IUCN RED LIST

of

ECOSYSTEMS ASSESSMENTS

www.iucnrle.org

Sandy Beaches & Dunes of the West African Transition

VU

Kwasi Appeaning Addo[1,2]*, Philip-Neri Jayson-Quashigah[1], Selasi Y. Avornyo[2], Michael Kwame-Biney[2], Winnie N. A. Sowah[2], Lord Offei-Darko[1], and Obed O. Okyere[1], Sean G. McGregor[3]

[1] Institute for Environment and Sanitation Studies, University of Ghana, G4489, Ghana
[2] Department of Marine and Fisheries Sciences, University of Ghana, G4490, Ghana
[3] International Union for Conservation of Nature IUCN HQ, Gland 1196, Switzerland

Abstract

The 'Sandy Beaches and Dunes of the West African Transition' form a regional ecosystem subgroup along the West African coast. It had a mapped extent of 584 km² in 2022, with a width ranging from 0.012 km to 4.796 km, and stretching over approximately 1321 km. This ecosystem subgroup extends along the shores of Mauritania, The Gambia and Senegal.

This ecosystem frequently experiences coastal hazards at varying scales, sometimes beyond its resilience threshold. Prominent among the hazards are erosion (-0.1 m/yr to -20.62m/yr) and submergence with regional sea-level rise (SLR) rates of ≈4 mm/yr. Anthropogenic factors such as coastal infrastructure development & urbanisation, sand mining, upstream river management and subsequent coastal land subsidence are also resulting in deterioration of the ecosystem.

In 2022, the sandy beach and dune ecosystem covers approximately 22% less than in 1986. The ecosystem area will decrease a further 32 % by 2072, should the current trend continue. Using a precautionary approach, the adoption of a very high SLR scenario (IPCC SSP5-8.5) indicated that about 15% of the ecosystem would be submerged by 2072. However, the inherent uncertainties in the landward delineation of the ecosystem, dune extents especially, and the Multi-Error Removed Improved Terrain Digital Elevation Model (MERIT DEM), may have resulted in the underestimation of the spatial distribution and the projected inundated extents respectively.

Overall, the status of the sandy beach and dune ecosystem of the West African Transition is **Vulnerable (VU)**.

Citation:

Appeaning Addo, K., Jayson-Quashigah, P-N., Avornyo, S. Y., Kwame-Biney, M., Sowah, W. N. A., Offei-Darko, L., Okyere, O. O. & McGregor S. G. (2023). '*IUCN Red List of Ecosystems, Sandy Beaches & Dunes of the West African Transition (Unit 1)*'. *EcoEvoRxiv.*

Corresponding author:

Email: kappeaningaddo@ug.edu.gh

Keywords:

Sand beaches; Coastal dunes; IUCN Red List of ecosystems; Ecosystem threats; Ecosystem collapse

Ecosystem classification:
MT1.3 Sandy Shorelines.

Assessment's distribution:
The West African Coast.

Summary of the assessment:

Criterion	A	B	C	D	E	Overall
Subcriterion 1	LC	LC	DD	NE		
Subcriterion 2	VU	LC	LC	NE	NE	VU
Subcriterion 3	DD	LC	DD	NE		

CR: Critically Endangered, EN: Endangered, VU: Vulnerable, NT: Near Threatened, LC: Least Concern, DD Data Deficient, NE: Not Evaluated

Sand Beaches & Dunes of the West African Transition

VU

1. Ecosystem Classification

IUCN Global Ecosystem Typology (version 2.1, Keith *et al.* 2022):

MT Transitional Marine-Terrestrial Realm

MT1 Shorelines Biome

MT1.3 Sandy Shorelines

IUCN Habitats Classification Scheme (version 3.1, IUCN 2012):

12. Marine Intertidal

12.2 Sandy Shoreline and/or Beaches, Sand bars, Spits etc.

13. Marine Coastal/Supratidal

13.3 Coastal Sand Dunes

A satellite image of the shoals, seagrass beds, and mudflats of Mauritania's Banc d'Arguin National Park blended with sand, dunes and sea (credit: NASA Earth Observatory)

Dunes, sandy beach and the Atlantic Ocean. Nouakchott, Mauritania (credit: Giovanni Miceli)

2. Ecosystem Description

Spatial distribution

The sandy beaches and coastal dunes in the West Africa Transition province include the shoreline ecoregions of the Gulf of Guinea West and the Sahelian Upwelling, that extends across Mauritania, Senegal, and The Gambia (figure 1). The estimated extent of the sandy beaches and coastal dunes in this province is 584 km² in 2022. The West African Transition province exhibits a spectrum of coastal features, ranging from high-energy beaches in Mauritania to mangrove ecosystems near the mouth of the Senegal River (Alves et al., 2020), that interrupt the continuity of the sandy beach and dune ecosystem along the coast at varying scales. The prevailing climate is intricately linked to the formation of sandy beaches and dunes, and the northern-most areas of coastal Mauritania and Senegal experience arid and relatively low humidity conditions which result in less vegetated but wider sandy beach and dune ecosystems compared to other regions of the West African coastline.

Sandy beach and dune ecosystems are usually characterised by a sandy profile from the point where wave action reaches the sediment bed, through a wave-dominated subaqueous zone and a wind and wave-dominated beach, up to the dune belt where aeolian processes dominate (Ijff, n.d). Figure 1 shows the profile of a coupled beach dune ecosystem.

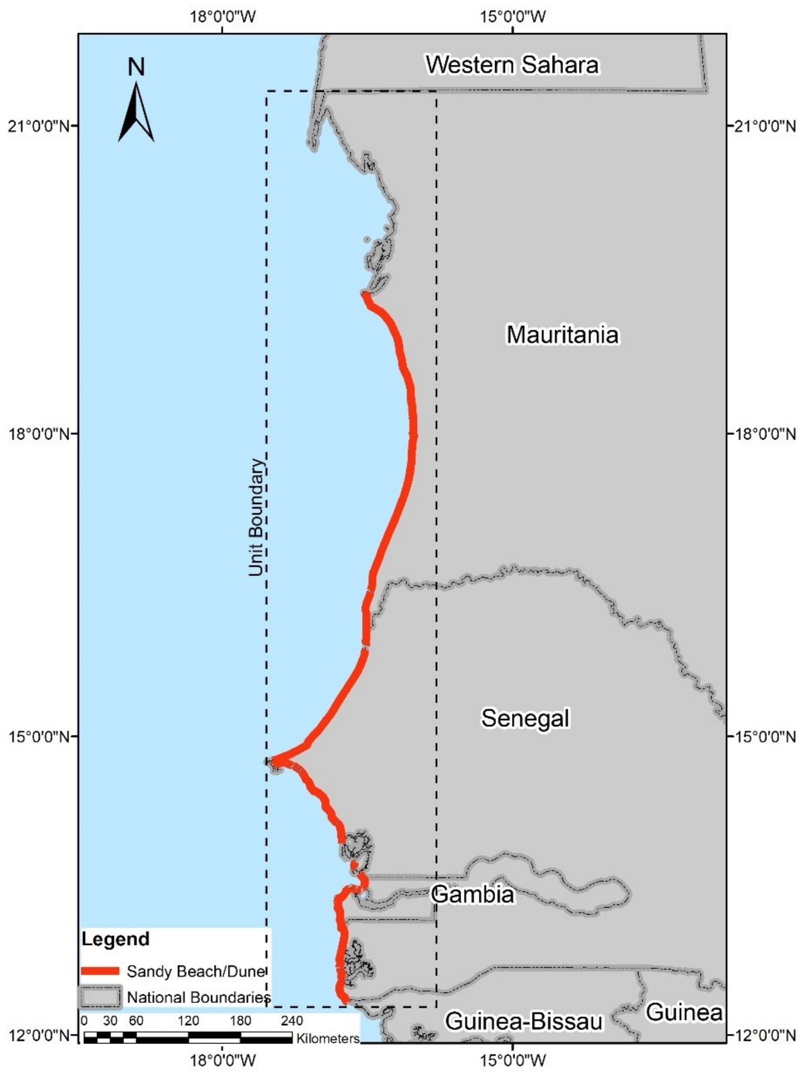


Figure 1: The spatial distribution of sandy beach and dune ecosystems from Mauritania to Senegal, along the West African Transition province coastline

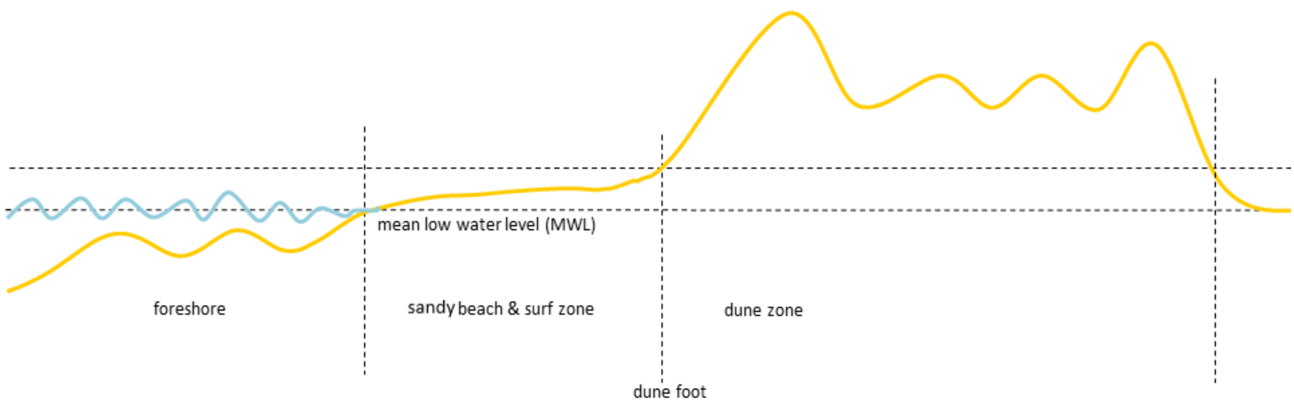


Figure 2: Profile of a sandy coast and dune system (modified from Stéphanie IJff, n.d.).

