IUCN Conservation Outlook Assessment 2017 **(archived)**
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Please note: this is an archived Conservation Outlook Assessment for The Sundarbans. To access the most up-to-date Conservation Outlook Assessment for this site, please visit https://www.worldheritageoutlook.iucn.org.

The Sundarbans

SITE INFORMATION

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

Site description:
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

2017 Conservation Outlook

Significant concern

The values of The Sundarbans are highly threatened by multiple on-going processes both within and external to the site, and the site's values are showing signs of deterioration. 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 adjacent to the Reserve Forest, shrimp aquaculture 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. 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. While internationally-funded programmes are underway to attempt to tackle these effects, scientific study into the resilience of the site in the face of these multiple changes to ecological processes and climatic changes to the site will be essential to inform effective management. Transboundary management with the Sundarbans National Park, India should be further considered, as this will be essential in the future to develop effective regional management strategies for the Sundarbans ecosystem as a whole.

Current state and trend of VALUES

High Concern
Trend: Deteriorating

The Sundarbans World Heritage Site is part of the Sundarbans Reserve Forest (Bangladesh) and is connected to the forest component within India. While the wider forest area remains the largest continuous mangrove forest in the world, it is now almost half the size of the area that existed in the late 1800s as a result of very high human pressure in settlements at its boundaries. 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 through 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 increasing population pressure and climatic changes. Populations of some of the site's rare and threatened mammals are considered relatively large. 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.
Recent 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. These current threats are likely to continue to increase in intensity in the future and combined with the nature of potential threats identified, including the proposed construction of power plants and increased shipping traffic, the need for greater and more sustainable management actions and capacity is urgent. While the status of the

site’s biodiversity appears to be largely stable, an increase in the intensity of current threats (i.e. under climate change or increased extractive pressures), combined with the threats posed by potential threats and / or discontinuation of efficient management actions may greatly change the current state of affairs.

Overall THREATS

High Threat

The current and potential threats to both the terrestrial and marine elements of the property are many and severe. Threats from aquaculture, shrimp fry fishing and harmful fishing practices, while largely occurring at the edge of the Sundarbans Reserve Forest and not within the site, are high and are currently not adequately managed due to insufficient funding and capacity. 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 – pose a great threat to the site’s values alongside unsustainable and illegal extraction of high value species including Bengal tigers for the illegal wildlife trade.

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. As a coastal area that is regularly affected by extreme weather events such as cyclone Sidr in 2007, the concern for the site’s values from these multiple threats becomes yet more severe, and the likely success of management is greatly compromised. The potential for increased pollutant loadings from the proposed Rampal power plant, as well as the associated increase in shipping traffic and dredging of the Passur River also pose a significant threat to the site’s values and its integrity in the future.

While a management plan is in place for the Sundarbans Reserve Forest, including the property, it does not take into account the mounting pressures on the Sundarbans in an integrated manner. There is currently no plan or management system in place that could adequately address the cumulative effects the property and its surrounding area are facing. Considering that the OUV of the property and the surrounding Sundarbans ecosystem is already undergoing changes due to drastic reductions of freshwater flow, the high likelihood for damaging cyclones and the overall uncertainty of climate change, the lack of an integrated system is of high concern for the conservation of the

OUV and the overall integrity of the property.

Overall PROTECTION and MANAGEMENT

Some Concern

The current protection and management system shows major deficiencies and 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 currently 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 to research into climate change adaptation is available for the area, funds required to successfully manage the site to mitigate these threats, and specifically sea level rise, into the future are furthermore likely to be extensive in the long-term. 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 transboundary management with the Sundarbans National Park World Heritage Site in India needs to be deliberated in order to adequately address these issues, particularly in the face of climate change.

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 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 (SoOUV, 2013).

