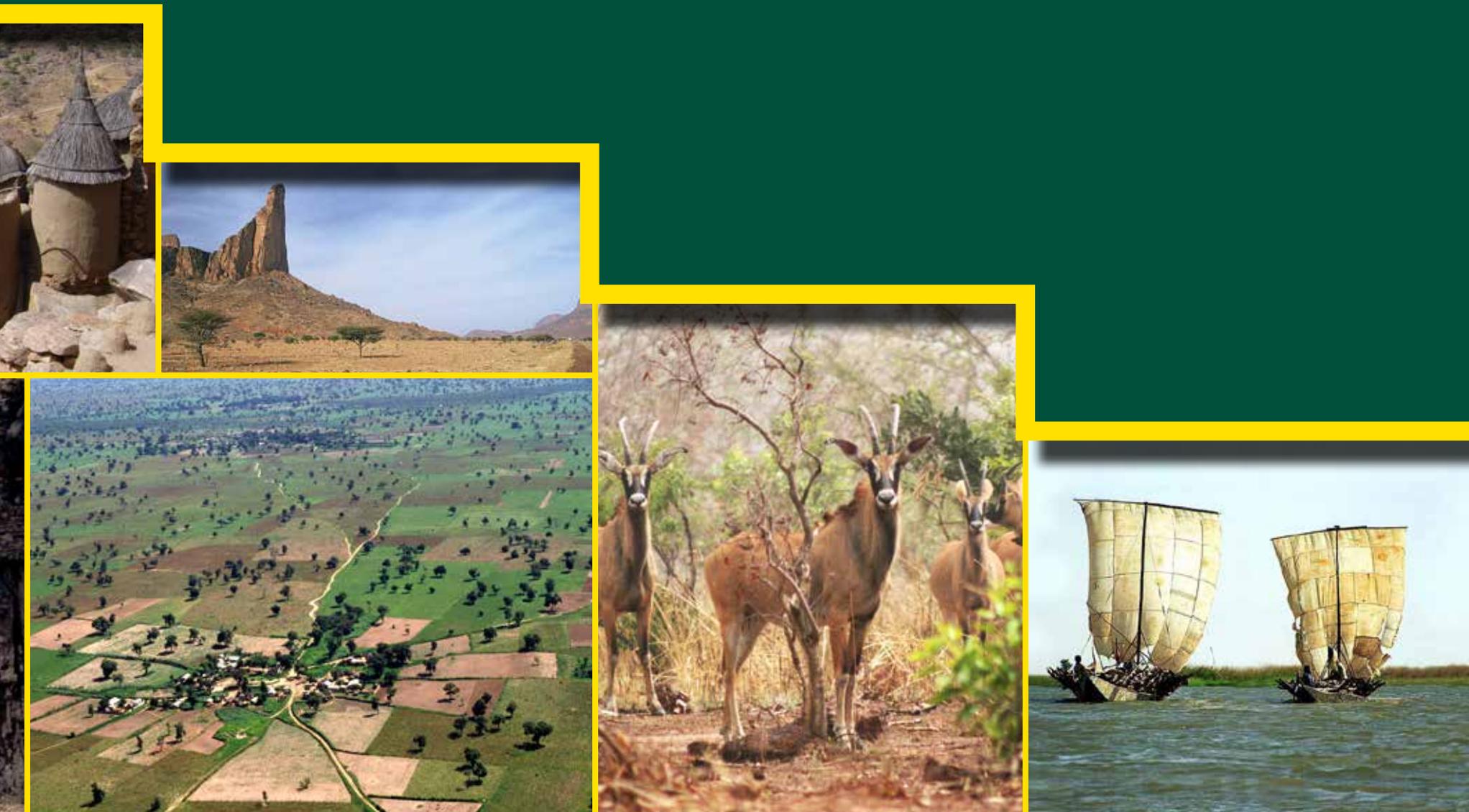


Landscapes of West Africa

A WINDOW ON A CHANGING WORLD



Landscapes of West Africa

A WINDOW ON A CHANGING WORLD



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science for a changing world