Biotic components of the ecosystem (characteristic native biota)

The fauna and flora of the sandy beach and dune ecosystems of West Africa are uniquely adapted to the challenging conditions of these dynamic coastal environments (Almar et al., 2023; Alves et al., 2020). These ecosystems host a diverse array of species that contribute to the overall stability and functionality of these coastal habitats (Töpfer et al., 2000). There are at least 66 animal and plant species in the taxa Actinopterygii, Aves, Reptilia, Liliopsida, and Magnoliopsida that have been associated with sandy beaches and dune habitats in the IUCN Red List of Threatened Species database (IUCN, 2022). These include two species that are critically endangered, one endangered species, and three that are vulnerable. Among the plant species, many exhibit adaptations to the sandy, saline conditions of coastal dunes, such as the beach morning glory (*Ipomoea pes-caprae*) and Chicken claws (*Sarcocornia perennis*).

Avian Species such as the Eurasian curlew (*Numenius arquata*) flock to these areas, making coastal dunes and beaches vital nesting and foraging grounds (Varriano et al., 2020). A variety of the shorebirds include the sanderling (*Calidris alba*), and spur-winged lapwing (*Vanellus spinosus*), as well as migratory species such as red knot (*Calidris canutus*) and the osprey (*Pandion haliaetus*) (Ishong et al., 2022). Snake eels (*Bascanichthys ceciliae*) inhabit the sandy shores, providing a critical food source for shorebirds and fish. Sea turtles, such as the loggerhead turtle (*Caretta caretta*), green turtle (*Chelonia mydas*), leatherback turtle (*Dermochelys coriacea*), and olive ridley turtle (*Lepidochelys olivacea*) use these coastal habitats for nesting (IUCN, 2022).

The sandy beach and dune ecosystems of the West African Transition are also home to diverse insects and invertebrates such as slender digging grasshopper (*Acrotylus patruelis*), Crabs such as the African ghost crab (*Ocypode africana*) and fiddler crab (*Uca leach*), and various burrowing species of snails including the Senegal nerite (*Nerita senegalensis*). Microorganisms, including fungi such as *Acaulospora cavernata*, are present in the sand and water, playing vital roles in nutrient cycling and decomposition, contributing to the overall health of these coastal ecosystems (Nixon, 1981). These diverse biotas make the sandy beach and dune ecosystems unique and ecologically significant (Happold & Michael Lock, 2013). Their adaptations to the challenging conditions of this coastal environment enable them to thrive and contribute to the intricate web of life along the shoreline.

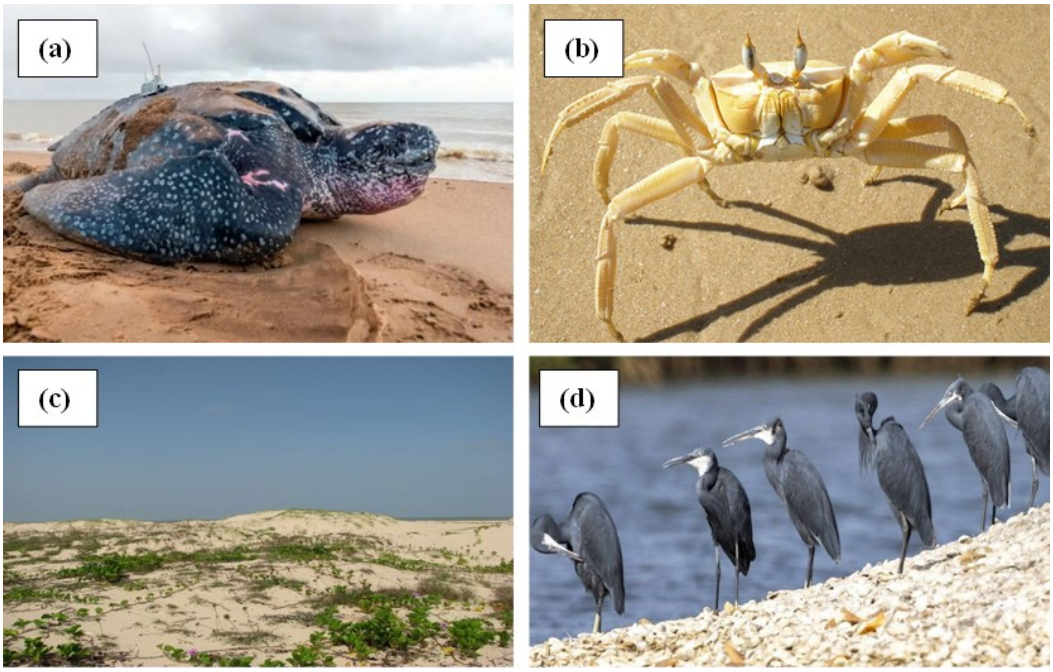


Figure 3: Fauna and flora on the sandy beaches and dunes of the West African Transition: (a) Leatherback sea turtle, *Dermochelys coriacea* (photo credit: Philippe Siuberski, Mauritania); (b) African ghost crab, *Ocypode africana* (photo credit: Jeroen Verhoeff, Gambia); (c) Beach morning glory, *Ipomoea pes-caprae* (photo credit: Sara Giles, Senegal); Western reef heron, *Egretta gularis* (photo credit: HP Eckstein, Senegal).

Abiotic Components of the Ecosystem

The abiotic components of the sandy beach and dune ecosystem result from the interplay between land and sea and are integral to shaping the physical and ecological dynamics of these coastal environments (Ciccarelli & Bona, 2022). This ecosystem exhibits distinct abiotic gradients of moisture content, salinity, temperature and wind exposure, from the seaward edge to the inland dunes, and the interactions between these abiotic elements and the inhabiting biota play a critical role in defining the unique characteristics of these areas (Jackson *et al.*, 2019a).

In a sandy beach or dune ecosystem, the sandy substrate serves as the foundation on which the entire ecosystem thrives (Brown & McLachlan, 2002). This loose granular sand directly influences the system's dynamics, including sediment stabilisation, nutrient retention, and habitat formation. The particle size, composition, and distribution of sand determine the substrate's permeability, influencing water infiltration and nutrient availability. Generally, sandy substrates are nutrient-poor. The availability of nutrients varies depending on factors like groundwater input and the deposition of organic matter by tides. This nutrient limitation also shapes the composition of plant and animal communities within the ecosystem, leading to the evolution of adaptations that allow species to thrive in nutrient-poor conditions.

The prevailing climate and weather conditions, including wind patterns, precipitation, and temperature regimes, are overarching abiotic factors. Changes in climate, such as sea-level rise, storm surge frequency, and alterations in ocean currents, can have profound and long-lasting impacts (Jackson et al., 2019b). In the case of dunes, the prevailing wind pattern plays a fundamental role in transporting sand which is critical for dune evolution and morphology.

Furthermore, the dynamic forces of wave action and tides continuously shape the physical structure of these coastal environments (Ritchie et al., 2005; Bird et al., 2013). Waves transport and redistribute sand, impacting the overall topography. They determine sediment transport, erosion, and the creation of characteristic beach or dune features (Bird, 2011). Tides inundate and expose distinct intertidal zones, namely the supralittoral, midlittoral, and sublittoral zones, creating dynamic environmental conditions, including variations in temperature, salinity, and wave exposure, supporting varied zone-specific assemblages of species that have adapted to different levels of moisture and salinity.

Key processes and interactions

A key process of sandy beaches and dunes is the cyclic, and extensive transport of sand. Through the action of wind, sand from dunes is blown onto the beach and transported by the actions of waves, tides and currents within the nearshore and offshore. These same tides and currents ultimately transport sand back to the beach system, which in turn repopulates the dunes. This cyclic regime ensures that sediment accumulation is maintained and balanced between beaches and dunes and is modified by the ecosystem topography, the prevailing wind direction and energy, and granulometry of the sand, since the grain size determines whether the sand will be retained in the system or transported.

A deficit in the sediment balance is an indication of an eroding system that results in reduced distribution, while a surplus sediment balance is an indication of an accreting system that indicates increased distribution. Accumulated sand forms essential habitats for species that are further shaped by interactions between the abiotic, and biotic environment. For example, the influx of nutrients like nitrogen and phosphorus from rainfall influences the distribution of pioneer plant species. In turn, groundwater deposits facilitate further plant growth, which in turn stabilises beaches with their root structures, binding sand and creating structures that act as protective barriers against erosion. Plants also trap windblown sand to build dune sand volume and enhance its stability, as well as break the impact of raindrops or wave splash to slow down the speed of water flow that could result in erosion. In addition to the accumulation of sand, plants also trap organic matter which develops the soil and affects plant succession. This build-up of organic matter is further increased by the arrival of fauna, such as sea turtles, which transfer nutrients from the ocean to the ecosystem, in the form of waste products while nesting on beaches.

Sandy beaches and dunes are also a major blue carbon sink providing carbon sequestration due to their high soil carbon accumulation rate and thus play a role in regulating greenhouse gas emissions as well as local and global carbon budget (Drius et al., 2016; Everrard et al., 2010). The ecosystem has the capacity to sequester carbon at a rapid rate and this may occur to a considerable depth or lateral extent (Chmura et al., 2003; Beaumont et al., 2014). Figure 4 is a schematic representation of the key interactions and processes in the dune and beach ecosystems.

