents an excellent example of ongoing ecological processes. The area is known for its wide range of fauna, including 260 bird species, the Bengal tiger and other threatened species such as the estuarine crocodile and the Indian python. © UNESCO

SUMMARY

2025 Conservation Outlook

Finalised on 11 Oct 2025

SIGNIFICANT CONCERN

The values of The Sundarbans are threatened by multiple on-going processes both within and external to the site. The ecosystem is showing degradation, with loss of important and globally endangered mangrove species due to felling, disease and altered freshwater inputs, changes to vegetation communities, and intense and on-going coastal erosion and retreat. Increased industrial development in the broader region and adjacent to the Reserve Forest and increases in shipping traffic are ongoing and increasing threats, causing water pollution, habitat loss, loss of food resources for higher biodiversity, bank erosion and sedimentation and accidental mortality of rare and threatened vertebrates. As population pressure on the Sundarbans increases, human extractive threats to the forest are likely to increase, and management funding and capacity is currently insufficient to adequately mitigate these pressures at their current intensity. Potential threats from proposed industry development in Bangladesh is also high and while responses to address it, such as the Strategic Environment Assessment for the South-West Region of Bangladesh and joint India-Bangladesh cooperative actions, are welcome, their effectiveness will need to be evaluated in the future. The scale of the potential impact on the OUV remains unknown which requires further research, and there is a clear risk of direct, indirect and cumulative impacts from developments in the area over the next 20 years if appropriate and adequate mitigation measures are not taken, and there remains a need to analyse potential risks and impacts in more detail. Climate change poses an extremely high level of concern for the site and its values, through rapid sea level rise and increases in the frequency and intensity of storms and tidal surges, which may produce devastating impacts.

FULL ASSESSMENT

Description of values

Values

World Heritage values

▶ **On-going ecological processes that lead to the creation and sustenance of mangrove ecosystems** **Criterion:(ix)**

The Sundarbans provides a significant example of on-going ecological processes as it represents the process of delta formation and the subsequent colonization of the newly formed deltaic islands and associated mangrove communities. These processes include monsoon rains, flooding, delta formation, tidal influence, and plant and animal colonization. As part of the world's largest delta, formed from sediments deposited by three great rivers: the Ganges, Brahmaputra and Meghna, and covering the Bengal Basin, the land has been moulded by tidal action and other processes, resulting in a distinctive physiology (World Heritage Committee, 2013).

▶ **Exceptional level of biodiversity** **Criterion:(x)**

The largest single tract of mangroves in the world, the Sundarbans supports an exceptional level of biodiversity in the terrestrial, aquatic and marine environments, including significant populations of globally threatened cat species, such as the tiger (World Heritage Committee, 2013).

▶ **Rare and threatened terrestrial and aquatic mammals** **Criterion:(x)**

The Sundarbans provides the only remaining habitat in the lower Bengal Basin for many faunal species. There have been 49 mammal species documented including the flagship mammal species of the area, the tiger Panthera tigris (EN). The Sundarbans (including the Indian portion) has previously been believed to be home to one of the largest populations of tigers in the world (estimated ~350-450 individuals), although these estimates are outdated and more recent surveys have shown a positive trend of the population, with latest the estimate of 125 tigers in Bangladesh side (Aziz et al., 2024). The area is the only mangrove habitat in the world that contains tigers.

Wild boar Sus scrofa (LC) and spotted deer Axis axis (LC) provide the main prey, constituting 89% prey biomass to the tiger diet (Aziz et al., 2020). Three species of wild cat are present: the jungle cat Felis chaus (LC), leopard cat Prionailurus bengalensis (LC) and fishing cat Prionailurus viverrinus (EN) (IUCN, 1997; 2016). Two globally threatened otter species – smooth-coated otter Lutra perspicillata (VU) and Asian small-clawed otter Aonyx cinerea (VU) (IUCN, 2021) – are also recorded for the site.
The area also contains highly threatened aquatic mammals: the rare Ganges river dolphin Platanista gangetica (EN) and Irrawaddy dolphin Orcaella brevirostris (VU) (IUCN, 1997; 2016). The area contains only one primate: rhesus macaque Macaca mulatta (LC) (IUCN, 1997; 2016).

▶ **Rare and threatened birds** **Criterion:(x)**

The Sundarbans supports a varied and colourful birdlife, with a total record of 315 species (World Heritage Committee, 2013). These include 95 species of waterfowl, 38 raptor, nine kingfisher, and many gulls, terns, woodpeckers, barbets, shrikes, drongos, mynas, minivets and babblers (IUCN, 1997). However, a recent study confirmed the occurrence of 299 species from the site after reviewing previous records (Chowdhury, 2020). Species within the Sundarbans of global conservation concern include Pallas's fish eagle Haliaeetus leucoryphus (EN), white-rumped vulture Gyps bengalensis (CR), Spoon-billed Sandpiper Calidris pygmaea (CR), lesser adjutant Leptoptilos javanicus (VU), masked finfoot Heliopais personatus (CR) and the greater spotted eagle Aquila clanga (VU). The brown-winged kingfisher Pelargopsis amauroptera, black-headed ibis Threskiornis melanocephalus, mangrove pitta Pitta megarhyncha and the rare grey-headed fish eagle Ichthyophaga ichthyaetus are considered to be

near threatened (NT) (IUCN, 2016).

▶ **Rare and threatened reptiles** **Criterion:(x)**

The Sundarbans has a relatively diverse herpetofauna, with 58 documented species of reptile and eight amphibians (World Heritage Committee, 2013). The mugger, Crocodylus palustris (VU) and the critically endangered gharial, Gavialis gangeticus (the most primitive living crocodile, and one of the most highly endangered) are now locally extinct in the area (considered to be a result of overexploitation), though the estuarine crocodile Crocodylus porosus (LC) still persists (IUCN, 1997). Three species of monitor lizard are present (IUCN, 1997), all of which are considered to be near threatened (IUCN, 2016). There are 18 recorded snake species, including the globally threatened king cobra, Ophiophagus hannah (VU). Chelonids include a number of marine turtle species, all of which are threatened with extinction globally; the olive ridley Lepidochelys olivacea (VU), green turtle Chelonia mydas (EN), and loggerhead turtle Caretta caretta (EN) (Hussein & Acharya, 1994; IUCN, 2016), and the critically endangered Northern river terrapin Batagur baska (CR) (IUCN, 1997; 2016). However, currently occurrence of these chelonids in the site except the olive ridley is unlikely (Aziz 2016).

▶ **Rare and threatened flora** **Criterion:(x)**

The mangrove diversity in the Sundarbans is some of the highest in the world (Sanyal et al., 2008). One of the most dominant mangrove species in the site is the Sundri Heritiera fomes (Ministry of Environment and Forests, 2010; Rahman et al., 2010). This species is listed as globally endangered on the IUCN Red List due to its restricted distribution, and may qualify as critically endangered within Bangladesh due to rapid population declines (IUCN, 2016).

▶ **Rare and threatened fishes** **Criterion:(x)**

The Sundarbans supports a rich fish diversity, many of which are commercially important in addition to their ecological values. Additionally, it is an important breeding and nursery site for benthic elasmobranches such as sawfish. Two species are confirmed to be present: narrow sawfish Anoxyristis cuspidata (EN) and largetooth sawfish Pristis pristis (CR) (Hossain et al, 2015), both of which are believed to have suffered general population declines with decreasing population trends globally (IUCN, 2016).

▶ **Rare butterflies** **Criterion:(x)**

The Sundarbans supports a diversified butterflies species, constiuting around one-fourth of the reported national fauna. Notably, the Sundarbans crow (Euploea crameri nicevillei) has an exclusive adaptation and ecological interactions with the Sundarbans mangrove vegetation. This butterfly is endemic to Bangladesh and restricted to a few locations in the Sundarbans (Hossain, 2014).

Assessment information

Threats

Current Threats **High Threat**

Current threats to the Sundarbans from altered hydrology and freshwater flows, pollution and increasing shipping are severe, and the combination and interaction of these multiple pressures represent a concern for the continued conservation of the site's Outstanding Universal Value in both the marine and terrestrial environments and importantly the integrity of the site. As a coastal area that is affected by extreme weather events, the concern for the site's values from these multiple threats becomes more severe, and the likely success of management greatly compromised.

▶ **Water-borne & other effluent Pollution** **High Threat**
(Water pollution caused by development of industry, agriculture and aquaculture) Outside site

The Sundarbans ecosystem is vulnerable to oil spillages, heavy metals, and nutrient enrichment from agro-chemicals as a result of industry, agriculture and aquaculture (State Party of Bangladesh, 2023).

Such impacts alter mangrove biogeochemistry, subsequently damaging mangrove ecology (Rahman et al., 2010), reducing the quality of habitat available for both terrestrial and aquatic species. With growing levels of industry in the area adjacent to the Sundarbans Reserve Forest and with limited management action in place to combat this threat these impacts are very likely to increase in intensity into the future. In recent years, concerns over possible water pollution associated with ongoing and planned industrial developments in the adjacent areas have increased (UNESCO, 2019, 2023; World Heritage Centre/IUCN, 2019).

▶ **Fishing, Harvesting & Controlling Aquatic Species** — **Low Threat**
(Shrimp fry harvesting) — Outside site

Shrimp fry (post-larvae shrimp) fishing to supply aquaculture farms in the Sundarbans continues to occur at what are likely to be unsustainable levels (Rahman et al., 2010). Harvesting of shrimp and prawn fry is a destructive process as the dragnets used not only severely deplete shrimp and prawn populations, but also juveniles of many non-target fish and crustacean species, cause erosion of the banks and mudflats, and prevent mangrove seedling establishment. These activities also have knock-on effects to the remainder of the Sundarbans' food chain, reducing resource availability for higher levels of biodiversity. Expansion of shrimp farming and increased population pressure mean that this impact is likely to continue. Fishing activities can also result in the entanglement of threatened aquatic vertebrate species (Ganges river dolphin, Platanista gangetica, and Irrawaddy dolphin, Orcaella brevirostis; Smith et al., 2009).

▶ **Invasive Non-Native/ Alien Species** — **Data Deficient**
(Introduced plant species) — Outside site
Invasive/problematic species
Derris trifoliata
Other invasive species names
Eichornia crassipes, Eupatorium odoratum

Invasive species have been found within the Sundarbans, and within the WH site (Biswas et al., 2007), and are more abundant and diverse at riverbanks. The three most harmful species found are Derris trifoliata, Eichornia crassipes and Eupatorium odoratum, which all cause concern for the health of Sundarbans biodiversity through impacts such as out-competing native species for access to light, nutrients and moisture and causing physical damage to native species (Biswas et al., 2007). Invasive populations are relatively abundant, spreading and locally dense. However, studies suggest that invasive species are still in a controllable stage, if appropriate management activities are applied. Effective monitoring of spread and targeted control actions for particularly destructive species (Biswas et al., 2007) is also needed.

More recent reports indicate that almost 88% of the Sundarbans mangroves area is affected by invasive species in which 55% severely damaged. 23 different invasive species were found of which only 4 are exotic. These data demonstrate the extent of the invasion and that native plant species can gradually become dangerous in their own environment (Axès et al. 2022). The extent within the WH site and the current impact on the OUV is unclear.

A project has been launched entitled "Developing Bangladesh National Red List of Plants and Developing Management Strategy of Invasive Alien Species (IAS) of plants in selected Protected Areas (PAs)" initiated by the Bangladesh Forest Department (BFD) and Bangladesh National Herbarium (BNH), under the Sustainable Forest and Livelihood (SUFAL) project, funded by the World Bank.