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On October 12, 2015, the Lunar Reconnaissance Orbiter took this striking view of the Earth as it circled 134 km above Compton Crater on the Moon, near the terminator between day and night. The sharp black outline of the lunar horizon is from mountains still on the night side of the terminator, silhouetted against the lower limb of the Earth. This image is reminiscent of the iconic Earthrise photograph taken by the crew of Apollo 8 as they orbited the Moon on December 24, 1968. Many people credit that unique view of our home planet as having sparked the environmental movement that so shaped our thinking about our planet during the 1970s and beyond.

Apart from its beauty, this image of the Earth from the Moon shows the African continent quite prominently. A great amount of cloud cover characterizes the blue planet. Several large areas are, however, clear: the deserts of North Africa and the Middle East, and in the Southern Hemisphere, the drylands of southern Africa. The tropical regions of Africa's mid-section are partially covered by belts of clouds that mark the intertropical convergence zone, where the northern and southern circulation patterns merge.





Dr. Djimé Adoum

Since the 1970s, West Africa has experienced many forms of climate stress — heavy rains, floods, and periods of drought. Drought has had a particularly devastating impact on agricultural production, pastoral livelihoods, and natural ecosystems. Economic losses alone are estimated in billions of dollars.

The concerns raised by these climate stressors have translated into initiatives to combat desertification and to adapt to climate change. The Comité Inter-états de Lutte contre la Sécheresse dans le Sahel (CILSS – The Permanent Interstate Committee for Drought Control in the Sahel) and the U.S. Agency for International Development (USAID) have put in place activities to benefit the population of the Sahel and all of West Africa.

The West Africa Land Use Dynamics (LULC) Project is emblematic of this cooperation. Initiated in 1999, the LULC project has had several phases including training national experts to extract pertinent information from satellite images to characterize vegetation cover and producing tools and supporting information on land cover dynamics.

This atlas — *Landscapes of West Africa: Window on a Changing World* — is part of the current phase of the LULC project and provides insights into the changes occurring at national and regional levels through mapping time series data from 1975 to 2013. This work highlights landscapes that have undergone major transformations, and examines the drivers of change and their environmental and socioeconomic impacts.

The atlas showcases the accomplishments of the LULC project, and makes a case for further investment in natural resource management. Aimed at both decision-makers and the general public, the Atlas has a goal of making people aware of the changes taking place in the landscapes of the region.

Beyond raising awareness, the atlas also aims to incite action to protect the environment of West Africa and the Sahelian region. We therefore invite everyone — scientists, students, researchers, teachers, planners, managers of development or research projects, local, national and regional decision-makers, donors, members of civil society organizations, and visitors to the region — to make the most of this work.

Congratulations to the experts at CILSS, U.S. Geological Survey, USAID and the country-level teams of the LULC project for this fruitful partnership. We truly hope that this cooperation will continue and deepen, with the view of regaining the equilibrium of ecosystems. Doing so will constitute a decisive step towards realizing a green economy in West Africa, thereby enhancing the well-being of all West African people.

A handwritten signature in blue ink, appearing to read 'Djimé Adoum'.

Djimé Adoum, Ph.D,

Executive Secretary

CILSS

Ouagadougou, Burkina Faso



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FROM THE AMERICAN PEOPLE

At the core of the U.S. Agency for International Development's (USAID's) mission is a deep commitment to work as partners in fostering sustainable development. Environments that are vulnerable to changing climate patterns are often the most reliant on agriculture for food and income, and the least able to financially protect themselves or respond to disasters. As effects of climate change are felt more severely, advanced mitigation and adaptation measures are key to resilience.