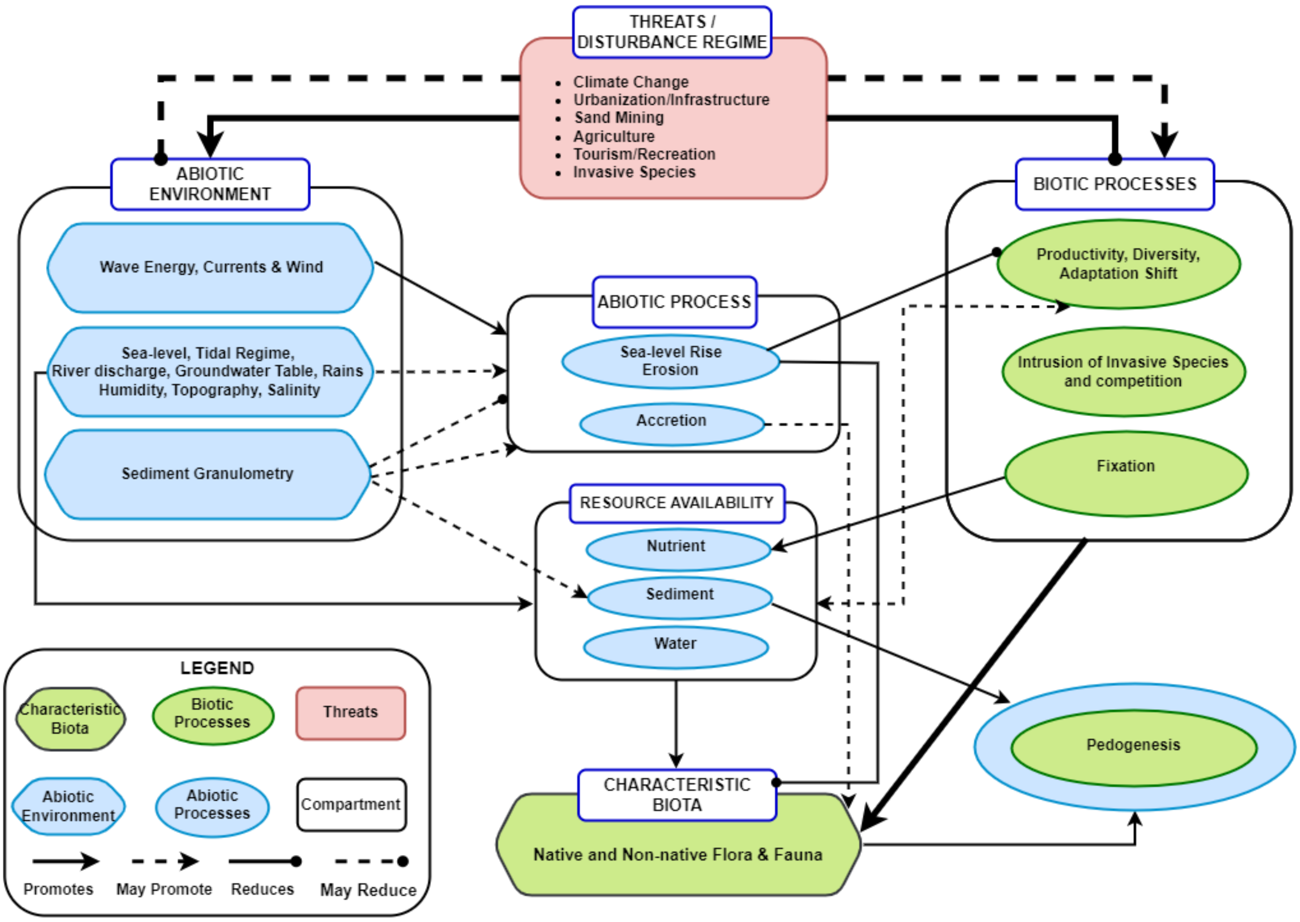


Figure 4: Key processes and interactions in the sandy beach and dune ecosystems

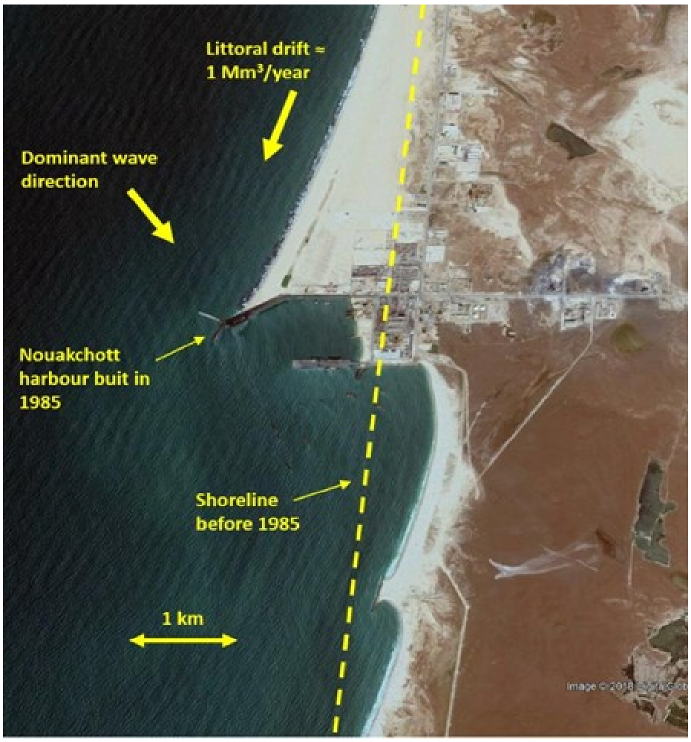
3. Ecosystem Threats and vulnerabilities

Main threatening process and pathways to degradation

Overall, the most severe threat to sandy beaches and dune ecosystems in the West African Transition province is sea-level rise, driven by global climate trends (Alves et al., 2020). Sea-level rise accelerates dune and beach erosion and flooding in low-lying areas, which leads to the loss of essential habitats and breeding grounds of various species (Appeaning Addo et al., 2011). The impact is significant as it directly affects the ecosystems' physical structure and the organisms that rely on them. Changes in ocean currents, waves, storm surges and subsidence affect these ecosystems as well. These changes lead to shifts in beach profiles and topography, increased erosion, and alterations in the distribution of beach organisms.

Coastal development, urbanisation, and habitat degradation is another significant concern (Steve et al., 2020). Increased coastal population and urbanisation have resulted in the encroachment of the dune and beach ecosystems for development, which has impacted the functions of the ecosystems (Appeaning Addo et al., 2008). Coastal development and urbanisation encroach on these ecosystems, leading to habitat loss, fragmentation, increased pollution levels, and habitat degradation. A ripple effect of coastal development and urbanisation is land subsidence due to loading and overdependence on groundwater. Subsidence lowers the elevation of dune and beach ecosystems, making them more susceptible to sea-level rise and saltwater intrusion. Unlike climate change and its cascading impacts, little is known, however, about the full spatial variability of subsidence, its processes, drivers and rates, especially within an African context, despite its vast impact on regional landscapes and livelihoods (Avornyo et al., 2023) and this threat has been highlighted as a significant concern in a number of localised areas (Avornyo et al., 2024; Johnston et al., 2021; Restrepo-Ángel et al., 2021).

Coastal developments also act as barriers that alter wind patterns and intensities which has significant implications for dune formation or maintenance. Moreover, developments such as hydroelectric dams (Syvitski and Kettner, 2011), which significantly degrade sandy beach and dune ecosystems (Nyarko et al., 2016; Alves et al., 2022), and coastal infrastructures such as breakwaters and jetties also alter hydrodynamic regimes, cause sediment imbalance and exacerbate erosion, especially at the lee or downdrift sides of artificialised coasts. Revetments, constructed along beaches to manage coastal erosion affect the morphology of the beach ecosystem and threaten sediment dynamics. Pollution and contaminants arising from development projects exacerbate the risks to this ecosystem (Zavantias, 2023), with contamination of beaches and dunes through water pollution, and oil spills (Almar et al., 2023). Concurrent with development, increased tourism and recreational activities, particularly during peak tourist seasons, directly harm the ecosystems and increase their vulnerability (Charuka et al., 2023; Park & You, 2023).



The seaport of Nouakchott (Mauritania) built in 1985 (Photo credit: Google Earth image & Job Dronkers). The port blocks the strong N-S littoral drift along the Mauritanian coast due to its orientation perpendicular to the dominant wave direction. The result is massive accretion at the updrift side and equivalent massive erosion at the downdrift side of the harbour.

Sand mining threatens sandy beaches and dunes along the entire range of the West African coastline (Appeaning Addo et al., 2018; Dada et al., 2021, Muñoz-Torrent et al., 2022). Large and small-scale mining of beach and dune sand for construction purposes has escalated the rate of erosion and sediment loss from the beach and dune systems (Appeaning Addo & Appeaning Addo, 2016). In The Gambia, beach sand mining has been identified as a major contributor to increased coastal erosion as well as affecting rice and vegetable farmlands in Saniang and Gunjur (Bojang et al., 2023). The excessive sand extraction from beaches and dunes for the construction industry at Dakar in Senegal has changed the balance between erosion and deposition and led to the gradual lowering of the land and the eventual massive scale of coastal erosion (Sane and Yamagishi, 2004).

Lastly, Invasive species directly affect the balance within these ecosystems by altering species composition and potentially displacing native species. This disturbance is evident through shifts in species interactions and community dynamics. One notable invasive species is Sargassum, which has been steadily beaching in large volumes in recent times along the West African coast (Marsh et al., 2023). Although it helps stabilise sandy shorelines and serves as a source of organic matter for beach ecosystems, excessive accumulations are highly detrimental. Massive amounts of decaying Sargassum on beaches and dunes release toxic gases such as ammonia, methane and hydrogen sulphide (Resiere et al., 2021) which are harmful to fauna and flora. Sargassum strandings may also result in the contamination of aquifers via leaching of arsenic, heavy metals and other compounds (Rodríguez-Martínez, 2020).