▶ Exceptional level of biodiversity

Criterion:(x)

One of the largest remaining areas of mangroves in the world, The Sundarbans supports an exceptional level of biodiversity in both the terrestrial and marine environments, including significant populations of globally endangered cat species, such as the Bengal tiger (SoOUV, 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 Bengal tiger Panthera tigris ssp. 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 the number to be considerably less (106; Day et al., 2015). 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 for the Bengal tiger (IUCN, 1997). Three species of wild cat are present: the jungle cat Felis chaus (LC) and leopard cat Prionailurus bengalensis (LC), and the globally endangered fishing cat Prionailurus viverrinus (EN) (IUCN, 1997; 2016). Three species of otter are present, two of which are globally threatened – smooth-coated otter Lutra perspicillata (VU) and the oriental small-clawed otter Aonyx cinerea (VU) (IUCN, 1997) – 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 of 315 species recorded (SoOUV, 2013). These include 95 species of waterfowl, 38 species of raptors, nine species of kingfisher, and many gulls, terns, woodpeckers, barbets, shrikes, drongos, mynahs, minivets and babblers (IUCN, 1997). Species within the Sundarbans of global conservation concern include Pallas’s fish eagle Haliaeetus leucoryphus (VU), the white-rumped vulture Gyps bengalensis (CR), the greater adjutant Leptoptilos dubius (EN), the masked finfoot Heliopais personatus (EN) and the greater spotted eagle Aquila clanga (VU). The brown-winged kingfisher Pelargopsis amauroptera, the black-headed ibis Threskiornis melanocephalus, the 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 (SoOUV, 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).

► 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).

Assessment information

Threats

Current Threats

High Threat

Current threats to the Sundarbans from altered hydrology, pollution and poor fishing practices 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.

▶ **Logging/ Wood Harvesting**

Low Threat
Outside site

Extraction of mangrove wood for subsistence and commercial purposes is no longer common within the Sundarbans Reserve Forest or other areas around the site. Extraction of timbers when it does occur results in an overall reduction in productivity of the forest, compromising both the overall aesthetic beauty of the area and resource availability to sustain the currently high levels of biodiversity. Extraction of mangrove trees will also alter soil and sedimentation dynamics and increase erosion, compromising the natural on-going ecological processes.

▶ **Solid Waste**

Low Threat

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.

► Marine/ Freshwater Aquaculture

Low Threat
Outside site

Sedimentation dynamics are altered by the loss of mangrove areas and creation of embankments for fisheries and shrimp ponds, thus compromising the on-going ecological processes of the site. Shrimp farming has been expanding over the last decades but there is no evidence of this occurring either within the site itself or the effective buffer zone around the property created by the Sundarbans Reserve Forest.

► Hunting (commercial/subsistence)

Data Deficient
Inside site, extent of threat not known
Outside site

Most illegal hunting appears to be concentrated on deer, but a so far unknown and unquantified risk remains from tiger poaching itself, due to high value of tiger products on the illegal markets (Barlow et al., 2008; Deodatus & Ahmed, 2002). The government of Bangladesh acknowledges that poaching of tigers is one of the largest and most immediate threats to Bangladesh’s tigers (BFD, 2013).

► Solid Waste

Low Threat
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.

► Water Pollution

High Threat
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. 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.

► Fishing / Harvesting Aquatic Resources

Low Threat
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 other fish 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).

► Air Pollution

Data Deficient
Inside site, throughout(>50%)
Outside site

Increased industrial activitiy (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. 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.

► Hunting (commercial/subsistence)

Low Threat
Outside site

Under the provision of the Wildlife Act, hunting within the site and the Sundarbans Special Forest is prohibited. Within the remainder of the forested area illegal hunting of wildlife populations has been recorded and is potentially 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 and in the past was found to be practiced by military personnel (Blower, 1985) and is likely also practiced by the dacoits, groups of robbers and pirates present in the forest. Hunting of mammal populations not only reduces the biodiversity values of the area directly, but may also serve to reduce food resources for the Bengal tiger throughout the forest, thus compromising the conservation value of the site. Hunting of the Bengal tiger in human-wildlife conflict situations in the region, although not likely to occur within the property itself, poses a threat to tiger numbers within the WH site (Ahmad et al., 2009).