Rapid changes are occurring across West Africa's natural and human landscapes and balancing the need to preserve natural ecosystems with the need to grow more food, together with ensuring resilience in the same ecosystems, is a challenge. USAID West Africa's (USAID/WA) Environmental Threats and Opportunity Assessment and its Climate Change Vulnerability Assessment revealed that timely and accurate information, indispensable for good governance in the environmental sector, is scant and barely accessible. Mitigating climate change impacts and conserving biodiversity can support sustainable development, and prevent countries from sliding further into poverty.

USAID/WA worked in partnership with the U.S. Geological Survey (USGS) and the Comité Inter-états de Lutte contre la Sécheresse dans le Sahel (CILSS – The Permanent Interstate Committee for Drought Control in the Sahel), to analyze changes in land use and land cover in West Africa and to better understand trends over the past 40 years with the goal of improving decision-making in land management. Products derived from these analyses include maps that provide a clear record of changes and trends in three periods — 1975, 2000 and 2013 — in 17 West African countries and aggregated to the regional level.

These maps and analyses form the foundation for future landscape scenarios and contribute to a body of best practices for the re-greening of landscapes in West Africa. Application of the atlas and associated data goes beyond informing decision-making on land

use planning. The time series maps provide credible information to help countries account for their carbon emissions to the United Nations Framework Convention on Climate Change and can also be used to quantify carbon emission trends in West Africa for the past 40 years.

This achievement would not have been possible without the U.S. Landsat Program. Landsat satellites have provided the longest-ever continuous global record of the Earth's surface. A partnership of the National Aeronautics and Space Administration and the USGS, the Landsat program provides image data that show the impact of human society on the planet — a crucial measure as the world's population has already surpassed seven billion people. The first Landsat satellite was launched in 1972 and now, 44 years later, Landsats 7 and 8 are continuing to provide an unbroken record of the Earth, providing critical information for monitoring, understanding and managing our resources of food, water, and forests. No other satellite program in the world comes close to providing such a long, unbroken record of geospatial information of the planet.

Knowing that these analyses will be put to use for decision making in natural resource management, I would like to thank all of the teams that worked tirelessly to produce this Landscapes of West Africa atlas. And my sincere gratitude goes to CILSS, the USGS, and the multitude of government institutions in West Africa for their commitment to completing this influential work.

Alex Deprez
Regional Mission Director
USAID/West Africa
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Alex Deprez



On behalf of the governments and the people of West Africa who have benefitted from the West Africa Land Use Dynamics Project, the Comité Permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel (CILSS – Permanent Interstate Committee for Drought Control in the Sahel) expresses its profound gratitude to all those who have contributed to the publication of this atlas. In particular, we would like to thank:

The U.S. Agency for International Development/West Africa (USAID/WA) which financed, encouraged and contributed actively to the review of this atlas;

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In Memory

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Introduction

Our global ecosystem is and has always been complex, dynamic, and in constant flux. Science tells us how natural forces of enormous power have shaped and reshaped Earth's surface, atmosphere, climate, and biota again and again since the planet's beginnings about 4.5 billion years ago. For most of the planet's history those environmental changes were the result of the interaction of natural processes such as geology and climate, and were described on the geological time scale in epochs spanning millions of years.

When humankind appeared on Earth around 200,000 years ago the influence of human activity on the environment must have been small and localized. The influence of scattered small groups of people on the global ecosystem would have been overwhelmed by the forces of natural systems (Steffen and others, 2007). Human population would not grow to 50 million (about 0.7 percent of the Earth's current population) for another 197,000 years. Population growth accelerated over the centuries that followed until the planet was adding more than that 50 million people every year. Our planet is now home to roughly 7.3 billion people and we are adding 1 million more people roughly every 4.8 days (US Census Bureau, 2011). Before 1950, no one on Earth had lived through a doubling of the human

population, but now some people have experienced a tripling in their lifetime (Cohen, 2003).

With hunting and the use of fire, later agriculture and urbanization, and eventually the industrial revolution and modern technology, the ability of humans to shape their environment also grew exponentially.