Definition of the collapsed state of the ecosystem

Dunes and sandy beaches are highly dynamic ecosystems that are always changing under the influence of both natural and human-induced stressors (Schlacher et al., 2008; Appeaning Addo et al., 2008). These processes can result in ecosystem collapse, which is a change from a baseline state to a point where the ecosystem has lost key defining features and functions. This is characterised by declining spatial extent, increased environmental degradation, decreases in, or loss of, key species, disruption of biotic processes, and ultimately loss of ecosystem services and functions (Keith et al., 2013; Bergstrom et al., 2021). In this context, sandy beach and dune ecosystem collapse is said to occur when its sand cover or spatial coverage declines to zero (100% loss). In some cases, however, the loss of spatial coverage is cyclical or seasonal due to alternating phases of erosion and accretion and may not necessarily mean a collapse of the ecosystem. This phase-alternating process can also occur over a longer period, resulting in a gradual loss of spatial coverage rather than a sudden collapse. In this case, the ecosystem is said to be in the process of collapsing.

Areas that persistently experience erosion, owing to their topography, bathymetry, relatively huge wave energy, shoreline orientation, strong currents (Appeaning Addo et al., 2008; Ankrah et al., 2023), and wind regime in the case of dunes, have a higher likelihood of ecosystem collapse. This likelihood of ecosystem collapse is further exacerbated by human-induced sediment imbalance and wind regime alteration. The existence of coastal infrastructure also prevents the landward migration of the ecosystems, potentially resulting in their collapse (Doody, 2013).

Furthermore, climate-change-induced sea-level rise is also likely to lead to ecosystem collapse. As no sandy beach or dune restoration can occur in a submerged system, a sandy beach or dune ecosystem collapse is said to occur when the system is submerged underwater. In this province, the region's sandy beach and dune ecosystems face local SLR rates at ≈4 mm/yr (Fox-Kemper et al., 2021; Garner et al., 2021) and erosion events with rates ranging from -0.1 m/yr to -20.62 m/yr (1986 to 2022), based on estimations in this study. These impacts, especially in low-lying coastal areas, are reducing the spatial distribution of sandy beaches or dunes in the province and threaten complete ecosystem collapse in some areas.

Threat Classification

Following the IUCN Threat classification (version 3.3) relevant to the West African Transition, the following threats apply to the sandy beach and dune ecosystems sustainability.

- 1 Residential & Commercial Development
    - Housing & Urban Areas
    - Villages, vacation homes, schools, land reclamation, urban areas.
    - Commercial & Industrial Areas
    - Shipyards, factories, power plants.
    - Tourism & Recreation Areas
    - Resorts, coastal and estuarine tourist resorts.

- Agriculture & Aquaculture
    - 2.1. Annual & Perennial Non-Timber Crops
      Shifting Agriculture (Vegetables)
      Small-holder Farming (Vegetables, Coconut etc.)

- Energy Production & Monitoring
    - 2.3 Mining & Quarrying
      Sand or salt mines

- Transportation & Service Corridors
    - 4.2 Utility & Service Lines
      Oil & gas pipelines, fiber optic cables.

- Human Intrusions & Disturbance
    - 6.1 Recreational Activities
      Off-road vehicles, motorcycles, ATV/Quad bikes.
    - 6.3 Work & other activities
      Biophysical research

- Natural System Modifications
    - 7.2 Dams & Water Management/Use
      Dam construction, groundwater pumping, channelisation, levees and dikes etc.
    - 7.3 Other Ecosystem Modifications
      Land reclamation, beach construction, riprap along shoreline

- Invasive & Other Problematic Species, Genes & Diseases
    - 8.1 Invasive Non-Native/Alien Species/Diseases
        - 8.1.1 Named Species (Sargassum)
- Pollution
    - 9.1 Domestic & Urban Wastewater
        - 9.1.1 Sewage
          Point and nonpoint sources (untreated sewage, outhouses, discharge from municipal waste treatment plants, open defecation)

        - 9.1.2 Run-off
          Nonpoint sources (fertilisers and pesticides)
    - 9.2 Industrial & Military Effluents
        - 9.2.1 Oil Spills
          Point-sources (oil spills from pipelines) and non-point-sources (oil spills from offshore operational wells).
        - 9.2.2 Seepage from Mining
          Nonpoint sources (arsenic from inland mining)
    - 9.3 Agricultural & forestry effluents
        - 9.3.1 Nutrient loads
        - 9.3.2 Soil erosion, sedimentation
        - 9.3.3 Herbicides & pesticides
    - 9.4 Garbage & solid waste
    - 9.5 Air-borne pollutants
        - 9.5.1 Acid rain
          Nonpoint source (NOx and SOx from coastal oil and gas refineries)

- Geological events
    - 10.2 Earthquakes/tsunamis

- Climate change & severe weather
    - 11.1 Habitat shifting & alteration.
        - Sea-level rise
    - 11.4 Storms & flooding
        - Erosion of beaches during storms and flooding

4. Ecosystem Assessment

Criterion A: Reduction in Geographic Distribution

Criterion A was assessed based on available spatial datasets that were used to estimate the area changes in the sandy beach and dune ecosystem of the West African Transition. The earliest regionally complete spatial datasets available were 1986 Landsat 4 & 5 images obtained from the United States Geological Survey (USGS) repository and the latest used was the 2022 Planet Image dataset. In estimating the area or width of the sandy beach and dune ecosystem for any given year, both the landward and seaward limits had to be delineated. The dry-wet boundary which approximates the high-water line (HWL), which has been widely used (Jayson-Quashigah et al., 2013; Appeaning Addo, 2015), was adopted as a proxy to establish the shoreline position. Semi-automatic extraction using bandmath was employed to extract the shorelines from the Landsat images whilst manual digitisation was carried out for the Planet data due to the higher resolution. Based on expert knowledge, the landward extents were delineated using the transitional boundary between the sand or dune ecosystem and terrestrial extents, especially along developed or artificialised beaches or dunes.

Sub-criterion A1 measures the trend in sandy beach or dune ecosystem extent during the last 50-year time period (1972 to 2022). Although the ecosystem's area analysis between 1986 and 2022 estimated an area decline of -21.98 % (Table 1), the time frame analysed (between 1986 and 2022) did not meet the 50-year period condition for assessing Criterion A1. Given the lack of historical data prior to 1986, a linear change was assumed to hindcast the analysis to 1972, to cover the 50-year period. Using all area estimations from 1986 to 2022, the analysis estimated an area decline of about 28 % between 1972 to 2022. The sandy beach or dune ecosystem of the West African Transition was, therefore, assessed as **Least Concern (LC).**

Table 1: Attributes of sandy beach or dune area changes between 1986 and 2022.

The West African Transition	1986 Area (km^2)	2022 Area (km^2)	Net Area Change (km^2)	Net Area Change (%)	Change Rate (%/yr)
	748.30	583.85	164.44	-21.98	-4.57

Sub-criterion A2 assesses the change in ecosystem extent in any 50-year period, including from the present to the future. The years considered for this sub-criterion are 1998, 2013, 2022, 2048 and 2072. The sandy beach or dune ecosystem indicated a net area gain of +0.35 % between 1998 and 2013, which changed to a net area loss of -17.82 % between 2013 and 2022, the largest decline in the ecosystem area. Applying a linear regression to the area estimations between 1998 and 2022, a change rate estimated was -0.64 %/year (Figure 5). A forecast of the linear trend predicts that the area estimates for the sandy beach and dune ecosystem of the West African Transition would decrease by -31.81 % from 1998 to 2048; by -47.08% from 1998 to 2072; and by -31.81 % from 2022 to 2072. Given that all projected changes in the sandy beach and dune ecosystem were higher than the 30% risk threshold but lower than the 50 % risk threshold, the sandy beach and dune ecosystem of the West African Transition was assessed as **Vulnerable (VU)** under sub-criteria A2. The country-based assessment is summarised in Appendix 3A.

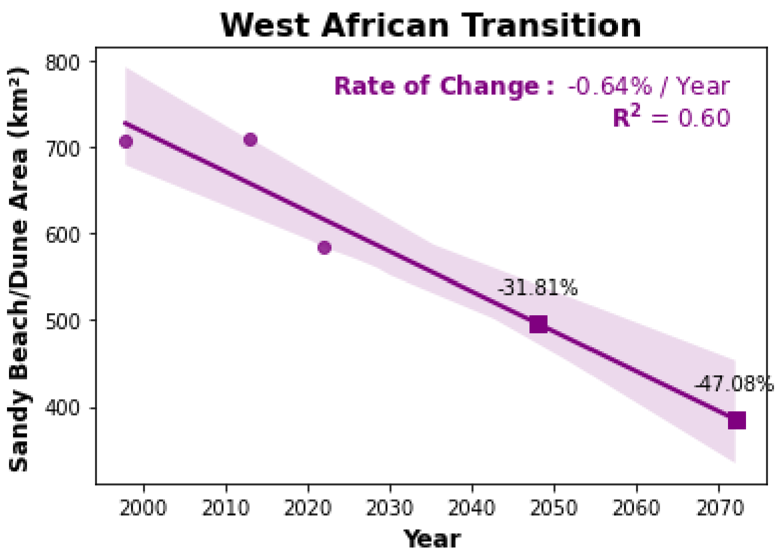


Figure 5: A linear projection of the West African Transition sandy beach or dune extent to 2072. The solid line and shaded area are the linear regression and 95% confidence intervals.

