The IUCN Red List of Ecosystems
Scope: Sub-global / Regional
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Gonakier forests of Senegal River floodplain, Senegal and Mauritania

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Overall risk category CR

NOT EVALUATED	DATA DEFICIENT	LEAST CONCERN	NEAR THREATENED	VULNERABLE	ENDANGERED	CRITICALLY ENDANGERED	COLLAPSED
NE	DD	LC	NT	VU	EN	CR	CO

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Biodiversity loss, Conservation Biology, Ecological communities, Environmental - chance, Extincion risk, Food-web perspective, Global synthesis, Habitat loss, Relative resilience, Vegatation classification

Ecosystem Description

Gonakier forests are a unique forest ecosystem dominated by Acacia nilotica (Gonakier) with A. raddiana and A. seyal. Although A. nilotica does occur in other ecosystems, it is a less common member of more floristically diverse savannas and shrub steppes, and does not form a forest canopy. Gonakier forests are typically inundated annually by wet season floods between July and November. Periodic floods are vital for sustaining forest structure and water dependent biota in the arid and semi-arid landscapes through which the river flows. Gonakier forests of the Senegal River floodplain are restricted to the riparian zone of the Senegal River from Dagana to Bakel. This area includes the border regions of northern Senegal, southern Mauritania and southeastern Mali. Change in land use (conversion of forest to agriculture) and changes to river flow regimes are the major current threats to Gonakier forests of the Senegal River floodplain.

Classification

IUCN Habitats Classification Scheme

- 1. Forest
  - 1.5. Forest - Subtropical/tropical dry

IUCN Global Typology

- Freshwater/Terrestrial
  - TF1. Palustrine wetlands
    - TF1.2 Subtropical/temperate forested wetlands

Distribution

Gonakier forests of the Senegal River floodplain are restricted to the riparian zone of the Senegal River from Dagana to Bakel. This area includes the border regions of northern Senegal, southern Mauritania and southeastern Mali.

System

Freshwater/Terrestrial

Biogeographic Realm

Afrotropical

Countries

Mali Mauritania Senegal

Geographic Region

West Africa

Characteristic Native Biota

This unique forest ecosystem is dominated by Acacia nilotica (Gonakier) with A. raddiana and A. seyal. Other woody species are uncommon but include Acacia albida, Adenololobus rufescens (syn. Piliostigma rufescens), Balanites aegyptiaca, Mitragyna inermis and Ziziphus mauritiana. The understorey is generally sparse and grassy, with Chloris plieurii, Dactyloctenium aegyptium and forbs Alysicarpus ovalifolius and Zornia glochidiata (Stancioff et al. 1985). Gaps created naturally or anthropogenically, are colonised by Panicum anabatistum, Borreia verticellata and Vetiveria nigritana (Stancioff et al. 1985). Due to regular inundation, the forest provides critical habitat for fish and migrating birds (Tappan et al. 2004). The diversity of woody species is comparatively low and the groundlayer flora is sparse and poorly documented. However, the structure, fluvial function and composition of the ecosystem is unique in the region and contrasts markedly with surrounding steppe and bare-earth ecosystems within the Senegal River valley ecoregion. Although A. nilotica does occur in other ecosystems, it is a less common member of more floristically diverse savannas and shrub steppes, and does not form a forest canopy.

Taxa

Acacia albida, Acacia nilotica, Acacia raddiana, Acacia seyal, Adenololobus rufescens, Alysicarpus ovalifolius, Balanites aegyptiaca, Borreia verticellata, Chloris plieurii, Dactyloctenium aegyptium, Mitragyna inermis, Panicum anabatistum, Vetiveria nigritana, Ziziphus mauritiana, Zornia glochidiata

Abiotic Features

The ecosystem is restricted to a broad alluvial valley along the Senegal River comprising levees, flats and depressions subject to annual flooding (Tappan et al. 2004). The valley includes a mosaic of forest, savanna and steppe that is determined largely by the hydrological and pedological conditions of the floodplain. The soils supporting Gonakier forest are hydromorphic and vertic sandy clay loams and clays and are inundated annually between July and November. The Sahelian tropical climate has a seasonal rainfall pattern, with wet summers in June-August and dry winters. Mean annual rainfall in the 1990s varied from 150 to 600 mm along the riverine corridor (Tappan et al. 2004).