▶ **Water-borne & other effluent Pollution** — **High Threat**
(Agro-chemical loads) — Inside site, throughout(>50%)
Outside site

A range of fertilizers, insecticides, fungicides, herbicides, rodenticides, and other chemicals are used to improve crop production and aquaculture, but with little concern or knowledge about their negative impact on the surrounding ecosystems. Nowadays, agricultural activities have intensified around the Sundarbans using chemical fertilizers and insecticides. The excessive use of these chemicals leads to

them draining into the rivers and being carried downstream through the Sundarbans to pose a significant risk to coastal waters. These pollutants get incorporated into the food chain and accumulate in higher tropic levels, disrupting ecosystem biochemical cycles. Some agrochemicals, notably pesticides and herbicides, are highly toxic and found to accumulate and persist in coastal and marine biota. They can also affect seagrass beds and other aquatic vegetation. Overall, agrochemical pollution leads to biodiversity loss, increased mortality of fish and shellfish, and human health risk through food chain contamination (Rahman et al., 2009). The uncontrolled application of chemical fertilizers on agricultural land has been increasing. Most of them are nitrogen- or phosphorus-based compounds, which have led to nutrient enrichment (eutrophication) in the Sundarbans region in recent years. This can cause algal blooms, changes in the structure of aquatic communities, decreased biological diversity, fish death, and oxygen depletion events (Hossain et al. 2024).

▶ **Pathogens**

High Threat

(Decreased productivity from infection by mangrove-specific diseases – i.e. "top-dying")

Inside site, widespread(15-50%)
Outside site

"Top dying" is a disease that affects dominant Sundri trees (Heritiera fomes; EN; V6), and is a cause of forest deterioration (Rahman et al., 2010). The incidence of top-dying in Sundri appears to increase with increasing salinity, and the species is subsequently replaced with the other common species Gewa Excoearia agallocha (Rahman et al., 2010). In the Bangladeshi portion of the Sundarbans, the extent of pure Sundri stands has decreased by 21% since 1926, as a result of "top-dying" as well as other impacts including sea level change, salinity increases, and wood harvesting (IUCN Consultation, 2014), and dominance of Sundri in mixed stands is diminishing (Iftekhar & Saenger, 2008). Approximately 70% of Bangladeshi Sundri stems have been estimated to be moderately or severely affected by the "top-dying" disease (Islam & Wahab, 2005) and due to declines in Sundri trees, forest structure in the Sundarbans has become simpler, mean forest height is decreasing, as well as above-ground biomass carbon (decreased by 4% from 2000 to 2023; Ali & Rahman, 2025), reducing habitat for arboreal mammals and birds (Iftekhar & Saenger, 2008). Increasing saline conditions are likely to facilitate the increase in death of infected trees into the future (Rahman et al., 2010). While the causes of the diseases are still poorly understood, some studies suggest that it might be linked to presence of certain chemicals in the soil and water (Awal, 2014).

▶ **Dams & Water Management/Use**

Very High Threat

(Dam creation resulting in increased salinity and modification to tidal influences on deltaic and bank formation)

Inside site, extent of threat not known
Outside site

Following the construction of the Faraka Barrage in India in 1975, the freshwater flows into the Sundarbans have dramatically decreased and the Gorai river flows have been reduced to a marginal portion (UNESCO World Heritage Centre/IUCN, 2019). The associated impacts on siltation and increased saliniaty are descibed above. However, reduced freshwater flows have other impacts as well. The threatened aquatic species, the Ganges river dolphin and Irrawaddy dolphin, have both been found to exhibit dependency on habitat characteristics associated with high freshwater flow, and as such are highly vulnerable to impacts from this threat (Smith et al., 2009). Reduced freshwater flow also impacts sedimentation, altering deltaic and bank formation and compromising the on-going ecological processes of the site (Iftekhar & Islam, 2004). The restoration of the flow is foreseen under the Bangladesh Delta Plan-2100. Furthermore, in 1996 the Governments of Bangladesh and India signed a Treaty for sharing the Ganges waters for a period of 30 years. Given the high importance of freshwater flows for the integrity and health of the Sundarbans ecosystem, it is vital that this matter is given highest priority, including in the bilateral cooperation between Bangladesh and India (UNESCO World Heritage Centre/IUCN, 2019).

▶ **Garbage & Solid Waste**

Low Threat

(Garbage and fishing equipment waste)

Inside site, localised(<5%)
Outside site

Population increases, including within river basins, means that there is large-scale production of garbage. Wastes, including fisheries equipment, often finds its way into the Sundarbans waters (Rahman et al., 2009). Discarded nets from fishing activities, particularly shrimp fry fishing, result in the

entanglement of threatened aquatic faunal species in discarded or active nets (e.g. Ganges river dolphin, Platanista gangetica; Irrawaddy dolphin, Orcaella brevirostis; and species of sawfish) compromising the biodiversity value of the site.

► Water-borne & other effluent Pollution

Low Threat

(Human wastewater and sewage)

Outside site

Population increases near river basins and attempts to modernize living conditions in coastal areas has meant that there has been an increase in sewage and wastewater effluents into the Sundarbans waters (Rahman et al., 2009). These inputs into the aquatic system may alter mangrove biogeochemistry (Rahman et al., 2009), especially if they are combined with reductions in freshwater inflow to the system, ultimately impacting the flushing of such nutrient inputs. As the Bangladeshi population continues to increase (Rahman et al., 2010), production of waste and modernization of lifestyles is likely to continue to increase. With no management action in place to combat this threat, and as population pressure continues to drive the expansion of industry, agriculture and aquaculture (Rahman et al., 2010), the threats from these impacts may increase in intensity in the future.

► Air-borne Pollutants

Low Threat

(Increases in airborne pollutants)

Inside site, throughout(>50%)
Outside site

Increased industrial activity (particularly the proposed coal fire plant) and traffic (both terrestrial and shipping) in the area is resulting in an increase in airborne pollutants, which can degrade mangrove ecology (Rahman et al., 2010). With plans for increased industrial activity adjacent to the Sundarbans Reserve Forest such impacts are likely to increase in the future (UNESCO, 2019). However, the extent to which airborne pollutants influence mangrove ecology and functioning in the area is unknown, and so an assessment of the intensity of this threat cannot be made based on available data.

As of April 2018, 190 industrial projects had been approved around the Mongla seaport in the Environmentally Critical Area (ECA) of the Sundarbans (65 km from the World Heritage site). 154 medium to heavy industries, small and cottage industries, agriculture, and natural resource-based industries operate in the ECA bordering the Sundarbans. The distance from the outer boundary of the Sundarbans Reserve Forest to the industries is between 5 and 10 km. All these industries were established in the 1990s and 2000s. Among them, 130 are categorized as “orange” (primarily non-polluting) and 24 as “red” (having a significant pollution threat to the surrounding environment). At the same time, many existing and newly established red-category industries exist in the urban areas, especially in Khulna, Jessore, and Bagerhat. The Sundarbans mangrove forest is situated downwind of urban and industrial areas in and around Khulna city and the industrial estate and seaport areas of Mongla. In these circumstances, there is an urgent need to monitor air quality in the Sundarbans regularly. Monitoring results available indicate generally good air quality (0 - 50 AQI as recommended by Bangladesh) with some localised differences (Hossain et al. 2024).

► Hunting, Collecting & Controlling Terrestrial Animals

High Threat

(Hunting)

Inside site, widespread(15-50%)

Under the provision of the Wildlife Act, hunting in the entire Sundarbans is prohibited, but illegal hunting of wildlife populations has been recorded and is an important threat to the integrity of the Sundarbans ecosystem (Rahman et al., 2010; UNEP-WCMC & IUCN, 2011). Within the three component Wildlife Sanctuaries, illegal hunting has also been detected (Aziz et al., 2017). Hunting of mammal populations, especially spotted deer, not only reduces the biodiversity values of the area directly, but may also serve to reduce food resources for the tiger throughout the forest, thus compromising the conservation value of the site. A study reported the local consumption of spotted deer, with an estimate of 11,195 deer/year by illegal hunting (Mohsanin et al. 2013). Recent reports (Hossain, 2025) indicate a resurgence in illegal deer hunting. The demand for venison has reached alarming levels, turning the Sundarbans into a hotspot for illegal hunting. It has created a lucrative black market, encouraging poaching syndicates to exploit the forest's resources and further endanger its delicate ecosystem. This growing demand has not only driven poaching but also enabled smuggling operations. Limited human capacities and the vast size of the forest inhibit effective law enforcement.

Retribution killing of the tiger in human-wildlife conflict areas is occasionally reported, although not likely to occur within the World Heritage Site itself, posing a threat to tiger numbers within the World Heritage Site (Ahmad et al., 2009). However, a decrease in human-wildlife conflicts has been observed in recent years (Khan et al., 2018). The government of Bangladesh acknowledged in the past that poaching of tigers is one of the largest and most immediate threats to Bangladesh's tigers (BFD, 2013; Khan et al., 2018). Locally organized poachers, in connection with outside traders, poach tigers using a number of methods, largely by poison baits and occassionally by bullets (Aziz et al., 2017). Some local use of tiger parts were also reported (Saif et al., 2016).

In 2022 the Bangladesh government announced it is implementing a complete ban on entry into the forest for three months, from July to August, which it says is the breeding season for the local wildlife. The communities surrounding the mangroves, who depend on the forests for food and resources, say this ban will affect their livelihoods and push them into hardship (Siddique, 2022).

► **Water-borne & other effluent Pollution** — **High Threat**
(Oil spills)
Inside site, widespread(15-50%)
Outside site

Concerns over potential oil spills associated with increased boats traffic have increased in recent years, particularly following a number of accidents, such as the oil tanker accident that happened in December 2014 (IUCN, 2016; UNESCO, 2019, 2021, 2023; World Heritage Centre/IUCN, 2019). As a response, the Government of Bangladesh has developed National Oil and Chemical Spill Contingency Plan (UNESCO, 2019), for which the preparation of localized contingency plans are underway (State Party of Bangladesh, 2022). However, its effective implementation will depend on available resources and capacities and therefore concerns remain, particularly as traffic on the waterways is predicted to increase in the future (World Heritage Centre/IUCN, 2019, 2023). Crude oil and its derivatives are the most damaging pollutants to enter the mangrove forest (Iftekher, 2004). Oil attached to mangrove leaves and roots can reduce photosynthesis, respiration and water metabolism, reducing mangrove productivity (Islam, 2001). Oil spills and other industry effluents (paper mill, match factory, and furniture making chemicals) can also degrade mangrove ecology (Peng, 2000).

► **Changes in Physical & Chemical Regimes, Changes in Precipitation & Hydrological Regime** — **Very High Threat**
(Siltation of inland rivers reducing freshwater flow into the mangroves)
Inside site, widespread(15-50%)
Outside site

Increased siltation of inland rivers, resulting from decreased overall freshwater flows into the system, has further dramatically decreased freshwater inputs to the Sundarbans (Haq, 2010; Anjum et al., 2018). Reduced freshwater flow serves to increase salt-water intrusion and irregular inundation serves to significantly degrade the health of the Sundarbans ecosystem (Iftekhar & Islam, 2004; World Heritage Centre/IUCN, 2019), causing reduction in forest cover and reduction in mangrove species diversity (Iftekhar & Islam, 2004; Akhtaruzzaman, 2000). Reduced freshwater flow also decreases sediment flow into the forest, altering deltaic and bank formation and compromising the on-going ecological processes of the site (Iftekhar & Islam, 2004). Increased freshwater extraction upstream, resulting from increases in the development of industry and agriculture (Rahman et al., 2010; World Heritage Centre/IUCN, 2019) significantly increases the threat posed to freshwater inflows in the future. Coupled with the potential impacts of sea level rise under climate change, this threat may significantly impact the OUV and integrity of the site.