Earth scientists use the geologic time scale to describe time periods where different processes and forces shaped events in the Earth's history, such as ice ages and mass extinction events. They use periods of time they call epochs, which range from 11,700 years (the Holocene) to millions of years (the Pleistocene and Neogene). In about 2000, Earth scientists coined a new word — Anthropocene — to describe

a new epoch where “the human imprint on the global environment has become so large and active that it rivals some of the great forces of nature in its impact on the functioning of the Earth system” (Steffen and others, 2011). Many in the Earth sciences believe that epoch has begun and that humankind with its vast numbers and its power to change the face of the Earth is at risk of putting the Earth system out of balance and causing

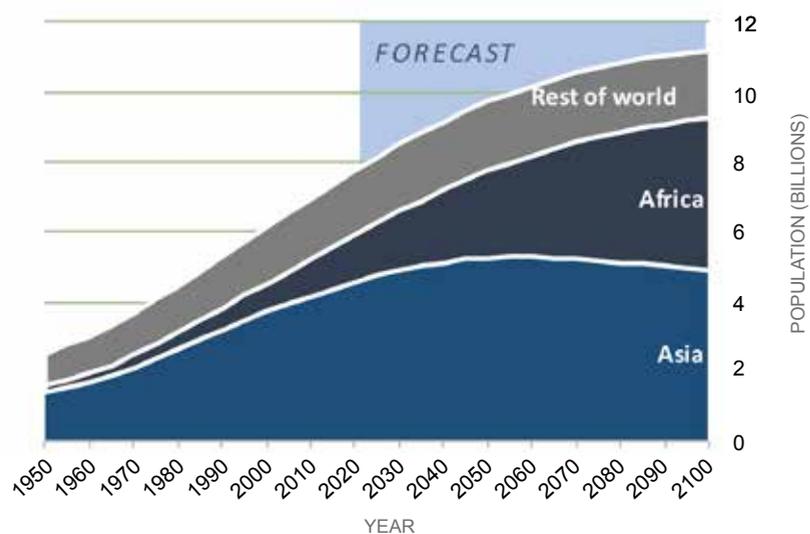
the collapse of natural systems that are essential for humans to thrive, perhaps even threatening the future of all humankind.

In 2015, the 17 countries included in this atlas are estimated to have a total population of over 369 million, representing a nearly 5-fold increase since 1950 — outstripping global population growth, which grew by 2.9 fold during the same time (UN, 2015). The young age structure of the West African population assures continued rapid population growth until 2050 and beyond. If United Nations estimates are correct the 17 countries in this atlas will grow to 835 million people by 2050; that would equate to 11.1 times as many people as lived on the same land in 1950 (UN, 2015)!

“Mai lura da ice bashin jin yunwa” — He who takes care of trees will not suffer from hunger.