Sub-criterion A3 measures the changes in sandy beaches or dune areas since 1750. Unfortunately, there were no reliable spatial datasets during this period, and therefore the sandy beach or dunes of West African Transition is assessed as **Data Deficient (DD)** for this sub-criterion A3.

Overall, the sandy beach and dune ecosystem of the West African Transition was assessed as **Vulnerable (VU)** under Criterion A.

Criterion B: Restricted Geographic Distribution

Criterion B measures the risk of collapse associated with restricted geographic distribution, based on standard metrics (Extent of Occurrence (EOO), Area of Occupancy (AOO), and Threat-defined locations).

Table 2: Extent of Occurrence, Area of Occupancy and Threat-defined locations

The West African Transition	Extent of Occurrence (EOO) (km^2)	Area of Occupancy (AOO)	Criterion B
	70,522.2	86	LC

Based on the digitised sandy beaches and dunes ecosystems spatial layer for 2022, the EOO of the sandy beach or dune ecosystems of the West African Transition was measured as 70,522.2 km^2 (Table 2) using the "Convex Hull" option of the "Minimum Bounding Geometry" tool in ArcGIS software (Figure 6). Hence, assessed as **Least Concern (LC)** under Sub-criterion B1. Using 10 x 10 km grid cells (Table 2 and Figure 6), the AOO was measured as 86 grid cells. Hence, assessed as **Least Concern (LC)** under sub-criterion B2. However, the extent of some dune strips, especially along developed or artificialised areas, were possibly underestimated due to indistinct transitional boundaries, only the sandy beach extents were accounted for extensively. However, considering the number of threat-defined locations, there is no evidence of plausible catastrophic threats leading to the potential disappearance of sandy beaches or dunes across their extent. As a result, the sandy beach and dune ecosystem is assessed as **Least Concern (LC)** under sub-criterion B3. The country-based assessment is summarised in Appendix 3B.

Overall, the sandy beach and dune ecosystem of the West African Transition was assessed as **Least Concern (LC)** under Criterion B.

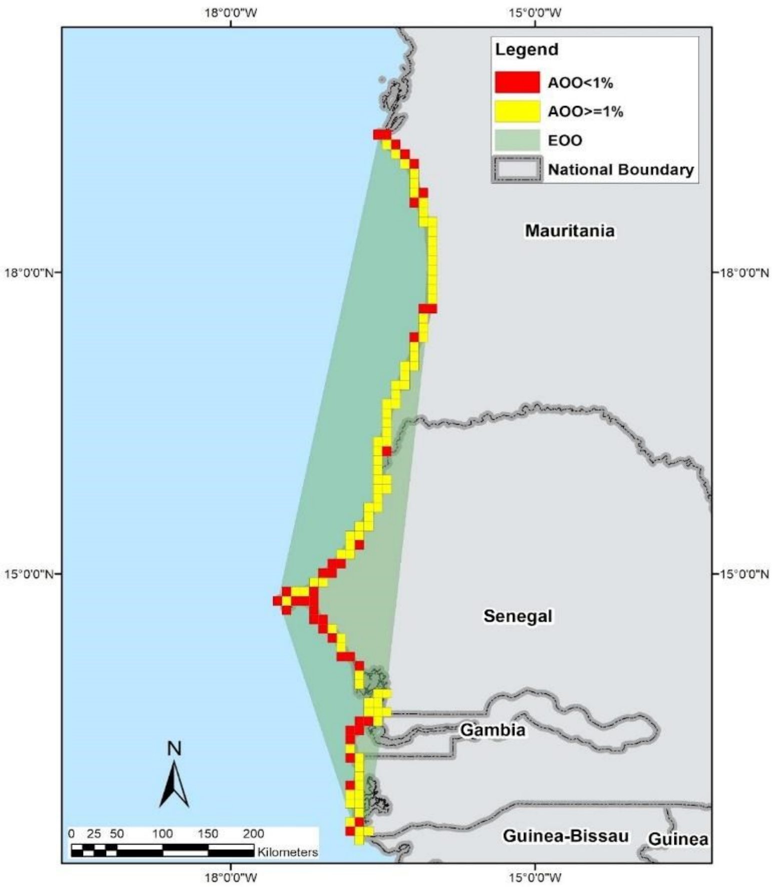


Figure 6: The West African Transition sandy beach and dune ecosystem Extent Of Occurrence (EOO) and Area Of Occupancy (AOO) in 2022. The yellow 10 x 10 km grids are more than 1% covered by the ecosystem and the red grids <1%.

Criterion C: Environmental Degradation

Criterion C measures the environmental degradation of abiotic variables necessary to support the dunes and beaches ecosystem. Sub-criterion C1 measures environmental degradation over the past 50 years: There were no reliable data to evaluate this sub-criterion for the entire West African Transitional coastline, and therefore the sandy beach and dune ecosystem of the West African Transition was assessed as **Data Deficient (DD)** for sub-criterion C1.

Sub-criterion C2 measures environmental degradation in the future, or over any 50-year period, including from the present. The bathtub model was used as a simple inundation model to predict the area of sandy beach and dune ecosystem that would be submerged at varying timeframes. The model's assumptions were: no land deformation; no inland sources of inundation; no inland migration of dunes and beaches ecosystem; and a homogenous sea level rise across the coast of the West African Transition. Multi-Error Improved Terrain (MERIT) DEM, the digitised sandy beach and dune ecosystem spatial layer for 2022, and IPCC's SLR projections were used.

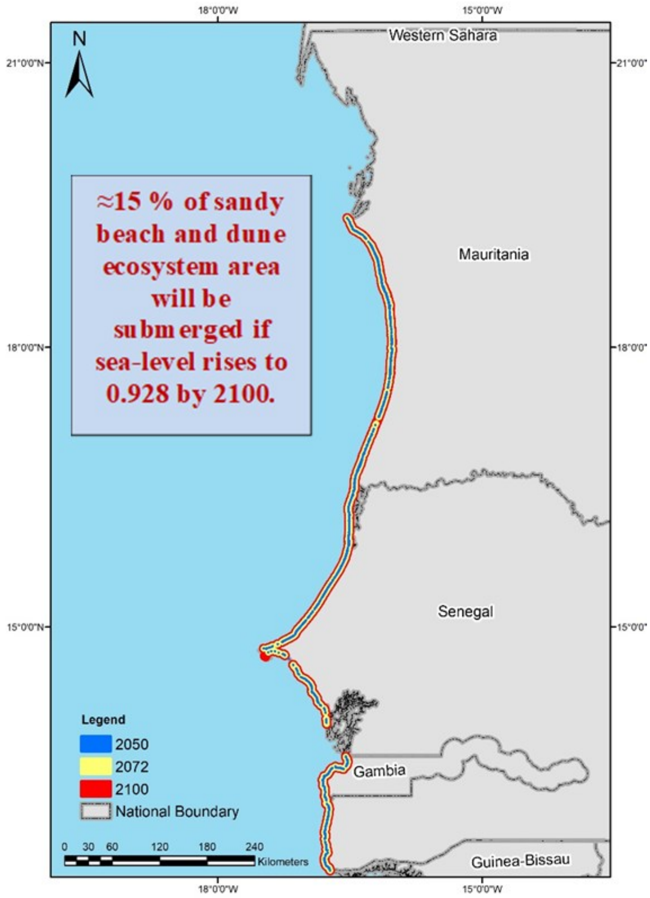


Figure 7: Predicted submergence of the sandy beach and dune ecosystem under IPCC SSP5-8.5 scenarios (0.928 m Global SLR by 2100). Sandy beach and dune ecosystem extents based on the 2022 digitised spatial layer.

Using this model and considering a plausible very high SLR scenario (IPCC SSP, 0.928 m SLR by 2100) as a precautionary approach, 15.22 % of the sandy beaches or dunes ecosystems would be submerged by 2072 (Figure 6). The sandy beach and dune ecosystem projected to be submerged by 2072 was below the 30% extent decline threshold. Considering that no sandy beach or dune formation can occur in a submerged system (100% relative severity), and 30% of the ecosystem would be inundated due to sea-level rise, the sandy beach or dune ecosystem of the West African Transition was, therefore, assessed as **Least concern (LC)** under sub-criterion C2. The results of the country-based assessments are summarised in Appendix 3C The assessment at the country level, also indicated a status of **Least concern (LC)** for each country in the West African Transition. However, there were uncertainties inherent in the MERIT DEM used. At a spatial resolution of 90 m, extents of projected coastal inundation were possibly underestimated. Furthermore, the model used did not account for the interaction between coastal erosion and sea-level rise, potentially leading to an underestimation of threats or projected impacts.

Sub-criterion C3 measures the change in abiotic variables since 1750. Unfortunately, there are no reliable spatial datasets during this period, and therefore the sandy beach and dune ecosystem of the West African Transition was considered **Data Deficient (DD)** for this sub-criterion.

Overall, the sandy beach and dune ecosystem of the West African Transition was assessed as **Least Concern (LC)** under criterion C.

Criterion D: Disruption of biotic processes or interactions

The distribution of biotic processes for the sandy beach and dune ecosystem of the West African Transition under criterion D was **Not Evaluated (NE)**.

Criterion E: Quantitative Risk

No model was used to quantitatively assess the risk of collapse for the sandy beach and dune ecosystem of the West African Transition; hence criterion E was **Not Evaluated (NE)**.