► Tourism/ visitors/ recreation

Very Low Threat
Inside site, scattered(5-15%)
Outside site

In some areas management of the impacts from tourists can be poor (i.e. oil spillages associated with tourist boats and waste production). However, tourism is currently low due to the difficulty in access to the site, transport and accommodation facilities. Mass tourism and its impacts are thus unlikely to affect the values of the property significantly (SoOUV, 2013).

► Invasive Non-Native/ Alien Species

Low Threat
Outside site

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 trifoliate, Eichornia crassipes and Eupetorium 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 invasives are still in a controllable stage, if appropriate management activity is applied. Effective monitoring of spread and targeted control actions for particularly destructive species (Biswas et al., 2007) is also needed.

► Industrial/ Military Effluents

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

Oil pollution, as outlined above in other related threats, remains a serious threat and is damaging to aquatic fauna and sea birds (Blower, 1985; Hussain & Acharya, 1994). 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). High concentrations of heavy metals (i.e. Zn, Cd, Cr, Pb and Cu) have been found within the mangrove sediment (Rahman et al., 2009). With limited management action in place to combat this threat and on going use of waterways throughout the Sundarbans as shipping lanes this threat is very likely to increase in intensity into the future.

► Water Pollution

High Threat
Inside site, throughout(>50%)
Outside site

Agro-chemicals, especially pesticides, have resulted in nutrient enrichment into Sundarbans waters, which can damage mangrove biogeochemistry reducing mangrove area and primary production (Rahman et al., 2009). High concentrations of organic pesticides have been reported in the mangrove sediment (Rahman et al., 2009).

► Other Biological Resource Use

Low Threat
Outside site

Honey and wax collectors enter the Sundarbans to access nests and collect these non timber forest products, with permits from the Forest Department (Chakrabarti, 1987). Entry to the forest can result in damage to vegetation, contributing to reduced quality of habitat and compromising the biodiversity values of the site. However, the number of collectors remains low and they are prohibited from entering the WH site itself, with collection restricted to the Sundarbans Reserve Forest. These activities have existed in the Sundarbans for thousands of years (Rahman et al., 2010). However, with increasing population pressure in surrounding settlements and the population of the country overall (Rahman et al., 2010; UNEP-WCMC & IUCN, 2011), honey collection may increase in the future, increasing the chance of impacts on the site.

► Other

High Threat
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 replaceed 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 and mean forest height is decreasing, 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).

► Erosion and Siltation/ Deposition

Very High Threat
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). 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), causing reduction in forest cover and reduction in mangrove species diversity (Iftekhar & Islam, 2004; Akhtaruzzaman, 2000). Habitat for threatened biodiversity is also subsequently affected (UNEP-WCMC & IUCN, 2011). Reduced freshwater flow also reduces nutrient supply to the area, reducing available nutrients for plans and the growth of the fish community (Rainbouth, 1991). 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) 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 reduce the outstanding universal values and integrity of the site.

► Housing/ Urban Areas

Low Threat
Outside site

Along with the Forest Act, 1927, the Bangladesh Wildlife (Preservation) (Amendment) Act 1974, controls activities such as entry, movement, fishing, hunting and extraction of forest products within the WH site (SoOUV, 2013). Under the provision of the Act, residence is prohibited. However, fisherman's camps are a source of disturbance where they exist in the Sundarbans Reserve Forest (UNEP-WCMC & IUCN, 2011), adjacent to the World Heritage site. Clearing areas of forest for camp creation is the primary impact on the area from these camps, however they are also a source of solid and waste pollution, and lead to illegal hunting and trapping of forest vertebrates by fishermen as well as woodcutters and naval and military personnel (Blower, 1985). Loss of habitat, pollution and poaching at fishing camps compromises the integrity of the site while also impacting on rare and threatened flora and fauna. With the shrimp farming industry increasing rapidly over the past decades, and with the increasing population pressure in the country (Rahman et al., 2010), construction of fishing camps is likely to continue, all be it primarily in the area outside the WH boundaries, producing a potential threat to the site's values.