Biotic Processes

Gonakier forests of the Senegal River floodplain are typically inundated annually by wet season floods between July and November. Periodic floods are vital for sustaining forest structure and water dependent biota in the arid and semi-arid landscapes through which the river flows. The trees are able to tolerate periods of inundation of up to several months. Stancioff et al. (1985) describe the forest as a pseudo-climax community because it occurs at the end of a post-disturbance succession, although a change in flood regime will likely result in a new formation. Overbank flows also redistribute resources and disperse propagules of plants and aquatic biota. The precise mechanisms and dependencies of the ecosystem on flood regimes are uncertain; however Stancioff et al. (1985) noted drought induced declines in tree density during the 1970s and 1980s, when an absence of flooding in some stands lead to the highest tree mortality rates observed within the wooded vegetation formations of Senegal. In some cases, the forest has been replaced by steppe.

Conceptual Model

Cause-effect model of ecosystem dynamics relevant for Gonakier Forests of Senegal River floodplain showing environmental and anthropogenic influences on ecosystem processes and components.

Threatening Processes

Change in land use (conversion of forest to agriculture) and changes to river flow regimes are the major current threats to Gonakier forests of the Senegal River floodplain. Land clearing was initially associated with traditional subsistence agriculture, which increased gradually over several centuries. Historically, clearing of the forest was carried out to make it more suitable for grazing (Stancioff et al. 1985). More recently, the land occupied by Gonakier forests has become an important resource for flood recession agriculture. In recent decades, extensive hydro-agricultural projects, designed to increase domestic food production and export production of rice and sugarcane, have resulted in more rapid transformation (Tappan et al.

2004). Cutting of wood for charcoal production, a major source of energy for local communities exacerbates the trends (Tappan et al. 2004). These processes have resulted in a contraction of the distribution of the ecosystem. On the other hand, changes in the flow regime of the Senegal River have occurred, both as a consequence of regional climate change and the construction of river regulation infrastructure. The entire catchment experienced declines in precipitation in the order of 10-50% during the twentieth century, with the greatest declines occurring in Senegal (Gonzalez et al. 2010; 2012). Inter-annual variation in Senegal's precipitation is closely (inversely) related to Sea Surface Temperatures in the Southern Atlantic Ocean (Fall et al. 2006). The relationship between flood occurrence and maximum river flows allows the conditions for ecosystem collapse to be estimated, given the dependence of Gonakier forest on flooding.

Collapse

For assessment of criteria A and B, collapse was assumed to occur when the mapped distribution or projected suitable habitat declines to zero. Because this is a floodplain ecosystem threatened by water interception and climate change, maximum river height as a proxy for overbank inundation to assess the relative severity of environmental degradation under criterion C was identified. Conservatively, the ecosystem will collapse when maximum river height falls to 0-10% of unregulated levels.

Ecosystem Risk Assessment

Assessment Protocol

IUCN RLE v2.0

IUCN Red List of Ecosystems Category and Criteria

Critically Endangered A1+A3

Last Assessed

2013

Justification

The status of The Gonakier forests from the Senegal River floodplains was determined by past declines in spatial distribution, rather than by the degradation of its ecological functions. These forests are classified as Critically Endangered under criterion A based on an 85-93% reduction in past and historic geographic distribution.

Criterion A CR

Summary

The geographic distribution of the Gonakier forests of the Senegal River floodplain has undergone a reduction of 85-93% in the past 50 years; historic decline (since before 1750) is estimated to be greater. Therefore, this ecosystem was assessed as Critically Endangered under subcriteria A1 and A3.

Risk Category CR

Subcriterion	Category	Justification
A1	CR	Three independent temporal analyses of the distribution of Gonakier forests have been carried out for different time periods during the past 50 years. Two of them focused on the Senegal side of the border. The first was a comparison of Corona and Landsat images captured in 1965 and 1992, respectively, showing a 77% decline in mapped area (Tappan et al. 2004). The second was a comparison of two Landsat images captured in 1975 and 2000 showing a 72% decline in area (Tappan, unpubl. analysis). The annualised rates of decline from these studies are remarkably similar, suggesting that rates of decline were roughly constant at 5% per year over a 35-year period 1965-2000. Assuming that rates of decline remained roughly constant for a 50-year period, extrapolation produces an estimate of 92-93% decline in distribution over the past 50 years. A third analysis focused on the global distribution of Gonakier forests encompassing both Senegal and Mauritania (CSE 2005). This comparison of Landsat images captured in 1984 and 2003 showed a 51% decline in Gonakier forest area. Assuming the rate of decline was roughly constant in Mauritania, as it appears to be in Senegal (Tappan et al. 2004), extrapolation produces an estimated decline of 85% over the past 50 years. Based on a bounded

estimate of 85-93% decline in distribution over the past 50 years, the status of Gonakier forests of the Senegal River floodplain is Critically Endangered under subcriterion A1.