5. Summary of the Assessment

CRITERION			
A. Reduction in Geographic Distribution	**A1** Past 50 years LC	**A2** Future or any 50y period VU	**A3** Historical (1750) DD
B. Restricted Geo. Distribution	**B1** Extent of Occurrence LC	**B2** Area of Occupancy LC	**B3** # Threat-defined Locations > 5 LC
C. Environmental Degradation	**C1** Past 50 years (1970) DD	**C2** Future or any 50y period LC	**C3** Historical (1750) DD
D. Disruption of biotic processes	**D1** Past 50 years (1970) **NE**	**D2** Future or Any 50y period **NE**	**D3** Historical (1750) **NE**
E. Quantitative Risk analysis		**NE**	
OVERALL RISK CATEGORY		**VU**	

Overall, the sandy beach and dune ecosystem of the West African Transition was assessed as **Vulnerable (VU)**.

6. References

Almar, R., Stieglitz, T., Appeaning Addo, K., Ba, K., Ondoa, G. A., Bergsma, E. W. J., Bonou, F., Dada, O., Angnuureng, D., & Arino, O. (2022). Coastal Zone Changes in West Africa: Challenges and Opportunities for Satellite Earth Observations. *Surveys in Geophysics*, 44 (1), pp. 249–275. https://doi.org/10.1007/s10712-022-09721-4.

Alves, B., Angnuureng, D. B., Morand, P., & Almar, R. (2020) A review on coastal erosion and flooding risks and best management practices in West Africa: what has been done and should be done, *Journal of Coastal Conservation*, 24(3). Available at: https://doi.org/10.1007/s11852-020-00755-7.

Appeaning Addo, K., Walkden, M., & Mills, J.P. (2008). Detection, measurement and prediction of shoreline recession in Accra, Ghana. *ISPRS Journal of Photogrammetry and Remote Sensing*, 63(5), pp. 543–558. https://doi.org/10.1016/j.isprsjprs.2008.04.001.

Appeaning Addo, K., Larbi, L., Amisigo, B., & Ofori-Danson, P. K. (2011). Impacts of coastal inundation due to climate change in a cluster of urban coastal communities in Ghana, West Africa. *Remote Sensing*, 3(9), 2029–2050. https://doi.org/10.3390/rs3092029.

Appeaning Addo, K., Nicholls, R. J., Codjoe, S. N. A., & Abu, M. (2018). A biophysical and socioeconomic review of the Volta delta, Ghana. *Journal of Coastal Research*, 34(5), pp. 1216–1226. https://doi.org/10.2112/JCOASTRES-D-17-00129.1.

Avornyo, S. Y., Appeaning Addo, K., Teatini, P., Minderhoud, P., Woillez, M.-N., Jayson-Quashigah, P.-N., & Mahu, E. (2023). A scoping review of coastal vulnerability, subsidence and sea level rise in Ghana: Assessments, knowledge gaps and management implications. *Quaternary Science Advances*, 12, pp. 100108. https://doi.org/10.1016/j.qsa.2023.100108.

Avornyo, S. Y., Minderhoud, P. S. J., Teatini, P., Seeger, K., Hauser, L. T., Woillez, M.-N., Jayson-Quashigah, P.-N., Mahu, E., Kwame-Biney, M., & Appeaning Addo, K. (2024). The contribution of coastal land subsidence to potential sea-level rise impact in data-sparse settings: The case of Ghana's Volta delta. *Quaternary Science Advances*, 14, pp. 100175. https://doi.org/10.1016/j.qsa.2024.100175

Bergstrom, D. M., Wienecke, B. C., Hoff, J., Hughes, L., Lindenmayer, D. B., Ainsworth, T. D., Baker, C. M., Bland, L., Bowman, D. M. J. S., Brooks, S. T., Canadell, J. G., Constable, A. J., Dafforn, K. A., Depledge, M. H., Dickson, C. R., Duke, N. C., Helmstedt, K. J., Holz, A., Johnson, C. R., & McGeoch, M. A. (2021). Combating ecosystem collapse from the tropics to the Antarctic. *Global Change Biology*, 27(9), pp. 1692–1703. https://doi.org/10.1111/gcb.15539.

Bird, C. E., Franklin, E. C., Smith, C. M., & Toonen, R. J. (2013). Between tide and wave marks: a unifying model of physical zonation on littoral shores. *PeerJ*, 1, pp. e154. https://doi.org/10.7717/peerj.154.

Bird, B. W., Abbott, M. B., Rodbell, D. T., & Vuille, M., (2011). Holocene tropical South American hydroclimate revealed from a decadally resolved lake sediment δ18O record. *Earth and Planetary Science Letters*, 310(3-4), pp. 192-202. https://doi.org/10.1016/j.epsl.2011.08.040.

Boateng, I., Bray, M., & Hooke, J. (2012). Estimating the fluvial sediment input to the coastal sediment budget: A case study of Ghana. *Geomorphology*, 138(1), pp. 100–110. https://doi.org/10.1016/j.geomorph.2011.08.028.

Bojang, A., Oyedotun, T. D. T., Sawa, B. A., & Isma'il, M. (2023). Spatio-temporal coastline dynamics of the Gambia littoral zone from 1989 to 2019. *Geosystems and Geoenvironment, 2*(4), pp. 100194. https://doi.org/10.1016/j.geogeo.2023.100194.

Brown, A. C., & McLachlan, A. (2002). Sandy shore ecosystems and the threats facing them: some predictions for the year 2025. *Environmental Conservation*, 29(1), pp.62–77. https://doi.org/10.1017/s037689290200005x.

Ciccarelli, D., & Bona, C. (2022). Exploring the Functional Strategies Adopted by Coastal Plants Along an Ecological Gradient Using Morpho-functional Traits. *Estuaries and Coasts*, 45, pp. 114–129. https://doi.org/10.1007/s12237-021-00945-y.

Charuka, B., Angnuureng, D. B., & Agblorti, S. K. (2023). Mapping and assessment of coastal infrastructure for adaptation to coastal erosion along the coast of Ghana. *Anthropocene Coasts*, 6(1), pp. 11. https://doi.org/10.1007/s44218-023-00026-6.

Chmura, G. L., Anisfeld, S. C., Cahoon, D. R., & Lynch, J. C. (2003). Global carbon sequestration in tidal, saline wetland soils. *Global biogeochemical cycles*, 17(4). https://doi.org/10.1029/2002GB001917.

Dada, O., Almar, R., Morand, P., & Menard, F. (2021) Towards West African coastal social-ecosystems sustainability: Interdisciplinary approaches. *Ocean & Coastal Management*, *211*, pp. 105746. https://doi.org/10.1016/j.ocecoaman.2021.105746.

Doody, J. P. (2013). Coastal squeeze and managed realignment in southeast England, does it tell us anything about the future?. *Ocean & Coastal Management*, 79, pp. 34–41. https://doi.org/10.1016/j.ocecoaman.2012.05.008.

Drius, M., Carranza, M. L., Stanisci, A., & Jones, L. (2016). The role of Italian coastal dunes as carbon sinks and diversity sources; A multi-service perspective. *Applied Geography*, *75*, pp. 127–136. https://doi.org/10.1016/j.apgeog.2016.08.007.

IJff. S.D. (n.d) Sandy shore environments. *Ecoshape*. Retrieved 25 October, 2023, https://www.ecoshape.org/en/landscapes/sandycoasts/sandy-shore-environments/.

Everard, M., Jones, L., & Watts, B. (2010). Have we neglected the societal importance of sand dunes? An ecosystem services perspective. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 20(4), pp. 476–487. https://doi.org/10.1002/aqc.1114.

Fox-Kemper, B., Hewitt, H. T., Xiao, C., Aðalgeirsdóttir, G., Drijfhout, S. S., Edwards, T. L., Golledge, N. R., Hemer, M., Kopp, R. E., Krinner, G., Mix, A., Notz, D., Nowicki, S., I. Nurhati, S., Ruiz, L., Sallée, J-B., Slangen, A. B. A., & Yu, Y. (2021). Ocean, Cryosphere and Sea Level Change. In: Masson-Delmotte, V., Zhai, P., Pirani, A., Connors, S. L., Péan, C., Berger, S., Caud, N., Chen, Y., Goldfarb, L., Gomis, M. I., Huang, M., Leitzell, K., Lonnoy, E., Matthews, J. B. R., Maycock, T. K., Waterfield, T., Yelekçi, O., Yu, R., & Zhou, B. (eds.) Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. *Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA*, pp. 1211–1362. https://doi.org/10.1017/9781009157896.011.

Garner, G. G., Hermans, T., Kopp, R. E., Slangen, A. B. A., Edwards, T. L., Levermann, A., Nowikci, S., Palmer, M. D., Smith, C., Fox-Kemper, B., Hewitt, H. T., Xiao, C., Aðalgeirsdóttir, G., Drijfhout, S. S., Edwards, T. L., Golledge, N. R., Hemer, M., Krinner, G., Mix, A., Notz, D., Nowicki, S., Nurhati, I. S., Ruiz, L., Sallée, J-B., Yu, Y., Hua, L., Palmer, T., & Pearson, B. (2021). IPCC AR6 Global Mean Sea-Level Rise Projections. Version 20210809. Dataset accessed [2023-09-15] at https://doi.org/10.5281/zenodo.5914709.

Happold, D., & Lock, M.J. (2013). The Biotic Zones of Africa. In: Kingdon, J., Happold, D.C.D., Hoffman, M., Happold, M., & Kalina, J. (eds.), *Mammals of Africa*. Bloomsbury.

Ishong, J. A., Afrifa, J. K., Iwajomo, S. B., Deikumah, J. P., Ivande, S. T., & Cresswell, W. (2022). Population trends of resident and migrant West African bird species monitored over an 18-year period in central Nigeria. *Ostrich*, 93(3), pp. 171–186. https://doi.org/10.2989/00306525.2022.2068691.

IUCN. (2022). The IUCN Red List of Threatened Species. (Version 2022-2). https://www.iucnredlist.org.