— Hausa proverb

Population growth in Africa and the rest of the world from 1950 to 2100



Wooded landscape fragmented by agriculture expansion in western Burkina Faso



JAMES ROWLAND / USGS

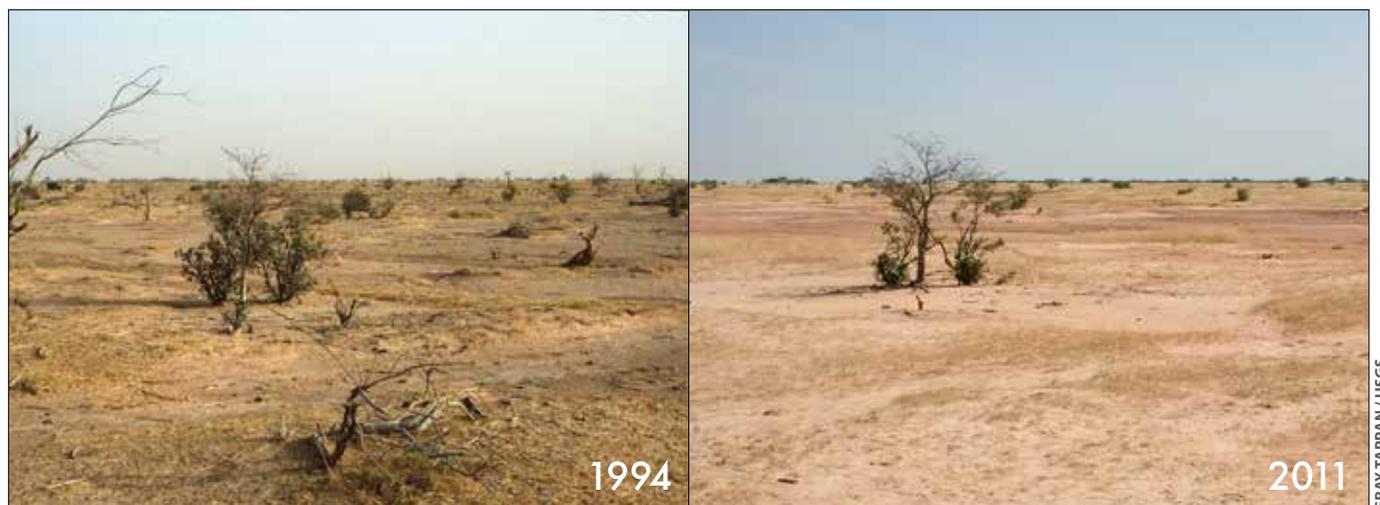
Parallel trends can be seen in the land cover changes of West Africa. With so many new families to feed, West Africa doubled the area covered by farms between 1975 and 2013. Vast areas of savanna, woodland, and forest landscape have been replaced or fragmented by cropland. At the same time villages, towns, and cities have grown in area — taking up 140 percent as much land as they had in 1975. In part to make way for those farms and settlements more than a third of the forest cover present in 1975 has been lost. In savanna and steppe landscapes of West Africa, drought, in some cases made worse by unsustainable land use practices, has degraded the vegetation cover contributing to a 47 percent increase in sandy areas (see top images

pair, opposite page). The future is unpredictable, but the trends of the past four decades projected into the future would be unsustainable.

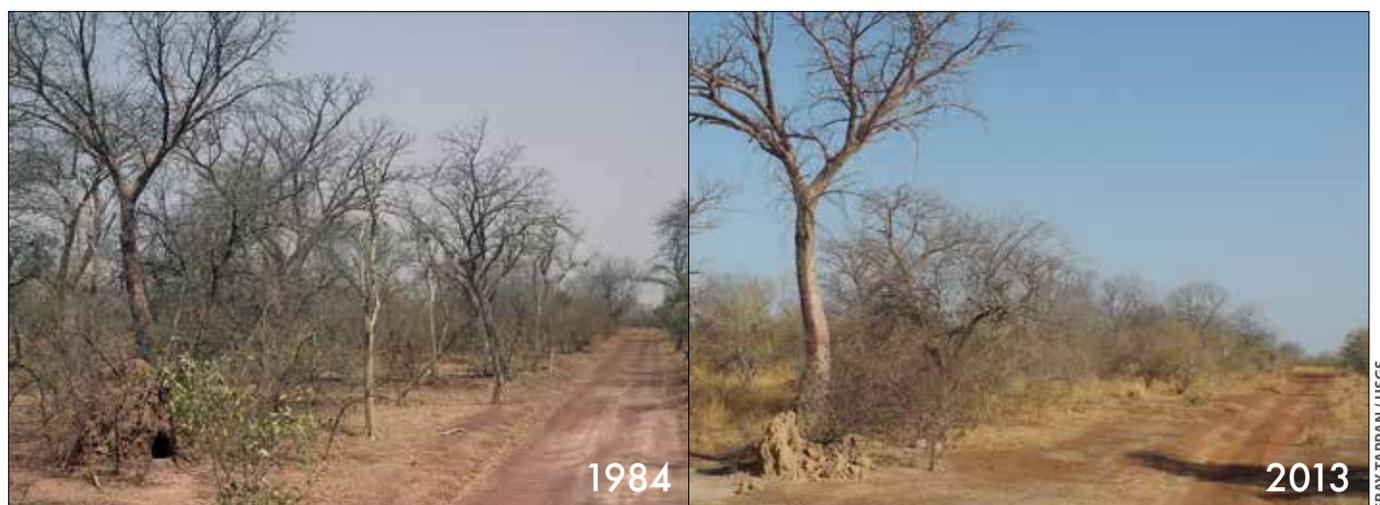
Conversion of the natural landscapes of West Africa to agriculture greatly reduces the natural biodiversity, and exposes the soil to wind and water erosion. The savanna, woodland, forest, and wetland ecosystems that are lost have some relatively tangible impacts such as the loss of natural ecosystem goods and services like wood for fuel and construction, honey, nuts, medicines, game animals, berries, and forage. There are also many important goods and services lost that are less visible such as biodiversity, carbon storage, water quality, water runoff versus infiltration, and regional climate functions.