Key Indicators in detail

Evidence of Continuing Decline: Decreasing
Evidence of Threatening Processes: Yes

Indicator Variable: Change in distribution

Extent (%): 85-93

Mapped distribution
Year: 1965
Mapped distribution (km2): 393.57
Year: 1975
Mapped distribution (km2): 116
Year: 1984
Mapped distribution (km2): 1,071.73
Year: 1992
Mapped distribution (km2): 90.70
Year: 2000
Mapped distribution (km2): 32
Year: 2003
Mapped distribution (km2): 526.02

A2a DD

No projections are available for the future distribution of Gonakier forests of the Senegal River floodplain. If declines continue at the current rate, the distribution may be expected to contract by a further 85 - 93%, however, this assumption may not hold true if protected areas prevent conversion of forests to agriculture. Thus, the ecosystem is classified as Data Deficient under subcriterion A2a.

Key Indicators in detail

Evidence of Continuing Decline: Unknown
Evidence of Threatening Processes: No

A2b DD

No projections are available for the future distribution of Gonakier forests of the Senegal River floodplain. If declines continue at the current rate, the distribution may be expected to contract by a further 85 - 93%, however, this assumption may not hold true if protected areas prevent conversion of forests to agriculture. Thus, the ecosystem is classified as Data Deficient under subcriterion A2b.

Key Indicators in detail

Evidence of Continuing Decline: Unknown
Evidence of Threatening Processes: No

A3 CR

The historic declines in Gonakier forests are likely to be greater than those estimated for the past 50 years. There is anecdotal evidence that agricultural expansion took place in Senegal at an increasing rate during the twentieth century. The national population increased tenfold during that period (Tappan et el. 2004) and continues to increase at 1-3 % per year (Gonzalez et al. 2012). Tappan et al. (2000) noted that eastern Senegal had been inhabited by people practicing subsistence agriculture for centuries and that most of the present day villages had been established by the 1930s when colonial agriculture was expanding at an increasing rate. In northwestern Senegal, Gonzalez (2001) documented declines in forest species richness and tree density from 1945 to 1993. However, little of the historical information is specific to Gonakier forests of Senegal River floodplain, so it is difficult to estimate how much of the decline in the distribution of these forests took place prior to 1965, the earliest date of imagery used in published mapping studies (Tappan et al. 2004). The available evidence suggests that the magnitude of in area decline must be at least 85-93%. The status of the ecosystem is therefore at least Endangered and likely to be Critically Endangered under subcriterion A3.

Key Indicators in detail

Evidence of Continuing Decline: Decreasing
Evidence of Threatening Processes: Yes

Indicator Variable: Change in distribution

Extent (%): 85-93

Mapped distribution

Criterion B VU

Summary

The Gonakier forests of Senegal River floodplains have a restricted distribution, with an extent of occurrence of 22,307 km2 and, as few as two threat-defined locations. There are continuing declines in distrinbution and in a measure of environmental quality of the ecosystem due to reduced water glows of the Senegal River. In this sense, the ecosystem is prone to severe threats such as clearing and drought, such that is may become, or may already be Critically Endangered. Thus, the ecosystem is classified as Vulnerable under criterion B.

Risk Category VU

Subcriterion	Category	Justification
B1	VU	A minimum convex polygon enclosing all occurrences mapped by CSE (2005) from imagery captured in 2003 has an area of 22,307 km2. There are continuing declines in distribution and in a measure of environmental quality of the ecosystem due to reduced flows of the Senegal River, and there may be as few as two threat-defined locations. The status of the ecosystem is therefore Vulnerable under subcriterion B1ai,ii,c.
B2	LC	Gonakier forests mapped from 2003 imagery occupied 151 10 x 10 km grid cells. Of these, 93 cells contained more than 1 km2 Gonakier forest (i.e. more than 1% of their area). The status of the ecosystem is therefore Least Concern under subcriterion B2.
B3	VU	Gonakier forests of Senegal River floodplain do not have a highly restricted area of occurrence. The most severe plausible threat to Gonakier forest is currently land conversion. Senegal and Mauritania represent different socio-economic communities and apparently exhibit different rates of forest clearing. If rates of clearing are similar between village communities, there may be as few as two threat-defined locations of the ecosystem. The ecosystem is prone to severe threats, such as clearing and drought, such that is may become, or may already be Critically Endangered. The status of the ecosystem is therefore Vulnerable under subcriterion B3.

Key Indicators in detail

Number of Threat-defined Locations: 2
Evidence of Continuing Decline: Decreasing
Evidence of Threatening Processes: Yes

Indicator Variable: EOO

Mapped distribution
Year: 2011
Mapped distribution (km2): 22,307

Key Indicators in detail

Number of Threat-defined Locations: 2
Evidence of Continuing Decline: Decreasing
Evidence of Threatening Processes: Yes

Indicator Variable: AOO

Mapped distribution
Year: 2011
Mapped distribution (10x10-km grid cells): 93

Key Indicators in detail

Number of Threat-defined Locations: 2
Evidence of Continuing Decline: Decreasing

Evidence of Threatening Processes: Yes

Criterion C VU

Summary

Gonakier forests of Senegal River floodplain presents a 35-44% of relative severity in environmental degradation in 100% of the ecosystem extent, according to data available of hydrological decline over the past 50 years. Therefore, the status of the ecosystem is Vulnerable under subcriterion C1.