Jackson, D. W. T., Costas, S., & Guisado-Pintado, E. (2019a). Large-scale transgressive coastal dune behaviour in Europe during the Little Ice Age. *Global and Planetary Change,* 175, pp. 82–91. https://doi.org/10.1016/j.gloplacha.2019.02.003.

Jackson, D. W. T., Costas, S., González-Villanueva, R., & Cooper, A. (2019b). A global 'greening' of coastal dunes: An integrated consequence of climate change?. *Global and Planetary Change*, 182, pp. 103026. https://doi.org/10.1016/j.gloplacha.2019.103026.

Jayson-Quashigah, P.-N., Appeaning Addo, K., & Kodzo, K. S. (2013). Medium resolution satellite imagery as a tool for monitoring shoreline change. Case study of the Eastern coast of Ghana. *Journal of coastal Research*, 65, pp. 511–516. https://doi.org/10.2112/si65-087.1.

Johnston, J., Cassalho, F., Miesse, T., & Ferreira, C. M. (2021). Projecting the effects of land subsidence and sea level rise on storm surge flooding in Coastal North Carolina. *Scientific Reports*, 11(1), pp. 1–13. https://doi.org/10.1038/s41598-021-01096-7.

Keith, D. A., Rodríguez, J. P., Rodríguez-Clark, K. M., Nicholson, E., Aapala, K., Alonso, A., & Zambrano-Martínez, S. (2013). Scientific foundations for an IUCN Red List of Ecosystems. *PLOS One*, 8(5), e62111. https://doi.org/10.1371/journal.pone.0062111.

Marsh, R., Skliris, N., Tompkins, E. L., Dash, J., Almela, D. V., Tonon, T., Oxenford, H. A., & Webber, M. (2023). Climate-sargassum interactions across scales in the tropical Atlantic. *PLOS Climate*, 2(7), p.e0000253. https://doi.org/10.1371/journal.pclm.0000253.

Miller, T. E. (2015). Effects of disturbance on vegetation by sand accretion and erosion across coastal dune habitats on a barrier island, *AoB PLANTS*, 7(1). https://doi.org/10.1093/aobpla/plv003.

Muñoz-Torrent, X., da Trindade, N.T., & Mikulane, S. (2022). Territory, Economy, and Demographic Growth in São Tomé and Príncipe: Anthropogenic Changes in Environment. In: Ceríaco, L.M.P., de Lima, R.F., Melo, M., Bell, R.C. (eds.) Biodiversity of the Gulf of Guinea Oceanic Islands. *Springer eBooks,* pp. 71–86. https://doi.org/10.1007/978-3-031-06153-0_4.

Nixon, S.W. (1981). Remineralization and Nutrient Cycling in Coastal Marine Ecosystems. In: Neilson, B.J., Cronin, L.E. (eds.) Estuaries and Nutrients. Contemporary Issues in Science and Society. *Humana Press*. https://doi.org/10.1007/978-1-4612-5826-1_6.

Nyarko, E., Klubi, E., Laissaoui, A., & Benmansour, M. (2016). Estimating recent sedimentation rates using lead-210 in tropical estuarine systems: case study of Volta and Pra estuaries in Ghana, West Africa. *Journal of Oceanography and Marine Research*, 4(141), pp. 2. https://doi.org/10.4172/2572-3103.1000141.

Park, J. M., & You, Y. H. (2023). Culturable Endophyte Fungi of the Well-Conserved Coastal Dune Vegetation Located on the East Coast of the Korean Peninsula. *Journal of Marine Science and Engineering*, 11(4), pp. 734. https://doi.org/10.3390/jmse11040734.

Resiere, D., Mehdaoui, H., Florentin, J., Gueye, P., Lebrun, T., Blateau, A., & Neviere, R. (2021). Sargassum seaweed health menace in the Caribbean: Clinical characteristics of a population exposed to hydrogen sulfide during the 2018 massive stranding. *Clinical Toxicology*, 59(3), pp. 215–223. https://doi.org/10.1080/15563650.2020.1789162.

Restrepo-Ángel, J.D., Mora-Páez, H., Díaz, F., Govorcin, M., Wdowinski, S., Giraldo-Londoño, L., Tosic, M., Fernández, I., Paniagua-Arroyave, J.F., & Duque-Trujillo, J.F. (2021). Coastal subsidence increases vulnerability to sea level rise over twenty first century in Cartagena, Caribbean Colombia. *Scientific Reports*, 11(1), p. 18873. https://doi.org/10.1038/s41598-021-98428-4.

Ritchie, W., Pond, K., Anthony, E. J., Maul, G., Wiberg, P. L., Hayes, M. O., Short, A. D., Healy, T. R., Barua, D. K., Charlier, R. H., Masselink, G., Masselink, G., Fairbridge, R. W., Reed, D. J., & Streever, W.

(2005). Wave and Tide-Dominated Coasts. In: Encyclopedia of Coastal Science. *Dordrecht, Springer Netherlands*, pp. 1046–1049. https://doi.org/10.1007/1-4020-3880-1_341.

Rodríguez-Martínez, R. E., Roy, P. D., Torrescano-Valle, N., Cabanillas-Terán, N., Carrillo-Domínguez, S., Collado-Vides, L., García-Sánchez, M., & van Tussenbroek, B. I. (2020). Element concentrations in pelagic Sargassum along the Mexican Caribbean coast in 2018-2019. *PeerJ*, 8, p.e8667. https://doi.org/10.7717/peerj.8667.

Sane, M., & Yamagishi, H. (2004). Coastal erosion in Dakar, western Senegal. *Journal of the Japan Society of Engineering Geology*, 44(6), pp. 360–366. https://doi.org/106114304/s200_moussa.

Schlacher, T. A., Schoeman, D. S., Dugan, J., Lastra, M., Jones, A., Scapini, F., & McLachlan, A. (2008). Sandy beach ecosystems: key features, sampling issues, management challenges and climate change impacts. *Marine ecology*, 29, pp. 70–90. https://doi.org/10.1111/j.1439-0485.2007.00204.x.

Steven, A., Appeaning Addo, K., Llewellyn, G., Ca, V. T., Boateng, I., Bustamante, R., & Vozzo, M. (2020). Coastal development: Resilience, restoration and infrastructure requirements. *World Resources Institute, Washington DC*. www.oceanpanel.org/blue-papers/coastal-development-resilience-restoration-and-infrastructure-requirements.

Syvitski, J.P., & Kettner, A. (2011). Sediment flux and the Anthropocene. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 369(1938), pp. 957–975. https://doi.org/10.1098/rsta.2010.0329.

Töpfer, K., Wolfensohn, J., & Lash, J. (2000). Coastal ecosystems, in: Töpfer, K., Wolfensohn, J. & Lash, J. (eds.), World Resources 2000-2001. *Elsevier*, pp. 69–85. https://doi.org/10.1016/B978-008043781-1/50004-9.

Varriano, S., Mallon, J. M., Folta, C., Coulibaly, H., Krajcir, K. J., McClung, M. R., Fagan, W. F., & Moran, M. D. (2020). Transfer of nitrogen by migratory birds in the African-Western Eurasian Flyways. *Animal Migration*, 7(1), pp. 52–57. https://doi.org/10.1515/ami-2020-0101.

Vermeer, D. (2010). Mauritania. In: Bird, E.C.F. (eds.) Encyclopedia of the World's Coastal Landforms. *Dordrecht, Springer*. https://doi.org/10.1007/978-1-4020-8639-7_162.

Yamazaki, D., Ikeshima, D., Tawatari, R., Yamaguchi, T., O'Loughlin, F., Neal, J. C., Sampson, C. C., Kanae, S., & Bates, P. D. (2017). A high-accuracy map of global terrain elevations. *Geophysical Research Letters*, 44(11), pp. 5844-5853. https://doi.org/10.1002/2017gl072874.

Zavantias, A. (2023). The impact of plastic pollution in the marine environment. *Master's thesis, Πανεπιστήμιο Πειραιώς*). https://dione.lib.unipi.gr/xmlui/handle/unipi/15728.

Authors:

Kwasi Appeaning Addo, Philip-Neri Jayson-Quashigah, Selasi Y. Avornyo, Lord Offei-Darko, Michael Kwame-Biney, Winnie N. A. Sowah, Lord Offei-Darko, Obed O. Okyere, and Sean G. McGregor.

Acknowledgments

The IUCN RED LIST of Gulf of Guinea North List of Ecosystems was made possible through the collaboration and dedication of the West African Sand Dune Specialists group. Their valuable contribution throughout the development process have been integral to the accuracy and quality of the final product.

We extend our sincere gratitude to Philip A. Darko, Paul Adu and Mawunyo Korku Avornyo, who provided valuable inputs during the completion of this ecosystem description and evaluation of the Red List of Ecosystems criteria.

We also wish to acknowledge Betty Dordzi and Lawrence of Ghana for providing us with exclusive photographs on some selected species as well as other online sources. The spatial data on the sandy beach and dune extent was obtained from Landsat & Planet images, while the DEM used in the assessment was obtained from Yamazaki et al. (2017).

Finally, we would also like to thank the Country Focal Persons for their support in the assessment of the sandy beaches and dunes that served as basis for this analysis.

Peer revision:

Ena Suárez

Marcos Valderrábano

Web portal:

http://iucnrle.org/

7. Appendices

1. **List of Key Species**

Key species of sandy beaches and dunes present in the West African Transition according to the IUCN Red List of Species (RLTS) database (IUCN, 2022). The Species were filtered by Presence (Extant or Possibly Extant), Seasonality (exclude passage species) and Origin (include native or reintroduced).