► **Changes in Temperature Regimes, Changes in Precipitation & Hydrological Regime** — **Very High Threat**
(Extreme weather events)
Inside site, widespread(15-50%)
Outside site

The Sundarbans is under increasing threat from climate change. Rising sea levels, intensifying cyclones and soil erosion are transforming the landscape, placing unprecedented stress on both the ecosystem and the local populations (Mitra, 2025).

Damage from extreme natural events (cyclones, tsunamis and tidal surges) may destroy Sundarbans

vegetation faster than any anthropogenic threats (Rahman et al., 2010), and can also result in mortality of some vertebrate populations (UNEP-WCMC & IUCN, 2011). Cyclones, tsunamis, tidal surges and storms can and have caused widespread destruction of forest area and habitat and can influence on-going ecological processes. The impact of cyclone Sidr in 2007 along 100km of coast, taking 3,500 lives, and destroying homes, livestock, agriculture and the region's entire fishing industry (UNEP-WCMC & IUCN, 2011) is one example of the impacts such events can cause. 40% of the site was seriously damaged, and most of this within the WH site (UNEP-WCMC & IUCN, 2011), and it is anticipated that the site will take 10-15 years to recover, if the ancillary threats of poaching, woodcutting etc. do not affect regeneration time (UNEP-WCMC & IUCN, 2011). Recently, the cyclone Remal has caused unexpected damage of biodiversity including wildlife, especially the deaths of a large number of spotted deer and other animals in May 2024. The storm caused a tidal surge that rooted up trees, drowned huge numbers of animals and partially submerged the forest for nearly 24 hours (Mitra, 2025).

Due to the large spatial scale of cyclones, tsunamis and tidal surge events, and the devastating impacts produced, coupled with the foreseen increases in these events under climate change (IPCC, 2012), the current and future threat from these natural events, and interactions between these and other sources of threats, are very high.

As climate events become more extreme, they expose the limitations of existing defences. Although the mangroves serve as a natural buffer against storm surges and floods, deforestation and land-use pressures are weakening their protective role. Over the last 20 years, reforestation programmes have made strides in restoring mangrove cover, yet these efforts are insufficient without greater financial and human resources. A coordinated approach, backed by substantial investment, is essential to effectively protect both people and ecosystems (Mitra, 2025).

Potential Threats

Very High Threat

Potential threats to the site's values from both industrial growth in the area and impacts from climate change are extremely serious. The potential for increased pollutant loadings, both air and water borne, from the Rampal and other proposed power plants, as well as the associated increase in shipping traffic and dredging of the Pashur River, provide a significant threat to the site's values in the future.
If the projections of sea level rise occur and nothing is done to combat projected increases, large areas of the Sundarbans will certainly be lost and the forest's composition severely altered. As the WH site is at the coastal margin of the forest, this threat could result in the severe destruction of the site and its Outstanding Universal Value.

► Unknown Threats

Very High Threat

(Sea level rise)

Inside site, widespread(15-50%)
Outside site

Much of the Sundarbans forest is not at an elevation very high above current sea level, and as such sea level rise threatens to submerge large portions of the area. Two islands have already been submerged, and a dozen more are threatened with submergence (Rahman et al., 2010). Coastal retreat is indeed occurring relatively rapidly within the Sundarbans, with some areas losing as much as 200m of coast per year (Cornforth et al., 2013). With the Sundarbans WH site including a large part of the coastal stretches and forest, coastal retreat is indeed a serious threat. With sea level rise, increased salinity will result in ecological succession to more salt-tolerant species, reducing mangrove biodiversity, particularly with salinity already increasing from reduced freshwater inputs (World Heritage Centre/IUCN, 2019). The result of increased sea level rise will be a reduction in overall mangrove area, alterations to on-going ecological processes, and reduced plant diversity, which will reduce habitat area and quality for higher level biodiversity such as the tiger. Threatened aquatic species, i.e. the Ganges river dolphin and Irrawaddy dolphin, have both been found to exhibit dependency for habitat characteristics associated with high freshwater flow, and as such are highly vulnerable to habitat loss from this threat (Smith et al., 2009). Increased salinity has also been associated with increased incidence of the top-dying disease of the endangered Sundri tree and such a loss of floral diversity and alterations to vegetation communities are thus likely to occur under sea level rise. Due to the low altitude of the area and the interaction with other existing threats (reduced freshwater inputs, resource extraction and pollution), the impact of sea

level rise is likely to be severe for the WH site. It has been estimated that a 25cm increase in sea level would destroy 40% of the Sundarbans, and a 45cm rise would destroy 75% by the end of the century (UNESCO, 2007b). This threat is likely unavoidable at a site level, but better protection of non-affected mangroves, and restoration activities could assist in adaptive management.

▶ Water-borne & other effluent Pollution

Very High Threat

Inside site, widespread(15-50%)
Outside site

(Impacts from the Maitree Super Thermal Power Plant and other industrial developments)

Over the recent years, a number of industrial developments have been proposed and initiated in the broader region surrounding the Sundarbans, including the 1320 MW Maitree Super Thermal Power Plant (STPP, formerly Rampal Power Plant), the Taltoli and the Kolapara Power Plants. Currently, the construction of Maitree Super Thermal Power Project is ongoing and is being monitored against the Environmental Management Plan (EMP) (State Party of Bangladesh, 2022). This issues has been a subject of number of World Heritage Committee Decisions and two reactive monitoring missions, which raised concerns about possible impacts on the World Heritage site, including water pollution, pollution from coal ash by air, increased dredging and shipping and the cumulative impacts of these (IUCN, 2016; UNESCO, 2019; UNESCO World Heritage Centre/IUCN, 2019). As a response the Government of Bangladesh has initiated a Strategic Environmental Assessed (SEA) for the South-West Region of Bangladesh, which however was mainly based on assumptions rather than data-based study results (UNESCO, 2023). The World Heritage Committee requested to continue to implement the SEMP in order to avoid direct, indirect and cumulative impacts from developments in the South-West region over the next twenty years that are identified in the SEA and submit additional studies and data-gathering frameworks (World Heritage Committee, 2023)

▶ Gathering, Harvesting & Controlling Terrestrial Plants & Fungi

Low Threat

Outside site

(Agricultural expansion at inland fringes)

Agricultural expansion occurs at the fringes of the Sundarbans Reserve Forest (both eastern and western), which effectively provides a buffer zone for the site. With increasing population pressure in surrounding settled areas (UNESCO World Heritage Centre/IUCN, 2019), agricultural expansion could become a serious problem for the Reserve Forest into the future if not correctly managed (UNEP-WCMC & IUCN, 2011). Land conversion for agricultural expansion may cause an increasing rate of forest and habitat loss for local biodiversity. Potential further increases in agro-chemical loadings into the Sundarbans waters mean the impacts from agricultural expansion could be greater than from land-cover change alone.

Overall assessment of threats

Very High Threat

The current and potential threats to both the terrestrial and marine elements of the World Heritage site are many and severe, especially due to their cumulative impact. The potential for increased pollutant loadings from the Rampal power plant and other proposed industrial developments, as well as the associated increase in shipping traffic and dredging of the Pashur River also pose a significant threat to the site's values and its integrity in the future. While the development of a Strategic Environment Assessment for the South-West Region of Bangladesh, initiated by the Government, presents an opportunity to consider holistically possible impacts of planned development on the World Heritage site, the possible cumulative impacts remain very high if the SEA does not result in further measures based on a comprehensive scientifically rigorous assessment. Processes occurring elsewhere in the Sundarbans and in the Bay of Bengal – altered hydrology due to freshwater extraction and the eastward migration of the Ganges, pollution and mangrove disease – also pose a great threat to the site's values. The threats from sea level rise and increased frequency and intensity of extreme weather events (cyclones, storms and tidal surges) under climate change are severe, and pose significant cause for concern for the site in the future.

Protection and management

Assessing Protection and Management

► Involvement of stakeholders and rightsholders, including indigenous peoples and local communities, in decision-making processes

Some Concern

The government of Bangladesh and the Forest Department recognise the dependency of human populations on the Sundarbans for subsistence and livelihoods (UNESCO, 2011). The site is managed by the Forest Department, which has controlled human extractive activities within the forest since the early 20th century, with extractive activities requiring permits (World Heritage Committee, 2013). Extractive activities are banned within the WH site, however, the degree to which illegal activities may be occurring and impacting the OUV is currently not comprehensively known. The need to develop better relationships with local people in order to reduce illegal activities outside the boundaries of the property but in areas of forest adjacent to it remains, particularly given the high population pressure in the remainder of the Bangladeshi Sundarbans (UNESCO World Heritage Centre/IUCN, 2019) and the threat from illegal activities. Reported plans to strengthen community involvement in the management of the site and address alternative income options have been encouraging (State Party of Bangladesh, 2022), for example through the GIZ "Support to the Management of the Sundarbans Reserved Forest Project (SMP II)". The State Party will need to ensure that adequate consultations with communities take place in developing these plans (UNESCO, 2023).

Mollick et al (2021) noted that there seems to be a wider implementation gap between the ambitious intent enshrined in the new policy framework for co-governance of mangroves and actual rollout of PA governance on the ground, especially in regards to good governance principles (stakeholders' participation, transparency, responsiveness, legitimacy, fairness and organizational capacity) indicating moderate level of governance in PA co-management in the Sundarbans.

► Legal framework

Mostly Effective

The site appears to have adequate legal protection in place. The World Heritage Site consists of three large wildlife sanctuaries, with IUCN Protected Area status IV: Sundarban West Wildlife Sanctuary, Sundarban East Wildlife Sanctuary and Sundarban South Wildlife Sanctuary, with all three managed for the protection of biodiversity (World Heritage Committee, 2013). The Sanctuaries were established in 1977 under the Bangladesh Wild Life (Preservation) Order 1973 amended by Bangladesh Wild Life (Preservation) (Amendment) Act 1974 (UNESCO World Heritage Centre/IUCN, 2019). In 2017, the boundaries of three wildlife sanctuaries were extended to include additional reserve forest areas, which now collectively cover 52% of the entire Bangladesh Sundarbans.

► Governance arrangements

Mostly Effective

Owned by the Government of Bangladesh, the property is managed by the National Forest Department. The Sundarbans is divided into Sundarbans East Forest Division and Sundarbans West Forest Division for ease of day-to-day management. The east division is further delineated into Sarankhola Forest Range and Chandpai Forest Range whilst the west division into Khulna Forest Range and Satkhira Forest Range (Hussain, 1991). Ideally, the Sundarbans is managed as reserve forest, except three designated areas that were declared wildlife sanctuaries (WS) in 1996 for higher level protection of wildlife and their habitats. The sanctuaries, comprising Sundarbans West (715 km2), Sundarbans South (370 km2), and Sundarbans East (312 km2), were collectively declared a UNESCO World Heritage Site in 1997. Additionally, there are five river-based WS, specifically designated for the protection of cetaceans in the Sundarbans. These sanctuaries have a higher degree of legal protection compared to the reserved forest areas of Sundarbans.