Risk Category VU

Subcriterion	Category	Justification
C1	VU	Flooding is a key ecological process that sustains this ecosystem. As floods occur only during the wet season months, the maximum annual river heights were assumed to be indicative of the river's capacity to flood each year. River height data were available for 100 years from 1904 to 2003 from four gauging stations within the distribution of Gonakier forests of Senegal River floodplain: Bakel; Matam; Podor; and Dagana. To assess criterion C, the mean annual maximum river height across these four gauging stations was assumed as a suitable proxy for environmental degradation. Hollis (1990) estimated that floods of 2500 m3/s needed for floodplain inundation would be very unlikely to occur based on river flows observed during 1986 -1989. Stancioff et al. (1985) observed extreme rates of tree mortality between the mid 1970s and the mid 1980s, corresponding to the lowest maximum river heights (473±-27 cm) observed during the 100 years of records. Relative severity of hydrological decline over the past 50 years was therefore between 35% and 44%. Therefore, the status of the ecosystem is Vulnerable under subcriterion C1. **Key Indicators in detail** Evidence of Threatening Processes: No **Indicator Variable:** River height Extent (%): 100 Relative Severity (%): 35-45 calculated Year: 1950 Mapped distribution (cm): 712 Year: 2000 Mapped distribution (cm): 619
C2a	DD	There are currently no future projections of flows of the Senegal River. **Key Indicators in detail** Evidence of Threatening Processes: No
C2b	NE	This subcriterion was not assessed. **Key Indicators in detail** Evidence of Threatening Processes: No
C3	DD	Available historic data suggest regional declines in precipitation have been ongoing since records began in the late 1800s (Nicholson 2000). For example, mean annual precipitation at St Louis at the mouth of Senegal River declined from 450 mm in 1855 to 240 mm in 2009, while twentieth century declines in precipitation were estimated to vary between 10 and 50% across the Senegal River catchment (Gonzalez et al. 2012). The impact of these changes on flows in the Senegal River is uncertain. As data on river flows are lacking over a longer historic time frame, the status of the ecosystem is Data Deficient under subcriterion C3.

Key Indicators in detail

Evidence of Threatening Processes: No

Criterion D DD

Summary

Tree dieback and mortality is one of the biological outcomes of the degradation processes described. Changes in tree density of cover would therefore be suitable proxy variables for biotic degradation. Gonzalez e al. (2012) found that tree density declined significantly from 1954 to 2002 in the western Sahel at Njóobéen Mbataar and Fété Olé, in northern Senegal and that tree species richness declined significantly from 1960 to 2000 across the Sahel in a sample of 14 village areas in Mauritania, Mali, Burkina Faso, Niger, and Chad. They attributed tree decline to two forms of climate variability: increasing temperature and decreasing precipitation, which were jointly attributable to global climate change (Gonzalez et al. 2012). There is also independent evidence of declines in tree density and species richness across the northern and central Senegal savannas. Unfortunately, there are insufficient data available specifically for Gonakier forests of Senegal River floodplain to draw reliable inferences about changes in tree density and species richness within that ecosystem. The status of the ecosystem under criterion D is therefore Data Deficient.

Risk Category DD

Subcriterion	Category	Justification
D1	DD	No reliable information is available to assess the disruption of biotic processes or interactions in the ecosystem in the past 50 years; thus, it is classified as Data Deficient under sub-criterion D1. **Key Indicators in detail** Evidence of Threatening Processes: No
D2a	DD	No reliable information is available to assess the disruption of biotic processes or interactions in the ecosystem in the next 50 years; thus, it is classified as Data Deficient under sub-criterion D2a. **Key Indicators in detail** Evidence of Threatening Processes: No
D2b	DD	No reliable information is available to assess the disruption of biotic processes or interactions in the ecosystem in a 50-year period; thus, it is classified as Data Deficient under sub-criterion D2b. **Key Indicators in detail** Evidence of Threatening Processes: No
D3	DD	No reliable information is available to assess the disruption of biotic processes or interactions in the ecosystem historically; thus, it is classified as Data Deficient under sub-criterion D3. **Key Indicators in detail** Evidence of Threatening Processes: No

Criterion E DD

Summary

No quantitative analysis has been carried out to assess the risk of ecosystem collapse for Gonakier forests of Senegal River floodplain

Risk Category

DD

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