Class	Order	Family	Scientific name	RLTS category	Common name
Actinopterygii	Anguilliformes	Anguillidae	*Anguilla anguilla*	CR	European eel
Actinopterygii	Anguilliformes	Ophichthidae	*Bascanichthys ceciliae*	LC	
Actinopterygii	Anguilliformes	Ophichthidae	*Callechelys leucoptera*	LC	
Actinopterygii	Elopiformes	Elopidae	*Elops lacerta*	LC	
Actinopterygii	Gobiiformes	Eleotridae	*Eleotris vittata*	LC	Senegal-sovekutling
Actinopterygii	Mugiliformes	Mugilidae	*Chelon bandialensis*	DD	Diassanga mullet
Actinopterygii	Siluriformes	Ariidae	*Carlarius heudelotii*	LC	Smoothmouth sea catfish
Aves	Charadriiformes	Scolopacidae	*Actitis hypoleucos*	LC	Common sandpiper
Aves	Charadriiformes	Scolopacidae	*Arenaria interpres*	LC	Ruddy turnstone
Aves	Charadriiformes	Burhinidae	*Burhinus capensis*	LC	Spotted thick-knee
Aves	Charadriiformes	Scolopacidae	*Calidris alba*	LC	Sanderling
Aves	Charadriiformes	Scolopacidae	*Calidris canutus*	NT	Red knot
Aves	Charadriiformes	Scolopacidae	*Calidris ferruginea*	NT	Curlew sandpiper
Aves	Charadriiformes	Scolopacidae	*Calidris minuta*	LC	Little stint
Aves	Charadriiformes	Charadriidae	*Charadrius alexandrinus*	LC	Kentish plover
Aves	Charadriiformes	Charadriidae	*Charadrius dubius*	LC	Little ringed plover
Aves	Charadriiformes	Charadriidae	*Charadrius hiaticula*	LC	Common ringed plover
Aves	Charadriiformes	Charadriidae	*Charadrius marginatus*	LC	White-fronted plover
Aves	Charadriiformes	Charadriidae	*Charadrius pecuarius*	LC	Kittlitz's plover
Aves	Charadriiformes	Laridae	*Gelochelidon nilotica*	LC	Common gull-billed tern
Aves	Coraciiformes	Alcedinidae	*Ceryle rudis*	LC	Pied kingfisher
Aves	Coraciiformes	Alcedinidae	*Corythornis cristatus*	LC	Malachite kingfisher
Aves	Falconiformes	Falconidae	*Falco peregrinus*	LC	Peregrine falcon
Aves	Passeriformes	Motacillidae	*Anthus pratensis*	LC	Meadow pipit
Aves	Passeriformes	Alaudidae	*Galerida cristata*	LC	Crested lark
Aves	Pelecaniformes	Ardeidae	*Egretta garzetta*	LC	Little egret
Aves	Pelecaniformes	Ardeidae	*Egretta gularis*	LC	Western reef-egret
Aves	Procellariiformes	Procellariidae	*Bulweria bulwerii*	LC	Bulwer's petrel
Reptilia	Testudines	Cheloniidae	*Caretta caretta*	VU	Loggerhead turtle
Reptilia	Testudines	Cheloniidae	*Chelonia mydas*	EN	Green turtle
Reptilia	Testudines	Dermochelyidae	*Dermochelys coriacea*	VU	Leatherback turtle
Reptilia	Testudines	Cheloniidae	*Eretmochelys imbricata*	CR	Hawksbill turtle
Liliopsida	Alismatales	Cymodoceaceae	*Cymodocea nodosa*	LC	Slender seagrass
Magnoliopsida	Asterales	Asteraceae	*Ambrosia maritima*	LC	Sea ambrosia

Class	Order	Family	Scientific name	RLTS category	Common name
Magnoliopsida	Fabales	Fabaceae	*Dalbergia ecastaphyllum*	LC	
Magnoliopsida	Malvales	Malvaceae	*Thespesia populnea*	LC	Portia tree
Magnoliopsida	Myrtales	Combretaceae	*Conocarpus erectus*	LC	Silver-leaved buttonwood

RLTS categories are: LC “Least concern”, DD “Data deficient”, NT “Near Threatened”, VU “vulnerable”, EN “Endangered”, CR “Critically Endangered”, EW “Extinct in The Wild”, EX “Extinct”. NE “Not Evaluated”.

2. **List of Associated Species**

List of taxa that are associated with sandy beaches and dunes in the West African Transition included in the IUCN Red List of Threatened Species (IUCN, 2022). The Species were filtered by Presence (Extant or Possibly Extant), Seasonality (exclude passage species) and Origin (include native or reintroduced).

Class	Order	Family	Scientific name	RLTS category	Common name
Actinopterygii	Anguilliformes	Ophichthidae	*Mystriophis rostellatus*	LC	
Aves	Charadriiformes	Charadriidae	*Vanellus spinosus*	LC	Spur-winged lapwing
Aves	Charadriiformes	Laridae	*Gelochelidon nilotica*	LC	Common gull-billed tern
Aves	Charadriiformes	Laridae	*Larus cirrocephalus*	LC	Grey-headed gull
Aves	Charadriiformes	Laridae	*Larus ridibundus*	LC	Black-headed gull
Aves	Charadriiformes	Scolopacidae	*Numenius arquata*	NT	Eurasian curlew
Aves	Passeriformes	Motacillidae	*Anthus campestris*	LC	Tawny pipit
Aves	Passeriformes	Motacillidae	*Anthus pratensis*	LC	Meadow pipit
Aves	Passeriformes	Muscicapidae	*Oenanthe oenanthe*	LC	Northern wheatear
Aves	Pelecaniformes	Pelecanidae	*Pelecanus rufescens*	LC	Pink-backed pelican
Insecta	Lepidoptera	Nymphalidae	*Vanessa cardui*	LC	Painted lady
Insecta	Orthoptera	Acrididae	*Acrotylus patruelis*	LC	Slender digging grasshopper
Mammalia	Carnivora	Canidae	*Vulpes rueppellii*	LC	Rüppell's fox
Mammalia	Carnivora	Canidae	*Vulpes zerda*	LC	Fennec fox
Mammalia	Rodentia	Muridae	*Gerbillus amoenus*	LC	Pleasant gerbil
Mammalia	Rodentia	Muridae	*Gerbillus gerbillus*	LC	Lesser Egyptian gerbil
Mammalia	Rodentia	Muridae	*Gerbillus tarabuli*	LC	Tarabul’s gerbil
Reptilia	Squamata	Lacertidae	*Acanthodactylus aureus*	LC	Golden fringe-fingered lizard
Reptilia	Squamata	Lacertidae	*Acanthodactylus senegalensis*	LC	
Reptilia	Squamata	Phyllodactylidae	*Tarentola chazaliae*	VU	Helmethead gecko
Reptilia	Squamata	Scincidae	*Chalcides armitagei*	NT	Armitage’s cylindrical skink
Reptilia	Squamata	Scincidae	*Chalcides sphenopsiformis*	**LC**	Duméril's wedge-snouted skink

Class	Order	Family	Scientific name	RLTS category	Common name
Reptilia	Squamata	Scincidae	*Scincus albifasciatus*	LC	
Reptilia	Squamata	Viperidae	*Bitis arietans*	LC	Puff adder
Reptilia	Testudines	Cheloniidae	*Chelonia mydas*	EN	Green turtle
Reptilia	Testudines	Dermochelyidae	*Dermochelys coriacea*	VU	Leatherback turtle
Liliopsida	Poales	Poaceae	*Echinochloa colona*	LC	Blé du Dekkan
Liliopsida	Poales	Poaceae	*Sporobolus virginicus*	LC	
Magnoliopsida	Caryophyllales	Aizoaceae	*Sesuvium portulacastrum*	LC	Shoreline Purslane
Magnoliopsida	Caryophyllales	Tamaricaceae	*Tamarix senegalensis*	LC	
Magnoliopsida	Fabales	Fabaceae	*Canavalia rosea*	LC	Beach bean
Magnoliopsida	Fabales	Fabaceae	*Dalbergia ecastaphyllum*	LC	
Magnoliopsida	Malvales	Malvaceae	*Hibiscus tiliaceus*	LC	Coast cottonwood
Magnoliopsida	Malvales	Malvaceae	*Thespesia populnea*	LC	Portia tree
Magnoliopsida	Sapindales	Rutaceae	*Zanthoxylum zanthoxyloides*	LC	

RLTS categories are: LC "Least concern", DD "Data deficient", NT "Near Threatened", VU "vulnerable", EN "Endangered", CR "Critically Endangered", EW "Extinct in The Wild", EX "Extinct". NE "Not Evaluated".

3. Criterion Assessment at Country Level

The following section provides a summary of sub-criteria when applied to each different country.

3A: Criterion A: Reduction in Geographic Distribution

Country	1998 Area (km²)	2022 Area (km²)	50-Year Percentage Status	Overall Risk category
Senegal	528.18	397.02	-43.22	**VU**
The Gambia	26.89	25.68	-3.6	**LC**
Mauritania	160.89	165.41	+4.38	**LC**

(+) imply increase in ecosystem extent; (-) imply ecosystem extent decline

3B: Criterion B: Restricted Geographic Distribution

Country	EOO (km²)	AOO <1%	AOO ≥1%	Overall Risk Category for all sub-criteria
Senegal	32,450	23	44	**VU**
The Gambia	1,550	6	3	**CR**
Mauritania	18,700	11	39	**EN**

3C: Criterion C: Environmental Degradation

Country	2048 Area (km^2)	2048 Area (%)	2072 Area (km^2)	2072 Area (%)	Overall Risk Category for all sub-criteria
Senegal	19.37	14.04	18.96	13.74	**LC**
The Gambia	2.20	24.04	2.35	25.68	**LC**
Mauritania	32.38	15.30	35.05	16.57	**LC**