► Dams/ Water Management or Use

Very High Threat
Inside site, extent of threat not known
Outside site

Combined with the gradual eastward migration of the Ganges, increased diversion of freshwater sources to the Sundarbans forest has occurred in recent years (i.e. up to 40% of the dry season flow of the Ganges was diverted upstream after the creation of the Farraka Barrage, India in 1974; IUCN, 1997; Sanyal & Bal, 1986). 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), causing reduction in forest cover and mangrove species diversity (Iftekhar & Islam,

2004; Akhtaruzzaman, 2000; Rahman et al., 2010). Habitat conditions for threatened biodiversity, i.e. the Bengal tiger, are also subsequently affected. Reduced freshwater flow also reduces nutrient influx, reducing available nutrients for plant diversity and the growth of the fish community (Rainbouth, 1991). 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). Increased freshwater extraction upstream may significantly increase this threat in the future, producing potentially serious problems. Coupled with the potential impacts of sea level rise under climate change, this threat may significantly reduce the integrity of the site and impact on its Outstanding Universal Values.

► Earthquakes/ Tsunamis

Very High Threat
Inside site, widespread(15-50%)
Outside site

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).
Much of the Forest Department’s infrastructure that was within the path of the cyclone was completely destroyed, severely reducing the ability to manage the site (UNEP-WCMC & IUCN, 2011). A 5-year rehabilitation project

("Re-establishing essential management capacity in the Sundarbans World Heritage property following the passage of cyclone Sidr") was undertaken following the devastation. 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 high.

► Shipping Lanes

High Threat
Inside site, scattered(5-15%)
Outside site

Oil pollution is a serious threat, which is damaging to aquatic fauna and sea birds (Blower, 1985; Hussain & Acharya, 1994), which can occur from the rerouting of large shipping vessels into sensitive portions of the forest (Rahman et al. 2010). These spillages can also damage mangrove ecology (Rahman et al. 2010) and cause instant mortality of mangrove seedlings (Hussain & Acharya, 1994), reducing the extent and quality of habitat available for both terrestrial and aquatic species. As a result of degradation of mangrove ecology, mangrove area, and primary production, sedimentation and deltaic and bank formation are also influenced, compromising the integrity of the on-going ecological processes of the site (UNDP, 2014). Several shipping accidents have occurred in the areas and waterways within the Sundarbans Reserve Forest in rapid succession in recent times. As the Bangladeshi population continues to increase (Rahman et al., 2010) and with predicted increases in shipping traffic from the expansion of the Mongla Port and associated industrial growth, trade and import increases are likely to mean that shipping through the area will increase. Although improvements have been made to contingency responses with the aid of the United Nations Development Programme (UNDP), with no management plans in place to combat this threat, the impacts are likely to increase in intensity in the future.

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 proposed Rampal power plant, as well as the associated increase in shipping traffic and dredging of the Passur River, provide a significant threat to the site's values in the future.
If the IPCC's 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.

▶ Crops

Low Threat
Outside site

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, 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.

▶ Other

Very High Threat
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. 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 Bengal 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). A 45cm rise in sea level has been projected to be likely by the end of the 21st century according to the IPCC (2013). This threat is likely unavoidable at a site level, but better protection of non-affected mangroves, and restoration activities could assist in adaptive management.

► Industrial/ Military Effluents

High Threat
Inside site, extent of threat not known
Outside site

If construction goes ahead, the proposed Rampal coal-fired power plant will be constructed along the banks of the Passur river, 14km north of the Sundarbans Reserve Forest. If not adequately managed, the operation of this plant will require shipping access through the forest for coal transport, and may emit industrial effluent to the Sundarbans water, and significantly increase the likelihood of oil spillages and airbourne pollutants, affecting wildlife populations, and mangrove ecology and productivity, subsequently producing severe impacts to the on-going ecological processes of the site. The associated dredging necessary to keep the channels of the Passur River open for navigation is likely to alter the morphology of the river channels, which, in combination with erosion and sedimentation caused by the wakes

of large vessels, would be likely to affect priority habitat for Ganges River dolphin and Irrawaddy Dolphin, as well as other aquatic species, such as the critically endangered Batagur turtle (Batagur baska) and vulnerable small clawed otter (Aonyx cinerea) (SOC report, 2014; UNESCO/IUCN Reactive Monitoring mission 2016).