► Integration into local, regional and national planning systems (including sea/landscape connectivity)

Some Concern

The preparation of a new Integrated Resource Management Plan (IRMP) for 2025-2035 is underway now for the Sundarbans. However, these plans are restricted to the SRF, including the site, and do not address threats from a regional or national perspective. As the Sundarbans WH site is influenced by processes that occur outside of its boundaries (i.e. freshwater inputs and pollutants), regional development planning based on landscape and hydrological characteristics is important to manage resulting regionally-based threats to its continued integrity (Iftekhar & Islam, 2004). It will be essential to ensure that the protection of the World Heritage site is comprehensively considered in strategic planning instruments, including the Strategic Environment Assessment for the South-West Region of Bangladesh, in order to provide a framework for averting and minimizing possible impacts (UNESCO World Heritage Centre/IUCN, 2019, 2021, 2023). Following this concern, the government has conducted Strategic Environmental Assessment (SEA) of South West Region of Bangladesh for Conserving the Outstanding Universal Value and its corresponding Strategic Environmental Management Plan (SEMP) in January 2022. However, the World Heritage Centre and the Advisory Bodies (2023) concludes that in the SEA's report, the scale of the potential impact on the OUV remains unknown which requires further research, and that there is a clear risk of direct, indirect and cumulative impacts from developments in the study area over the next 20 years if appropriate and adequate mitigation measures are not taken, and that there remains a need to analyse potential risks and impacts in more detail.

► Boundaries — Mostly Effective

The boundaries of the World Heritage property are adequate to maintain the property's Outstanding Universal Value, and were deemed sufficient at the time of site inscription. The boundaries are largely demarcated by rivers, making their presence well known, and while there is no officially designated buffer zone, the Sundarbans Reserve Forest which effectively surrounds the property on the inland boundary, acts as a buffer zone from many of the potential threats and impacts. An important improvement to the preservation of the site’s Outstanding Universal Values would be to consider a transboundary site, managed jointly with the Sundarbans National Park World Heritage Site, India as has been discussed previously (UNESCO, 2008). Being part of a large interconnected system, management activities and their successful implementation affect both WH sites, and more systematic, integrated management would serve to increase the integrity of both sites.

► Overlapping international designations — Data Deficient

The Sundarbans, encompassing hundreds of islands and a maze of rivers, rivulets and creeks, collectively forms about 30% waterbodies of the total area in Bangladesh side. Considering the wetlands of international importance, the entire Bangladesh Sundarbans was listed as the 560th Ramsar Site in 1992. There is regular communication between the focal points of the two designation, but the extent and effectiveness of collaboration is not known.

► Implementation of World Heritage Committee decisions and recommendations — Mostly Effective

Latest Committee decisions include 43 COM 7B.3, 44 COM 7B.91, and 45 COM 7B.14. In the latest decisions the WH Committee has commended the state party for responding to the decisions with appropriate action (UNESCO, 2023, 2021), including the finalization of the Strategic Environment Assessment for the South-West region of Bangladesh, and bilateral mechanisms India-Bangladesh Joint Working Group and the India-Bangladesh Joint River Commission. The Committee further requested the State Party to fully implement all the recommendations made by the 2019 Reactive Monitoring mission and previous Committee decisions, as well as continue strengthening cooperative action for the eco-hydrology of the property and the adjoining Sundarbans National Park in India (UNESCO, 2021, 2023).

► Climate action — Some Concern

Bangladesh has formulated a number of policies and regulatory frameworks for enabling climate resilient sustainable development, including the National Adaptation Programme of Action (NAPA, 2005), Bangladesh Climate Change Strategy and Action Plan (BCCSAP, 2009), Bangladesh Delta Plan 2100, and Mujib Climate Prosperity Plan. The Sundarbans is in the frontline of experiencing regular tidal surges and cyclones resulting in the damage of biodiversity including vegetation and wildlife, with reporting deaths

of a large number of spotted deer and other animals during the recent cyclone Remal in May 2024. The Forest Department, responding to climatic emergency, has developed 12 'raised land' accompanying freshwater ponds to provide shelter for wildlife during climatic emergency, such as cyclones and tidal surges (Mitra, 2025).

The Forest Department along with NGOs of these countries further assist and encourage local afforestation and seek to reduce dependency of the Sundarbans for firewood. In Bangladesh, NGOs with the assistance of the Forest Department utilise the 'net-fencing method' – using net-fences to trap floating seeds in the muddy space outside the embankment so that plants can grow there easily and make forest to strengthen the embankment. Bangladesh Forest Research Institute (BFRI) conducts mangrove research, particularly on Sundari trees whereas, the Institute of Environmental Studies & Wetland Management (India) conducts soil and water quality monitoring (Hassan et al. 2018).

► Management plan and overall management system — Mostly Effective

The Ministry of Environment and Forests (MoEF) is comprised of two departments: the Bangladesh Forest Department (BFD), and the Department of Environment (DoE). The responsibility for the management of forested areas in Bangladesh lies with the BFD and it is this department that is responsible for the field-level presence within the SRF and the property to patrol and monitor the site. The property is managed by the Bangladesh Forest Department (BFD) through the Chief Conservator of Forests, Conservator of Forests, Khulna Circle and staff, who report to the BFD. The Conservator of Forests, Khulna Circle, appears to hold primary responsibility for implementation of the Management Plan for the property, along with other key responsibilities for the day-to-day management including tourism and staff management through the Sundarbans East and West Forest Divisions, the stations and field camps. The Sundarbans East and Sundarbans West Forest Divisions are administered by two separate Divisional Forest Officers (DFO) under a Conservator of Forest (CF) within Khulna circle of the Bangladesh Forest Department. An additional DFO oversees the Wildlife Management and Nature Conservation Division within the same circle. The entire Bangladesh Sundarbans was divided into 55 forest compartments for management purpose. The regular activities are executed by frontline staffs stationed across 104 stations and guard posts (BFD, 2010). An integrated Management Plan for the Sundarbans was developed in 1998-99 and was valid up to 2010. An updated Management Plan was subsequently developed for 2010-2020 (BFD, 2010), with current version being updated for 2025-2035. The Bangladesh Tiger Action Plan 2018-2027 is also of high relevance for the management of the site (Khan et al., 2018).

► Law enforcement — Some Concern

The Conservator of Forests, Khulna Circle appears to hold primary responsibility for implementation of the Management Plan for the property, along with other key responsibilities including enforcement of the management and legal framework. The property itself is not permanently inhabited and extraction of resources is prohibited within its boundaries. It is difficult however to confirm whether this regulation is fully respected but there are very few reports of illegal activities within the property itself. Poaching of tigers remains a threat, although it is considered relatively lower in Bangladesh compared to other countries (Stoner et al., 2016). The resources and capacity to effectively address this threat and provide the necessary enforcement actions are most likely lacking with the management agency reliant on project specific funding for training and support. However, certain improvements in capacities and engagement of local communities have been reported recently (UNESCO World Heritage Centre/IUCN, 2019, 2021, 2023).

The SMART (Spatial Monitoring & Reporting Tools) has been implemented in the Sundarbans since 2015. The aim of this SMART is to monitor and protect wildlife and curbing other illegal activities including illegal fishing. One the constraints of this monitoring includes the regular reshuffling of the monitoring team members (i.e., coming in and going out), thereby requiring continuous training as well as motivation of the team members. Another notable issue is the lack of evaluation of the effectiveness of SMART in achieving the objectives, as reflected in the unabated poaching of spotted deer (e.g. Hossain,

2025).

▶ Sustainable finance — Some Concern

The majority of finance for management of the Sundarbans is provided by the central government (56%; State Party of Bangladesh, 2023). Other funding has come from bilateral international fundings (42%). However, while existing funding sources are secure in the medium-term, the budget is currently extremely limited for many of the basic activities that are necessary for the successful ecological monitoring and law enforcement for illegal activities (Ahmad et al., 2009; UNESCO, 2011; State Party of Bangladesh, 2014, 2023). The need for greater sustainable finance will likely increase into the future under increases in the intensity and severity of extreme storms, cyclones and tidal surges under climate change (IPCC, 2012). The current budget provided need to be improved for current and future management needs, and presents a constraint to the capacity to manage the site.

▶ Staff capacity, training and development — Some Concern

Current staff capacity partly meets management needs (State Party of Bangladesh, 2023). There currently exists some staff training and development opportunities for Forest Department staff. For the conservation of the resources and biodiversity of the property, the Government in association with national and international NGOs provides management and monitoring training, e.g. on computer application, cyber tracker application, combating wildlife related offence, GIS mapping, ecological monitoring, filing of forest cases etc. However, the situation could be improved in most areas with much of this training supported through specific, short term project funding. Especially the SMART (Spatial Monitoring & Reporting Tools) implementation to better monitor and protect wildlife and curbing other illegal activities includes the regular reshuffling of the monitoring team members (i.e., coming in and going out), thereby requiring continuous training as well as motivation of the team members.

▶ Education and interpretation programmes — Some Concern

The BTAP has identified education and awareness of the importance of the Bengal tiger as a key requirement (Ahmad et al., 2009) for its conservation. NGOs, including WildTeam and WCS, have been conducting education awareness activities in the Sundarbans over at least the past two years (IUCN Consultation, 2014) but current efforts are insufficient to ensure widespread uptake.

▶ Tourism and visitation management — Some Concern

Tourism to the site is minimal, largely due to restricted access and poor facilities (World Heritage Committee, 2013). However, the trend in annual visitation is increasing. According to the last Periodic report, annual visitor numbers ranged between 120.000 and 150.000. The Integrated Resources Management Plan (IRMP) and the Policy for Tourism in the Sundarbans is followed to manage visitors and eco-tourism, and while a fee is collected it remains minimal and does not contribute to the management of the site (State Party of Bangladesh, 2014, 2023). Efforts to increase the contribution of tourism to education and awareness of maintaining the values of the WH property are welcomed, however should the trend in visitor numbers continue to increase in the future without proper management it might impact the integrity of the OUV.

▶ Sustainable use — Some Concern

The Sundarbans Reserve Forest is utilised for subsistence and livelihood purposes (timber collection, honey collection, fishing and aquaculture, and some poaching) (State Party of Bangladesh, 2023). This is monitored and controlled by the Forest Department, who grant permits for access and collection of forest goods. But extractive activities are not permitted within the site itself (SoOUV, 2013). However, threats from both legal and illegal resource extraction remain high throughout the forest, with potential impact on the Outstanding Universal Values of the site itself. However, monitoring capacity and resources are not currently sufficient for fully effective monitoring of illegal activity, although there are reports of increased deer hunting in the forest area (e.g. Hossain, 2025). Importantly, there is little baseline information to assess appropriate sustainable offtake rates (Ahmad et al., 2009). Increased monitoring capacity and resources are required if fully effective law enforcement is to take place to successfully manage the site.

Local people benefit from eco-tourism activities e.g. tour operators, tour guides, interpreter, selling of souvenir items to the tourists,
developing of home stay or eco cottage facilities etc., since it is the best alternative livelihood for them to replace the traditional resource collection activities. To provide an undisturbed breeding ground to the wildlife eco-tourism and other interventions are strictly prohibited from June to August (breeding season). The Government is trying to engage the local forest dependent people in eco-tourism based alternative livelihoods and to shift it to the buffer zone areas. The WS area is managed under the PA co-management rules from 2017 which provides 50% of the revenue earned to the CMC (co-management committee) in the next year as grant (State Party of Bangladesh, 2023).