► **Water Pollution, Household Sewage/ Urban Waste Water, Industrial/ Military Effluents, Air Pollution**

Very High Threat
Inside site, widespread(15-50%)
Outside site

The high likelihood for: (i) contamination of the property and the surrounding Sundarbans forest from air and water pollution arising from both its location, in a wind risk zone, and its anticipated methods to minimise impacts; (ii) the substantial increase in shipping and dredging required in the immediate vicinity of the property for the plant's construction and operation; (iii) the additional removal of freshwater from an already increasingly saline environment that is starting to alter the functioning of the ecosystem; (iv) an EIA that does not address the effects on the OUV of the property nor provide convincing evidence that effects on the Sundarbans will be mitigated; and (v) the intrinsic connectivity between the property and the Sundarbans forest the Rampal power plant presents a serious threat to the site, its values and integrity.

Protection and management

Assessing Protection and Management

► **Relationships with local people**

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 (SoOUV,

2013). Extractive activities are banned within the WH site, however, the degree to which illegal activities may be occurring is currently not known (UNESCO, 2011). 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 and the threat from illegal activities. Management should seek to develop greater links with local communities to enhance participation in outreach and education programmes, as well as participatory management.

► Legal framework

Some Concern

The site appears to have adequate legal protection in place. The entire Sundarbans Reserve Forest is designated as a Ramsar Site (IUCN & UNEP-WCMC, 2014). 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 (SoOUV, 2013). Law enforcement is carried out by the Forest Department. Individuals breaking the law are apprehended, prosecuted and either fined or jailed (SoOUV, 2013). However, it is currently not known the degree to which illegal activities may be occurring within the site (UNESCO, 2011), or in the surrounding Sundarban Reserve Forest, and monitoring capacity and resources are not currently sufficient for fully effective monitoring of illegal activity. Furthermore, despite a ban on mosquito net fishing for shrimp fry and the use of gillnets, illegal use of this equipment within the area has been recorded although primarily only in the waterways within the Sundarbans Reserve Forest. Increased monitoring capacity and resources are required if fully effective law enforcement is to take place.

► 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 as well as their prey species has been identified by NGOs and project staff working in the area as a high priority threat to the tiger population in the Sundarbans, ranking it as widespread in its scope, affecting tigers across all or most of the Sundarbans population. 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.

► Integration into regional and national planning systems

Some Concern

An integrated Management Plan for the Sundarban mangrove forest was developed in 1998-99, valid up to 2010, and a subsequent management plan for the Sundarbans Reserve Forest is in place and valid up to 2020. Both of 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).

► Management system

Some Concern

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.
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). A Bangladesh Tiger Action Plan 2009 exists (PR Questionnaire, 2014) as well as a Pilot National Program for Tiger conservation in Bangladesh (BFD, 2013). However, the management system is currently only partially being implemented (PR Questionnaire) and there is currently no integrated management system in place that comprehensively addresses all threats to the property.

► Management effectiveness

Some Concern

No formal management effectiveness assessment has been conducted for the site. However, the current management system is under resourced and lacks the capacity to address the threats to the site and maintain the property’s Outstanding Universal Value.

► Implementation of Committee decisions and recommendations

Some Concern

Committee decisions so far have included 32 COM 7B.10, 33 COM 7B.12, 35 COM 7B.11, 38 COM 7B.64, and 39 COM 7B.8. In a number of these decisions the WH Committee has commended the state party for responding to the decisions with appropriate action (UNESCO, 2009; 2011), however, in more recent decisions there has been concern that information requested has not been provided and actions, specifically regarding the Rampal Power Plant have not been taken (Monitoring Mission, 2016). The 2016 Monitoring Mission to the site concluded that the majority of concerns raised in Decision 39 COM 7B.8 were yet to be adequately addressed and that minimal progress had been made to deal with the threats outlined in the Decision.