► Monitoring — Some Concern

There is some monitoring carried out at the site, but it is predominantly directed towards apprehending illegal poaching and other activities, as opposed to management needs and improving understanding of the Outstanding Universal Values of the site. Baseline information against which to assess trends in ecological and biodiversity values is largely lacking (Ahmad et al., 2009). In recent years, new projects have been proposed and launched to improve ecological monitoring following both the devastation of the area by cyclone Sidr in 2007 and to monitor the development of climate change impacts on the area (UNESCO, 2011). The latest developments include the development and endorsement of a methodological framework for ecological monitoring of the Sundarbans with technical assistance from the IUCN Bangladesh (Bangladesh Forest Department, GIZ GmbH, 2023). Implementation of this monitoring framework is currently underway where baseline data is being collected from over 100 biotic and abiotic indicators as prescribed in the monitoring framework.
Drone monitoring and SMART (Spatial Monitoring & Reporting Tools) are regularly implemented in the Sundarbans to monitor and protect wildlife and curbing other illegal activities including illegal fishing. One the constraints of this monitoring includes the regular reshuffling of the monitoring team members (i.e., coming in and going out), thereby requiring continuous training as well as motivation of the team members. Another notable issue is the lack of evaluation of the effectiveness of SMART in achieving the objectives, as reflected in the unabated poaching of spotted deer.

► Research — Some Concern

There is some scientific research being conducted within the site, largely specific to the research and monitoring of tigers, Ganges river dolphins and Irrawaddy dolphins and their habitat (e.g. Burton et al., 2008; Smith et al., 2009). Further study has also been conducted on cyclone damage to mangrove health, invasive species, and threat assessment (e.g. Biswas et al., 2007; Rahman et al., 2009; 2010; Cornforth et al., 2013; Halder et al. 2021). Recently, tiger prey assessment has been done that provided baseline population estimates (Aziz, 2023). However, knowledge gaps still exist in many areas; specifically in the existence and generation of baseline information on animal populations, upon which management strategies can be made and the impact of specific threats to Sundarbans biodiversity assessed (Ahmad et al., 2009). Mallick (2023) recently published a book bringing together 45 years' worth of experience-derived information about more than 7,000 micro- and macro- species, which form the unique biodiversity of the Sundarbans ecosystem, as it struggles against the natural and anthropogenic threats.
Furthermore, more research to improve understanding of the ecological processes, properties and functioning of the Sundarbans in relation to climatic, hydrological, biotic and edaphic influences on the health of the Sundarbans and the underlying on-going ecological processes that drive its persistence (Iftekhar & Islam, 2004) is needed. Such research is essential to further understanding of the impacts of specific threats to the system and to inform ecosystem management. Studies are being developed in this space (e.g. Kanjin & Alam, 2024) but more are required.

► Effectiveness of management system and governance in addressing threats outside the site — Serious Concern

Major threats from outside the site are numerous and intense. Unsustainable resource exploitation, coupled with industrial development (specifically the Rampal Power Plant), human and agricultural waste inputs, increasing intensity of shrimp aquaculture and fry fishing, changes to the inundation and salinity

regimes of the area from reduced freshwater flows and sea level rise, and the predicted increase in the frequency and intensity of storms and tidal surges under climate change are increasingly presenting challenges for the fragile Sundarbans ecosystem. Management implementation and preventative action to reduce these threats, and particularly for climate change threats, has been severely lacking. Many threats to the Outstanding Universal Values occurring outside the site are largely unmanaged despite posing a potentially enormous impact to the values of the site. The property is lacking a clear and comprehensive assessment of the overall combined effects expected from increasing coastal developments and associated activities.

▶ **Effectiveness of management system and governance in addressing threats inside the site** — **Some Concern**

Illegal human activities relating to fishing and poaching of tigers and its major prey species, the spotted deer inside the WHS are persistent threats. Ideally, these areas are closed to any forms of human activities according to the Wildlife (Conservation and Security) Act, 2012. However, forest and wildlife related crimes as well as tiger and prey poaching remains unabated (Aziz et al., 2017; Hussain et al., 2018; Aziz et al., 2024a), despite SMART patrol being implemented since 2015.

Overall assessment of protection and management — **Some Concern**

The current protection and management system is currently unable to maintain the site's values and integrity over the long-term. While the central government support for policy initiatives to protect the site's values is good, capacity to implement policies effectively is limited. Funding is insufficient to provide the monitoring and protection necessary to ensure the safeguarding of the site's Outstanding Universal Value, and redirection of increased funds from the Forest Department towards the Sundarbans, as well as greater input from the international community, is essential to improve capacity and training, and the ability to effectively monitor and research the state of the site's values and the intensity of the impact of current and potential threats. While projects funding research into climate change adaptation is available, targeted funds are required to successfully manage the site to mitigate these threats. Moreover, many threats to the site's Outstanding Universal Value have their source within the remainder of the Sundarbans ecosystem (within both Bangladesh and India) and Bay of Bengal. Funding and capacity to preserve the site's Outstanding Universal Values is inadequate to tackle these wider threats, and effective transboundary management with the Sundarbans National Park World Heritage Site in India is needed to adequately address these issues, particularly in the face of climate change.

State and trend of values

Assessing the current state and trend of values

World Heritage values

▶ **On-going ecological processes that lead to the creation and sustenance of mangrove ecosystems** — **High Concern** — **Trend:Deteriorating**

The eastward migration of the Ganges river and overall reduction in freshwater flows into the ecosystem is causing a long-term ecological change across the Sundarbans. This process is intensified due to increased diversion of freshwater sources to the Sundarbans forest that has occurred in recent years (UNEP-WCMC & IUCN, 2011; UNESCO World Heritage Centre/IUCN, 2019). Reduced freshwater flow serves to increase salt-water intrusion and irregular inundation (IUCN, 1997; UNEP-WCMC & IUCN, 2011), and also leads to increased soil acidification. These consequences of dam creation and freshwater extraction serve to significantly degrade the health of the Sundarbans ecosystem (Iftekhar & Islam, 2004; Rahman et al., 2010; UNEP-WCMC & IUCN, 2011), affecting plant biomass production and siltation, sedimentation and deltatic and bank formation. Increased saline intrusion is causing the replacement of

Sundri trees by Gewa through top-dying (IUCN, 1997; Rahman et al., 2010; UNEP-WCMC & IUCN, 2011). This trend is predicted to be long-term (Christensen, 1984), and causes shifts in vegetation communities and habitat for the site's rare and threatened biodiversity (Iftekhar & Saenger, 2008). The Sundarbans is also experiencing extensive coastal erosion and retreat, which is considered to be largely attributable to increased frequency of storm surges and other extreme natural events, rises in sea-level and increased salinity (Cornforth et al., 2013). In some areas of Bangladesh, coastal retreat has been found to be as much as 200 m per year (Cornforth et al., 2013). This represents a potentially great loss of carbon storage (Rahman et al., 2010), and loss of habitat for important biodiversity such as the tiger. Sea level rise due to climate change will exacerbate these impacts to the on-going ecological processes within the Sundarbans. With sea level rise, increased salinity will result in increasing ecological succession to more salt-tolerant species (loss of Sundri vegetation communities to those dominated by Gewa), reducing mangrove biodiversity and impacting the structure of the forest, ultimately also impacting the ecological processes of the site (UNESCO World Heritage Centre/IUCN, 2019).

▶ Exceptional level of biodiversity

High Concern
Trend:Deteriorating

The Sundarbans remains the largest continuous mangrove forest in the world (Rahman et al., 2010). However, the loss of habitat over time, which is occurring in all three of the wildlife sanctuaries that together make up the World Heritage site, is significant (Cornforth et al., 2013). Overexploitation and top-dying of Sundri trees (and others) across the Sundarbans has resulted in a shift in existing vegetation communities (Ministry of Environment and Forests, 2010). The extent of pure Sundri stands has decreased by 21% since 1926, and dominance of Sundri in mixed stands is diminishing (Iftekhar & Saenger, 2008). With this as well as the ongoing threats to the faunal diversity within the site, and particularly that of impacts under climate change, the biodiversity of the Sundarbans is likely to remain under threat in the future should appropriate management actions not be taken. Studies continue to report on biodiversity loss in the Sundarbans (e.g. Rashid, 2024; Khan et al. 2021; Ali et al. 2021)

▶ Rare and threatened terrestrial and aquatic mammals

High Concern
Trend:Deteriorating

The Sundarbans supports a diverse assemblage of rare and threatened terrestrial and aquatic mammals (IUCN, 1997; Aziz, 2024b). However, due to the multiple threats present in the area, six globally threatened species have been locally extirpated over the last century: Javan rhinoceros (CR), greater one-horned rhinoceros (VU), water buffalo (EN), swamp deer (VU), hog deer (EN) and leopard (VU; Aziz, 2024b). Several other mammal species found within the Sundarbans are currently considered to be threatened with extinction nationally: tiger (EN), Asian small-clawed otter (EN), smooth-coated otter (CR), Irrawaddy dolphin (NT), Indo-pacific humpback dolphin (LC), Indo-Pacific finless porpoise (NT), Ganges river dolphin (VU), and northern red muntjac (LC; Ministry of Environment and Forests, 2010; IUCN, 2015; Aziz, 2024b). Populations of the Ganges river dolphin, Irrawaddy dolphin and Bengal tiger within the Sundarbans are all currently relatively high, with populations of the latter two species representing stronghold populations for these species globally (IUCN, 1997; Smith et al., 2006; IUCN, 2016). The population size of tigers shows a positive trend, from an estimate of 106 individuals in 2015 (Dey et al. 2015) to 114 in 2018 (Aziz et al. 2018), and 125 in the latest census conducted in 2024 (Aziz et al. 2024a). A recent tiger’s prey survey under the IUCN’s ITHCP initiative provided a baseline density estimate of 35.44, 15.75, and 0.26 individuals per km2 for spotted deer, wild boar, and northern red muntjac, respectively (Aziz, 2023). The status of populations of Ganges river dolphin and Irrawaddy dolphin in the Sundarbans appear to be favorable at present, although the populations could begin to show decreases should important threats (saltwater intrusion, entanglement in fishing equipment, dredging, shipping accidents and pollution) not be effectively addressed. Threats from poaching, habitat loss and degradation (both aquatic and terrestrial), pollution, altered hydrology and entanglement in hazardous fishing equipment are likely to increase in intensity in the future without effective management. As such, declines in rare and threatened mammal populations over the last few years are likely, and effective management to mitigate the impacts of current and future threats is essential to ensure the continued integrity of the site’s rare and threatened mammal populations.

▶ Rare and threatened birds

High Concern
Trend:Deteriorating

The Sundarbans has a varied and colourful bird life, and supports a high level of avian diversity for a mangrove ecosystem (Khan, 2005). A relatively recent study provided an updated checklist of 299 avifauna, comprising 160 resident and 139 migratory species, from the Sundarbans of Bangladesh (Chowdhury, 2020). This study documented a total of 28 globally threatened and Near Threatened species from the Sundarbans: three of them are Critically Endangered (Spoon-billed Sandpiper Calidris pygmaea, White-rumped Vulture Gyps bengalensis and Slender-billed Vulture Gyps tenuirostris), four Endangered (Masked Finfoot Heliopais personatus, Great Knot Calidris tenuirostris, Steppe Eagle Aquila nipalensis and Pallas's Fish Eagle Haliaeetus leucoryphus), three Vulnerable and 18 Near Threatened (Chowdhury, 2020). The Sundarbans supports several regionally important bird species, such as the Buffy Fish Owl Ketupa ketupa and Streak-breasted Woodpecker Picus viridanus, as well as a number of mangrove-specialists: Masked Finfoot, Brown-winged Kingfisher, Ruddy Kingfisher Halcyon coromanda, Mangrove Whistler Pachycephala cinerea and Common Flameback Dinopium javanense (Siddiqui et al., 2008). Currently little empirical data on population trends exists for the rare and threatened birds of the Sundarbans. One bird species is known to have been extirpated from the Sundarbans over the last century: Swamp francolin Francolinus gularis (VU; Ministry of Environment and Forests, 2010); while there is no recent occurrence of Spoon-billed sandpiper, with the last report back in 1992 (Thompson et al., 1992). It is also feared that the population of Masked finfoot could decrease significantly in recent times due to climatic and anthropogenic adversities.

A comprehensive study was conducted across the Sunardbans in Bangladesh and India during 2019–2022 (Mallick, 2023) to bridge the knowledge-gaps of the avian diversity and habitat use through structural review of published and grey literature as well as field-based rapid assessment in the potential sites. 598 species, classified under 23 orders, 85 families and 277 genera, including seven extinct and about 40 old records, have been recorded in the study area. The terrestrial, arboreal and aquatic habitats are conveniently utilised by 32% resident and 68% migratory (summer and winter) birds for meeting their biological needs. 32.27% of them are commonly sighted and 67.73% rarely confronted. Considering the present biotic and abiotic threats, the rare birds are of high priority for future conservation actions.

Over-exploitation of forest resources due to growing anthropogenic pressures by the the surrounding population is alarming. Moreover, coverage and density of the larger trees, canopy closure and diversity have declined over the last 100 years or so. Due to variation of freshwater supply and salinity across the Sundarbans from west to the east, 0.4% of the forest area in Bangladesh is
replaced by dwarf species every year. Recently, many key mangrove plant species like Heritiera fomes, Nypa fruticans and Phoenix paludosa, which were very abundant in the Sundarbans 50 years ago, have declined relatively as the salinity has increased. In addition, higher salinity in the mangroves leads to depletion of nutrients that might influence the population of planktons, benthic organisms and other macro-invertebrates vis-à-vis top-level predators such as birds. Sea level rise by an average of 3 centimeters a year over the past two decades and 12% shoreline-loss during last four decades also have threatened the shorebirds. On the other hand, excessive collections of Tiger Prawn (Penaeous monodon) fry from the rivers by thousands of local fishermen since
1980s, is not only restricted to the buffer zone and, in this process, more than hundred times of non-target fish and crustacean fry are destroyed, for which the aquatic birds are also declining. Increasing frequency and severity of the cyclones is causing lots of damage to the habitat and the birds as well as their food. Of late, the cyclone Amphan, which hit the Sunderbans on 20 May 2020 at a speed of
155 kmph–165 kmph, carried the pelagic sea birds deep into the mainland (bird fallout) and different types of frigatebirds (Fregata spp.), Oceanites oceanicus, Onychoprion fuscatus, Thalasseus bengalensis, Thalasseus bergii, Anous stolidus and Ardenna tenuirostris were sighted, a few of them are new records in the region. The cyclone has also killed and maimed many of these birds (Mallick, 2023).

▶ Rare and threatened reptiles

Low Concern
Trend:Deteriorating

Two species of globally threatened crocodilian were extirpated from the Sundarbans in the past, believed to be a result of over exploitation: mugger (Crocodylus palustris, VU) and gharial (Gavilalis gangeticus, CR). The estuarine crocodile (Crocodylus porosus) still remains present in the site, though its numbers have been largely depleted over the past century due to excessive exploitation for its skin (Rahman & Asaduzzaman, 2010). The population size of this reptile is relatively low compared to vast mangrove swamps, with a mean number of 140 (95% CI: 90-190) individuals surviving in the Sundarbans, with major threats to the reptile documented including the disturbance by resource collectors, cargo vessels, and water pollution (Aziz and Islam, 2018). Many reptiles present within the Sundarbans are currently threatened with extinction nationally: estuarine crocodile (CR), Northern river terrapin (CR), Burmese python Python molurus (EN), king cobra Ophiophagus hannah (EN) and spot-tailed pit viper Trimeresurus erythurus (EN; Ministry of Environment and Forests, 2010). Until recently, it was believed that the globally and nationally critically endangered (CR) Northern river terrapin Batagur baska was functionally extinct (no known nesting sites) in Bangladesh (Turtle Conservation Coalition, 2011). In 2013 juveniles were discovered in the Sundarbans (Lowe, 2013), suggesting the potential presence of a viable population. However, high demand for use of this species within Bangladesh (Turtle Conservation Coalition, 2011) means that its persistence into the future may be unlikely. The Forest Department, partnered with the Turtle Survival alliance and IUCN-Bangladesh to run a breeding programme for the species for reintroduction, and the captive population is now increasing, enormously improving the conservation situation for this species in the site (TSA, 2009). There has also been a general decline in densities and sightings of snake species in the area over the last 20 years (Rahman & Asaduzzaman, 2010). At present, Olive Ridley Turtle may no longer visit the coast of Sundarbans, and the species could be heavily affected by coastal fishing (Aziz 2016). Currently little empirical data on population trends exists for the reptiles of the Sundarbans. However, considering the combined intensive threats of habitat degradation and loss (both terrestrial and aquatic), poaching, entanglement in fishing gear, pollution and extreme weather events, it is likely that declines may be occurring (particularly for marine turtles).

▶ Rare and threatened flora

Low Concern
Trend:Deteriorating

Populations of Sundari trees (Heritiera fomes; EN) in the Sundarbans wider ecosystem are declining (IUCN, 2016) as a result of numerous impacts including “top-dying” and timber harvesting. The extent of pure H. fomes stands has decreased by 21% since 1926, and dominance of H. fomes in mixed stands is diminishing (Iftekhar & Saenger, 2008). Approximately 70% of H. fomes stems have been estimated to be moderately or severely affected by the “top-dying” disease (Islam & Wahab, 2005), which causes high mortality, threatening mangrove diversity, forest cover and ecosystem complexity. More than 5-6% of the entire Heritiera fomes are now suffering
from top dying (Khan et al. 2021). Due to declines in H. fomes, forest structure in the Sundarbans has become simpler and mean forest height is decreasing, reducing habitat for arboreal mammals and birds (Iftekhar & Saenger, 2008). In addition, as the dominant mangrove species in the back mangrove of the Sundarbans, loss of H. fomes trees poses a threat to the biodiversity, ecological and aesthetic values of the site (Rahman et al., 2010).

Observed changes in land cover, NDVI, and LST over a few decades offer a significant understanding of the environmental dynamics in the Sundarbans. The decline in densified mangrove coverage observed confirms Hossain et al. (2022) study, which finds that the mangrove forest in the Sundarbans is declining. This aligns with global trends of mangrove forest depletion and can be associated with numerous drivers, including anthropogenic pressures such as land conversion for agriculture and aquaculture, as well as natural stressors like sea-level rise. The finding of this study indicates that about 4.7% of the mangrove forest has changed to water bodies while 2.9% has changed to bare areas from 1973 to 2023. Generally, these findings show that the Sundarbans mangrove has a decreasing trend over the years. This is similar to the previous studies on the Sundarbans that found an increasing trend in waterbodies and barren land with a decreasing trend in mangrove cover. This implies that the decrease in mangrove cover in Sundarbans may be due to the expansion of water bodies which can be

partly attributed to the rising sea levels and deforestation (Kanjin and Alam, 2024).

▶ **Rare and threatened fishes**

Low Concern
Trend:Deteriorating

Sawfish – both narrow sawfish and largetooth sawfish – have been recorded in the site and have suffered population declines and range reductions. The narrow sawfish is currently listed as endangered with a decreasing population trend on the IUCN Red List while the largetooth sawfish is critically endangered with a decreasing population trend. A rapid assessment revealed the average annual sawfish encounter rate declines from 3.7 individuals (using 22 year lifetime recall data) to 1.5 (using 5 year recall data), and further to 0.7 (using 1-year recall data) in Bangladesh. Social research methods revealed by-catch as the main cause of the decline (Hossain et al., 2015).

▶ **Rare butterflies**

Low Concern
Trend:Data Deficient

Although the Sundarbans crow was reported as endemic to the Sundarbans globally and have exclusive adaptation and ecological interactions with the Sundarbans mangrove vegetation, very little data as well as its host plants in the Sundarbans, thus requiring further research to assess actual status of its population (Hossain, 2014).

Summary of the Values

▶ **Assessment of the current state and trend of World Heritage values**

High Concern
Trend: Deteriorating

Degradation of the Sundarbans has been, and continues to be, significant due to natural and anthropogenic alterations to the hydrology and ecology of the site, including threats to and impacts on, mangrove diversity (degradation and displacement of Sundri trees), biomass production, primary productivity, on-going ecological processes of tidal inundation, siltation, sediment dynamics, and deltaic and bank formation as well as overall biodiversity levels. The degradation of the ecological values of the site is increasing and this trend is likely to continue with anthropogenic pressures and climatic changes. Populations of some of the site's rare and threatened mammals are considered high, however, while the current situation appears to be favourable for aquatic mammal populations, the limited available data suggests that certain species of rare and threatened terrestrial mammals in the Bangladeshi Sundarbans may be decreasing. The results of bird surveys in one of the component wildlife sanctuaries, indicates the situation for rare and threatened birdlife within the site appears to be favourable, however across the Sundarbans research raises concern regarding the impacts from overexploitation, canopy coverage changes, sea level rise, higher salinity and extreme weather events on avifauna. Success in breeding programmes for critically endangered and functionally extinct herpetofauna (Northern river terrapins) gives promise for the conservation of this species if the threats that previously lead to its demise can be properly addressed. However, little information exists on the status and trends of other rare and threatened reptiles. The limited data available suggests that populations of crocodile and snake species may be declining. Thus, it appears that the effects of current identified threats on the site's values remain high, and ecosystem-level assessments of the impacts of threats is necessary to fully determine the resilience of its values into the future.

Additional information

Benefits

Understanding Benefits

▶ **Carbon sequestration**

Mangrove forests store enormous amounts of carbon, rivalling that of other tropical rainforests (Donato et al., 2011). As the world's largest remaining mangrove forest, the wider Sundarbans, including the World Heritage site, provides a large and significant carbon storage. The area thus has major climate change mitigation value globally, as well as locally, due to the potential impact of climate change to the area and to Bangladesh as a whole (Rahman et al., 2010).

Factors negatively affecting provision of this benefit :
- Climate change Impact level - High, Trend - Increasing
- Pollution Impact level - Moderate, Trend - Increasing
- Overexploitation Impact level - Low, Trend - Continuing
- Invasive species Impact level - Low, Trend - Increasing
- Habitat change Impact level - Low, Trend - Increasing

► Coastal protection,
Flood prevention

Mangrove forests provide protection for coastal and inland areas and human populations, from extreme weather events including cyclones and from flooding from tidal surges and tsunamis. As highlighted by the 2007 cyclone, coastal communities, infrastructure, and biodiversity are highly susceptible to such events (UNESCO, 2007a). The Sundarbans, and particularly mangroves, are thus extremely important in protecting settlements, infrastructure and biodiversity.

Factors negatively affecting provision of this benefit :
- Climate change Impact level - Moderate, Trend - Increasing
- Pollution Impact level - Low, Trend - Increasing
- Overexploitation Impact level - Low, Trend - Increasing
- Invasive species Impact level - Low, Trend - Increasing
- Habitat change Impact level - Low, Trend - Increasing

► Soil stabilisation

The on-going geological processes of the Sundarbans include deltaic and bank formation. The Sundarbans mangrove trees serve to trap sediment and organic matter inputs, stabilizing the sediments and reducing organic matter inputs into the Bay of Bengal.