► Boundaries

Some Concern

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.

► Sustainable finance

Some Concern

The majority of finance for management of the Sundarbans is provided by the central government (98%; PR Questionnaire 2014). Other previous funding has come from the WH International Assistance fund and UNESCO Sector for External Relations for post-Sidr recovery and restoration of management capacity (UNESCO, 2009), and from USAID for monitoring unsustainable exploitation (UNESCO, 2009). 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; PR Questionnaire, 2014). 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 is thus inadequate for basic current and future management needs, and presents a serious constraint to the capacity to manage the site.

► Staff training and development

Some Concern

Staff capacity is currently not sufficient to manage the site appropriately, and adequately trained and motivated staff are currently limited. There currently exists some staff training and development opportunity for Forest

Department staff. However, the situation could be improved in most areas with much of this training supported through specific, short term project funding. There is very little availability of training opportunities for many very important areas: research and monitoring, promotion, and community outreach, interpretation and education.

► 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). 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. It is currently not known the degree to which illegal extractive activities may be occurring within the site (UNESCO, 2011), and monitoring capacity and resources are not currently sufficient for fully effective monitoring of illegal activity (Ahmad et al., 2009). 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.

► Education and interpretation programs

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 (SoOUV, 2013). However, the trend in annual visitation is increasing. There is no integrated tourism management plan for the site and the tourism industry does not currently work with the WH site managers, and while a fee is collected it remains minimal and does not contribute to the management of the site (PR Questionnaire, 2014). At present, tourism thus does not contribute to education and awareness of maintaining the values of the WH property, potentially compromising the Outstanding Universal Values of the site, particularly should the trend in visitor numbers continue to increase in the future.

► Monitoring

Serious 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). In addition, the BTAP and PNP has established plans to increase monitoring activities of threats to the tiger population and its habitat and food (Ahmad et al., 2009; BFD 2013), which, if appropriately implemented, may improve understanding of the status and trends in the Outstanding Universal Values of the site. However, there is still a lack of ecological monitoring in the site.

► 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 (Biswas et al., 2007; Rahman et al., 2009; 2010; Cornforth et al., 2013). However, large 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). Furthermore, 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 in order to further understanding of the impacts of specific threats to the system and to inform ecosystem management.

Overall assessment of protection and management

Some Concern

The current protection and management system shows major deficiencies and 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 currently 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 to research into climate change adaptation is available for the area, funds required to successfully manage the site to mitigate these threats, and specifically sea level rise, into the future are furthermore likely to be extensive in the long-term. 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 transboundary management with the Sundarbans National Park World Heritage Site in India needs to be deliberated in order to adequately address these issues, particularly in the face of climate change.

► **Assessment of the effectiveness of protection and management in addressing threats outside the site**

Some 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 huge 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. However, the Forest Department's "Sundarbans Environmental and Livelihoods Security" (SEALS) project, completed in 2014 (IUCN Consultation, 2014), provides ecological monitoring of the impacts of climate change. The Forest Department has also proposed a project to restore coastal greenbelt mangroves – "Rehabilitation of Sidr's Damage and Climate Change Resilient Afforestation" (UNESCO, 2009; 2011). The Forest Department and WH Committee further urged for improved work to understand, mitigate and adapt to the impacts of black carbon on the Sundarbans (UNESCO, 2011). However, many other 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.

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 (i.e. up to 40% of the dry season flow of the Ganges was diverted upstream after the creation of the Farraka Barrage in 1974; IUCN, 1997; UNEP-WCMC & IUCN, 2011). 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 Bengal tiger. Sea level rise under 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.

► 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.

► 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). 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), water buffalo (EN), swamp deer (VU), gaur (VU), hog deer (EN) and sambar (VU; IUCN, 2013). Several other mammal species found within the Sundarbans are currently considered to be threatened with extinction nationally: Bengal tiger (EN), oriental small-clawed otter (EN), smooth-coated otter (EN), Irrawaddy dolphin (CR), melon-headed dolphin (CR), finless porpoise (EN), Ganges river dolphin, and barking deer Muntiacus muntjak (EN; Ministry of Environment and Forests, 2010; IUCN, 2016). Populations of 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). Currently little empirical data on population trends exists for the rare and threatened mammals of the Sundarbans, though a novel monitoring

methodology is being implemented to survey trends in the relative abundance of tigers in the area into the future (Barlow et al., 2008). However, foresters throughout the Bangladeshi Sundarbans have reported declines of tigers and deer are currently declining (Rahman & Asaduzzaman, 2010).

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

Low Concern
Trend:Stable

The Sundarbans has a varied and colourful bird life, and supports a high level of avian diversity for a mangrove ecosystem (Khan, 2005). The area provides habitat for several globally threatened species (see Worksheet 1). A study of the birdlife of the Sundarbans East Wildlife Sanctuary found that bird diversity is high, with nine species recorded for the first time in the Bangladeshi Sundarbans (Blue breasted quail Coturnix chinensis (LC), Spot-billed duck Anas poecilorhyncha (LC), Dollarbird Eurystomus orientalis (LC), Indian pitta Pitta brachyura (LC), Black-naped oriole Oriolus chinensis (LC), Lesser racket-tailed drongo Dicrurus remifer (LC), Scaly thrush Zoothera dauma (LC), Yellow-eyed babbler Chrysomma sinense (LC), and ruby-cheeked sunbird Anthreptes singalensis (LC); Khan, 2005). The study determined that the birds of the Sundarbans East Wildlife Sanctuary were not under severe pressure at the time of the study (Khan, 2005). Several bird species within the Sundarbans are threatened with extinction nationally: Blyth’s kingfisher Alcedo hercules (EN), Ruddy kingfisher Halcyon eoromanda

(VU), Masked finfoot Heliopaid personata (EN), Greater adjutant Leptoptilos dubious (CR), lesser adjutant Leptoptilos javanicus (EN), Dollarbird (CR), Brown fish owl Ketupa zeylonensis (VU), White-bellied sea eagle (EN) and Malayan night heron Gorsachius melanolophus (CR; Khan, 2005; Ministry of Environment and Forests, 2010). 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).

Despite the apparent favorable situation for the avifauna of the Sundarbans (Khan, 2005), threats to its bird life (e.g. habitat loss and degradation, top-dying of Sundri trees, clearing for conversion for aquaculture, and pollution) are severe and potentially increasing. It is likely that declines in some avian species and general abundance have occurred in the area and will increase in the future with increasing intensity of these threats, as well as climate change, if appropriate management action is not taken.

► 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 the critically endangered gharial (Gavilalis gangeticus). 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). While it is thought that this trade has reduced in recent years there seems to be little sign of population recovery (Rahman & Asaduzzaman, 2010).

Many reptiles present within the Sundarbans are currently threatened with extinction nationally: estuarine crocodile (CR), Northern river terrapin (CR), rock 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 CARINAM, 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).

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. 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).

▶ 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).

Summary of the Values

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

High Concern
Trend: Deteriorating

The Sundarbans World Heritage Site is part of the Sundarbans Reserve Forest (Bangladesh) and is connected to the forest component within India. While the wider forest area remains the largest continuous mangrove forest in the world, it is now almost half the size of the area that existed in the late 1800s as a result of very high human pressure in settlements at its boundaries. 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 through 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 increasing population pressure and climatic changes. Populations of some of the site’s rare and threatened mammals are considered relatively large. 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.
Recent 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. These current threats are likely to continue to increase in intensity in the future and combined with the nature of potential threats identified, including the proposed construction of power plants and increased shipping traffic, the need for greater and more sustainable management actions and capacity is urgent. While the status of the site's biodiversity appears to be largely stable, an increase in the intensity of current threats (i.e. under climate change or increased extractive pressures), combined with the threats posed by potential threats and / or discontinuation of efficient management actions may greatly change the current state of affairs.

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).

► 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.

► 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.

► 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.

► 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.

► 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.

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/ individuals	Project duration	Brief description of Active Projects

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.
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.
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.

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