Factors negatively affecting provision of this benefit :
- Climate change Impact level - Moderate, Trend - Increasing
- Invasive species Impact level - Low, Trend - Increasing
- Habitat change Impact level - Low, Trend - Increasing

► Fishing areas and conservation of fish stocks

The Sundarbans provide important spawning and nursery grounds for several economically important, fish species (IUCN, 1997). With increased fishing activities adjacent to the area, the protection of the WH site serves to sustain breeding and nursery areas for important fish species.

Factors negatively affecting provision of this benefit :
- Climate change Impact level - Moderate, Trend - Increasing
- Pollution Impact level - Low, Trend - Increasing
- Overexploitation Impact level - Moderate, Trend - Increasing
- Invasive species Impact level - Low, Trend - Increasing
- Habitat change Impact level - Low, Trend - Increasing

► Sacred natural sites or landscapes

The Sundarbans World Heritage site is part of one of the largest remaining mangrove areas in the world, with much of the site remote and accessible only by boat (SoOUV, 2013).

► Pollination

The Sundarbans supports large numbers of honey-bees which produce great quantities of honey and wax, which in turn provide livelihoods for local people living adjacent to the Sundarbans Reserve Forest, outside the site (IUCN, 1997). These bees and other pollinators found within the site may also prove to be important for pollination of local crops, and to maintaining the Sundarbans forest diversity.

Factors negatively affecting provision of this benefit :

- Climate change Impact level - Moderate, Trend - Increasing
- Pollution Impact level - Low, Trend - Increasing
- Overexploitation Impact level - Low, Trend - Continuing
- Invasive species Impact level - Low, Trend - Increasing
- Habitat change Impact level - Low, Trend - Continuing

► Outdoor recreation and tourism

Due to limited access to the Sundarbans and specifically the World Heritage site, combined with limited visitor facilities, tourism and recreation in the site remains relatively low (SoOUV, 2013). However, in recent years annual visitation has been increasing (PR Questionnaire, 2014), and into the future may begin to provide more jobs.

Factors negatively affecting provision of this benefit :

- Climate change Impact level - Low, Trend - Increasing

Summary of benefits

The benefits from the Sundarbans are largely in the conservation of the mangrove area, which provides habitat for many charismatic species of global conservation concern, as well as in mitigating accelerating climate change impacts through carbon storage, and protection of local infrastructure and populations from extreme weather events, the frequency of which may increase under climate change. There are also economic benefits in terms of job creation, fisheries stocking and tourism.

Projects

Compilation of active conservation projects

№	Organization	Brief description of Active Projects	Website
1	WildTeam	Work with local communities and government to elicit education and awareness of tiger conservation issues, create Tiger Response Teams to reduce human-tiger conflict, training for local people (i.e. honey collectors) in safety, provide funds for tiger-related livestock losses, research into deer abundance and social research into threatening human behaviours. Monitoring work for the Bengal tiger to assess population size and trends – new methods of monitoring being developed.	www.wild-team.org
2	Zoological Society of London Dr Gitanjali Bhattacharya	The Zoological Society of London has supported numerous conservation projects in the Bangladesh Sundarbans, focusing on both terrestrial and aquatic fauna. ZSL runs capacity building programmes via its EDGE programme, which supports local scientists who are working on conservation projects that address threats to the worlds most threatened and evolutionarily distinct species. ZSL also works with remote sensing to monitor the state of the Sundarbans mangrove forest and has worked closely with local partners and the BFD on tiger conservation. With Dhaka University, ZSL conducted a rapid assessment of sawfish status and exploitation in Bangladesh and is currently developing conservation measures based on the results.	www.zsl.org

№	Organization	Brief description of Active Projects	Website
3	Wildlife Conservation Society - Bangladesh Cetacean Diversity Project	Systematic research and monitoring of cetacean populations and habitat. Work with government agencies and local communities to identify and address threats to cetaceans. Develop a conservation management plan with recommendations for an effectively managed Protected Area Network with local and government input and support. Provide training and technical support for scientists and resource managers to devise, advocate and implement rigorous research and effective conservation interventions. Foster support for cetacean conservation through community education programs, development of educational materials for dissemination through popular media, and workshops and meetings with government officials and NGO representatives.	
4	Centre for Advanced Research in Natural Resources and Management (CARNIAM)	Marine Turtle Conservation Project – sea turtle nest site surveys, studying nesting habitats, threats, regular surveys along the coast line, training and advocacy for sea turtle conservation, awareness building. Currently conducting a survey of the Estuarine crocodile in the area to assess its conservation status in the Sundarbans. “Bangladesh Python Project”: a radiotelemetry project to gain insight into their biology, behavior, habitat preferences and movements. “Project Batagur”: breeding and reintroduction programme for the critically endangered Northern river terrapin. Also surveying for the presence and status of this species in the Sundarbans.	
5	IUCN Bangladesh	“Environmental Management and Biodiversity Conservation Plan for the Sundarbans’ Biodiversity”: develop a strategy and action plan for the management and biodiversity conservation for Sundarbans (fill information gaps that constrain informed decision-making in the Sundarbans, generate knowledge on biodiversity and explore conservation options that produce local benefits, identify policy reforms, investments and technical assistance needed to bolster the capacity of governmental agencies to address the environmental priorities linked with biodiversity conservation, and identify cost-effective investment options to enhance the welfare of the people living in the Sundarbans periphery areas and conserve biodiversity in the Sundarbans). “Implementation of Mangroves for the Future (MFF) outreach activities in Bangladesh”: prepare a national strategy and action plan to create opportunities for the sustainable management of coastal areas, participate in MFF regional training and knowledge-sharing events, develop capacity of professionals working for ICM in Bangladesh, publication and dissemination of outreach materials and knowledge products, and identify and develop coastal management opportunities in Bangladesh.	www.iucn.org/bangladesh

REFERENCES

№	References
1	(PR) Periodic Reporting Questionnaire (2014). The Sundarbans.
2	(SoOUV) Statement of Outstanding Universal Value (2013). The Sundarbans.
3	Ahmad, I.U., C.J. Greenwood, A.C.D. Barlow, M.A. Islam, A.N.M. Hossain, M.M.H. Khan, J.L. and Smith, D. (2009). Bangladesh Tiger Action Plan 2009-2017. Bangladesh: Bangladesh Forest Department, Ministry of Environment and Forests, Government of the People's Republic of Bangladesh.
4	Akbar Hossain, K., Masiero, M., & Pirotti, F. (2024). Land cover change across 45 years in the world's largest mangrove forest (Sundarbans): the contribution of remote sensing in forest monitoring. European Journal of Remote Sensing, 57(1), 2097450.
5	Akhtaruzzaman, A. (2000). 'Mangrove Forestry Research in Bangladesh'. In Asia-Pacific cooperation on research for conservation of mangroves: proceedings of an international workshop, Okinawa, Japan, 26-30 March, 2000. Japan: United Nations University.
6	Ali, M., Tasnim Mukarram, M., & Islam, A. (2021). Environmental degradation due to deforestation in the Sundarban forest of Bangladesh. Int. J. Sci. Eng. Res, 12, 855-862.
7	Axès, J., Mosdal, M.A., Zazzera, S., Barzasi, A.L., Olaussen, M. (2022). Invasive species in mangrove forests (Bangladesh). University of Bergen. Available at: https://clichex.w.uib.no/files/2022/03/215_1_paper.pdf
8	Aziz, A., Barlow, A. C. D., Greenwood, C. C., and Islam, A. (2013) Prioritizing threats to improve conservation strategy for the tiger Panthera tigris in the Sundarbans Reserve Forest of Bangladesh. Oryx, 47 (4) 510-518.
9	Aziz, M. A. (2023). Status of tiger prey species in the Sundarbans of Bangladesh. Jahangirnagar University, Bangladesh. 65 pp.
10	Aziz, M. A. (2024b). Tigers of the Sundarbans: Population, Threats, and Conservation Genetics. Jahangirnagar University, Bangladesh. 112 pp.
11	Aziz, M. A. and Islam, M. A. (2018). Population status and spatial distribution of saltwater crocodile, Crocodylus porosus in the Sundarbans of Bangladesh. Bangladesh Journal of Zoology, 46(1), 33–44.
12	Aziz, M.A. (2016). Threats to olive ridely turtles on the Sundarbans coast of Bangladesh. Indian Ocean Turtle Newsletter 24, 2-4.
13	Aziz, M.A., Islam, M.A., and Groombridge, J.J. (2020). Spatial differences in prey preference by tigers across the Bangladesh Sundarbans reveal a need for customised strategies to protect prey populations. Endangered Species Ressearch, 43: 65–73.
14	Aziz, M.A., Kabir, M.J., Shamsuddoha, M., Ahsan, M.M., Sharma, S., Chakma, S., Jahid, M., Chowdhury, M.M.R., Rahman, M.M. 2018. Status of tigers in Bangladesh Sundarban 2018. Bangladesh Forest Department, Dhaka. 50 pp.
15	Aziz, M.A., Rahman, H.A., Chakma S., Chowdury M.M.R., and. Hossain, A.N.M. (2024a). Status of tigers in the Sundarbans of Bangladesh. Bangladesh Forest Department, Ministry of Environment, Forest and Climate Change. 58 pp.
16	Aziz, M.A., Tollington, S., Barlow, A., Goodrich, J., Shamsuddoha, M., Islam, M.A., Groombridge, J.J. (2017). Investigating patterns of tiger and prey poaching in the Bangladesh Sundarbans: Implications for improved management. Global Ecology and Conservation, 9: 70-81.
17	BFD (2010). Integrated Resources Management Plans for The Sundarbans (2010 - 2020): Vol. I, Ministry of Environment and Forests. Dhaka.

№	References
18	Bangladesh Forest Department (2010) Integrated Resources Management Plans for the Sundarbans 2010-2020. Forest Department, Ministry of Environment and Forests.
19	Biswas, S.R., Choudhury, J.K., Nishat, A. and Rahman, M. (2007). Do invasive plants threaten the Sundarbans mangrove forest of Bangladesh? Forest Ecology and Management 245:1-9.
20	Chowdhury, S.U. (2020). Birds of the Bangladesh Sundarbans: status, threats and conservation recommendations. FORKTAIL 36 (2020): 35–46.
21	Christensen, B. (1984). Ecological Aspects of the Sundarbans. Italy: FAO.
22	Cornforth, W.A., Fatoyinbo, T.E., Freemantle, T. and Pettorelli, N. (2013). Advanced Land Observing Satellite Phased Array Type L-Band SAR (ALOS PALSAR) to inform the conservation of mangroves: Sundarbans as a case study. Remote Sensing 5:224-237.
23	Dey, T.K., Kabir, M.J., Ahsan, M.M., Islam, M.M., Chowdhury, M.M.R., Hassan, S., Roy, M., Qureshi, Q., Naha, D., Kumar, U., and Jhala, Y.V. 2015. First Phase Tiger Status Report of Bangladesh Sundarbans. Bangladesh Forest Department, Ministry of Environment and Forests, Government of Bangladesh.
24	Donato, D.C., Kauffman, J.B., Murdiyarso, D., Kurnianto, S., Stidham, M. and Kannien, M. (2011). Mangroves among the most carbon-rich forests in the tropics. Nature 4:293-297.
25	Halder, N. K., Merchant, A., Misbahuzzaman, K., Wagner, S., & Mukul, S. A. (2021). Why some trees are more vulnerable during catastrophic cyclone events in the Sundarbans mangrove forest of Bangladesh?. Forest Ecology and Management, 490, 119117.
26	Haq, S.A. (2010). 'Impact of climate change on "Sundarbans", the largest mangrove forest: ways forward', paper delivered at the 18th Commonwealth Forestry Conference, Edinburgh, 29 June 2010.
27	Hassan, K., Higham, J., Wooliscroft, B., & Hopkins, D. (2019). Climate change and world heritage: A cross-border analysis of the Sundarbans (Bangladesh–India). Journal of Policy Research in Tourism, Leisure and Events, 11(2), 196-219.
28	Hossain, A.N.M., Lynam, A.J., Ngoprasert, D., Barlow, A., Barlow, C.G. and Savini, T. (2018). Identifying landscape factors affecting tiger decline in the Bangladesh Sundarbans. Global Ecology and Conservation, 13 (2018), e00382.
29	Hossain, H. (2025). Illegal deer hunting in Sundarbans a growing concern. Dhaka Tribune. Published online 23 January 2025. Available at: https://www.dhakatribune.com/bangladesh/371592/illegal-deer…
30	Hossain, M. (2014). Checklist of butterflies of the Sundarbans mangrove forest, Bangladesh. Journal of Entomology and Zoological Studies, 2 (1): 29-32.
31	Hossain, M.A., Thompson, B., Chowdury, G., Mohsanin, S., Zubair, F., Koldewey, H and Islam, M.A. (2015). Sawfish exploitation and status in Bangladesh. Aquatic Conservation. 25(6):781-799.
32	Hossain, Mahmood, Chameli Saha, Sanjoy Saha, Hawlader Mohammed Nurul Islam, Mushfiq Ahmed, Tanvir Ahmed, Abdul Halim Farhad Sikder, and Md Mutasim Billah. "Is the Sundarbans of Bangladesh in a State of Pollution?." Open Journal of Forestry 14, no. 1 (2024): 19-41.
33	Hussain, Z. (1991). Management of the Sundarbans Forest. IUCN - The Intenational Conservation Union, Bangkok
34	IPCC (2012). Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. Special Report of the Intergovernmental Panel on Climate Change. UK: Cambridge University Press.
35	IUCN (1997). World Heritage Nomination – IUCN Technical Evaluation. Sundarban Wildlife Sanctuaries (Bangladesh). Switzerland: IUCN.
36	IUCN (2016). 'The IUCN Red List of Threatened Species. Version 2016.3.' Accessed 8 January 2017.

№	References
37	IUCN (2021). ‘The IUCN Red List of Threatened Species. Accessed on 27 February 2025.
38	IUCN and UNEP-WCMC (2014). ‘The World Database on Protected Areas (WDPA)’. Cambridge: UNEP-WCMC. Accessed 7 March 2014.
39	IUCN and UNESCO. (2016). Report on the Mission to The Sundarbans World Heritage Site (Bangladesh). Gland, Switzerland and Paris, France: IUCN and UNESCO World Heritage Centre.
40	IUCN, 2014. Confidential consultation.
41	IUCN–Bangladesh (2004). Bengal Tiger in the Bangladesh Sundarbans. Dhaka: IUCN.
42	Iftekhar, M.S. (2004). Environmental consciences of oil pollution on the Bangladesh Sundarban: a brief review. ISME 3:11.
43	Iftekhar, M.S. and Islam, M. (2004). Degeneration of Bangladesh’s Sundarbans mangroves: a management issue. International Forest Review 6:123-135.
44	Iftekhar, M.S. and Saenger, P. (2008). Vegetation dynamics in the Bangladesh Sundarbans mangroves: a review of forest inventories. Wetlands Ecology & Management 16:291-312.
45	Islam, M.S. and Wahab, M.A. (2005). A review on the present status and management of mangrove wetland habitat resources in Bangladesh with emphasis on mangrove fisheries and aquaculture. Hydrobiologia 542:165-190.
46	Islam, Sadiq. ‘World's largest mangrove forest under threat’. CNN, (29 June 2001). http://www-cgi.cnn.com/2001/fyi/student.bureau/06/29/sundar...; . Accessed 7 March 2014.
47	Kanjin, K., & Alam, B. M. (2024). Assessing changes in land cover, NDVI, and LST in the Sundarbans mangrove forest in Bangladesh and India: A GIS and remote sensing approach. Remote Sensing Applications: Society and Environment, 36, 101289.
48	Khan, M. S., Abdullah, S., Salam, M. A., Mandal, T. R., & Hossain, M. R. (2021). Review assessment of biodiversity loss of sundarban forest: Highlights on causes and impacts. Indonesian Journal of Forestry Research, 8(1), 85-97.
49	Khan, M.M., Ahsan, M.M., Jhala, Y.V., Ahmed, Z.U., Paul, A.R., Kabir, M.J., Morshed, H.M., Hossain, A.N.M. (2018). Bangladesh Tiger Action Plan, 2018-2027. Strengthening Regional Cooperation for Wildlife Protection (SRCWP) Project. Bangladesh Forest Department, Ministry of Environment and Forests.
50	Khan, M.M.H. (2005). Species diversity, relative abundance and habitat use of the birds in the Sundarbans East Wildlife Sanctuary, Bangladesh. Forktail 21:79-86.
51	Lowe, Heather. ‘River terrapin hatchlings found in the wild’. Turtle Survival Alliance, (21 June 2013). http://www.turtlesurvival.org/blog/1-blog/223-river-terrapi...; Accessed 11 March 2014.
52	Mallick, J. K. (2023). A review and field verification of avian diversity and habitat use in the greater Sundarbans of India, Bangladesh and their hinterland. Probe, 5(1), 1778.
53	Mallick, J.K. (2023). Biodiversity of the Sundarbans: Ethics of Conservation Ecology (1770-2022).
54	Mitra, R. (2025). The Sundarbans: Battling climate change in the world’s largest mangrove forest. The Chartered Institution of Water and Environmental Management. Published online 25 April 2025. Available at: https://www.ciwem.org/news/the-sundarbans-battling-climate-...
55	Mohsanin, S., Barlow, A.C.D., Greenwood, C.J., Islam, M.A., Kabir, M.M., Rahman, M.M., Howlader, A. 2013. Assessing the threat of human consumption of tiger prey in the Bangladesh Sundarbans. Animal Conservation, 16: 69−76.

№	References
56	Mollick, A. S., Roy, M., Khan, N. I., Islam, W., Sadath, N., & Nath, T. K. (2022). Assessing good governance in protected areas (PA) co-management: a case study of the Sundarbans Mangrove forests of Bangladesh. Journal of Sustainable Forestry, 41(3-5), 277-301.
57	Peng, L. (2000). Environmental ecology and economic utilization of mangroves in China. China: China Higher Education Press.
58	Rahman, M.M., Chongling, Y., Islam, K.S. and Haoling, L. (2009). A brief review on pollution and ecotoxicologic effect on Sundarbans mangrove ecosystem in Bangladesh. IJE E 1:369-382.
59	Rahman, M.M., Rahman, M.M. and Islam, K.S. (2010). The causes of deterioration of Sundarban mangrove forest ecosystem in Bangladesh: Conservation and sustainable management issues. Aquaculture, Aquarium, Conservation & Legislation International Journal of the Bioflux Society 3:77-90.
60	Rahman, M.R. and Asaduzzaman, M. (2010). Ecology of Sundarban, Bangladesh. Journal of Science Foundation 8:35-47.
61	Rashid, M. (2024). Utilizing Remote Sensing and GIS Technologies to Monitor Deforestation and Biodiversity Loss in the Sundarbans Mangrove Forest. Available at SSRN 5065335.
62	Saif, S., Russell, A. M., Nodie, S. I., Inskip, C., Lahann, P., Barlow, A., … MacMillan, D. C. (2015). Local Usage of Tiger Parts and Its Role in Tiger Killing in the Bangladesh Sundarbans. Human Dimensions of Wildlife, 21(2), 95–110.
63	Sanyal, P., Mukhopadhyay, A. and Das, I. (2008). Sundarban-the greatest mangal diversity of the planet. Journal of the Indian Society of Coastal Agricultural Research, 26:58-62.
64	Siddique, A. (2022). Bangladesh ban on resource hunting in Sundarbans leaves communities facing hardship. Mongabay Asia. Published online 30 May 2022. Available at: https://news.mongabay.com/2022/05/bangladesh-ban-on-resourc…
65	Siddiqui, K. U., Islam, M. A., Kabir, S. M. H., Ahmad, M., Ahmed, A. T. A., Rahman, A. K .A., Haque, E. U., Ahmed, Z. U., Begum, Z. N. T., Hassan, M. A., Khondker, M. & Rahman, M. M. (eds.) (2008) Encyclopaedia of flora and fauna of Bangladesh 26. Dhaka: Asiatic Society of Bangladesh.
66	Smith, B.D., Braulik, G., Strindberg, S., Ahmed, B. and Mansur, R. (2006). Abundance or Irrawaddy dolphins (Orcacella brevirostris) and Ganges river dolphins (Patanista gangetica gangetica) estimated using concurrent counts made by independent teams in the waterways of the Sundarbans mangrove forest in Bangladesh. Marine Mammal Science 22: 527-547.
67	Smith, B.D., Braulik, G., Strindberg, S., Mansur, R., Diyan, M.A.A. and Ahmed, B. (2009). Habitat selection of freshwater-dependent cetaceans and the potential effects of declining freshwater flows and sea-level rise in waterways of the Sundarbans mangrove forest, Bangladesh. Aquatic Conservation 19:209-225.
68	Stoner S., Krishnasamy, K., Wittmann, T., Delean, S. and Cassy P. (2016). Reduced to skin and bones: full analysis. TRAFFIC report, Selangor, Malaysia.
69	Thompson, P. M., Harvey, W. G., Johnson, D. L., Millin, D. J., Rashid, S. M. A., Scott, D. A., Stanford, C. & Woolner, J. D. (1993) Recent notable bird records from Bangladesh. Forktail 9: 13–44.
70	Turtle Conservation Coalition (2011). Turtles in Trouble: The World’s 25+ Most Endangered Tortoises and Freshwater Turtles—2011. Canada: IUCN/SSC Tortoise and Freshwater Turtle Specialist Group, Turtle Conservation Fund, Turtle Survival Alliance, Turtle Conservancy, Chelonian Research Foundation, Conservation International, Wildlife Conservation Society, and San Diego Zoo Global.
71	UNEP-WCMC and IUCN (2011). The Sundarbans Bangladesh. World Heritage Information Sheet. UK: UNEP-WCMC.

№	References
72	UNESCO (2007a). World Heritage Centre Report: Evaluation of Cyclone Sidr Impacts on Sundarbans WH Site. 4 December 2007.
73	UNESCO (2007b). Case Studies on Climate Change and World Heritage. France: UNESCO.
74	UNESCO (2008). Report on the 32th Session of the Committee. France: UNESCO World Heritage Centre.
75	UNESCO (2009). Report on the 33th Session of the Committee. France: UNESCO World Heritage Centre.
76	UNESCO (2011). Report on the 35th Session of the Committee. France: UNESCO World Heritage Centre.
77	UNESCO World Heritage Centre and IUCN (2019). Report on the Mission to The Sundarbans World Heritage Site (Bangladesh). Gland, Switzerland and Paris, France: UNESCO World Heritage Centre and IUCN.