Expansion of degraded land in the Ferlo region of Senegal



Decline in vegetation cover and biodiversity in east-central Senegal



It is in the hands of today's decision makers to formulate wise, well informed choices about how to manage West Africa's land, to ensure that vital ecosystem services and agricultural productivity are able to support tomorrow's people. To make good choices the governments of West Africa need good information about the rapid changes now occurring, the causes of those changes, and the interactions occurring between climate, land use, other human activity, and the environment.

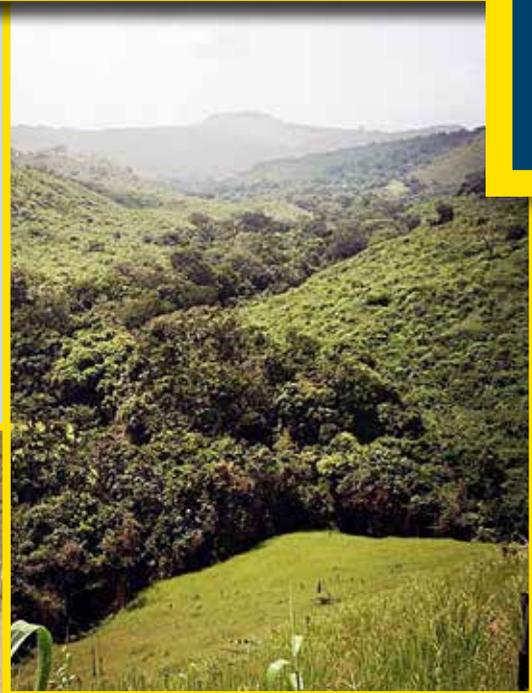
Experts from institutions in 17 countries in West Africa have partnered with the Comité Inter-états de Lutte contre la Sécheresse dans le Sahel (CILSS – The Permanent Interstate Committee for Drought Control in the Sahel), the U.S. Agency for International Development (USAID) West Africa and the U.S Geological Survey (USGS) to map changing land use and land cover and associated factors across much of West Africa through the West Africa

Land Use Dynamics Project. This publication presents the results of that work. The following chapters present maps, graphs, tables, and images detailing the natural environment of these 17 countries and changes that have taken place over the past four decades.

This atlas tells a story of rapid environmental change with both hopeful and worrisome chapters. The story is told with maps and numbers detailing the rate, magnitude, and location of land cover change but also with words and images that seek to make the story more real for the people living in West Africa and around the globe. The hope is that this information helps to build a clearer picture of past and current land use and land cover in order to guide us all in making informed choices that will support the livelihoods and well-being of ours and future generations.







Chapter

III

Country Profiles, Land Use and Land Cover, and Trends



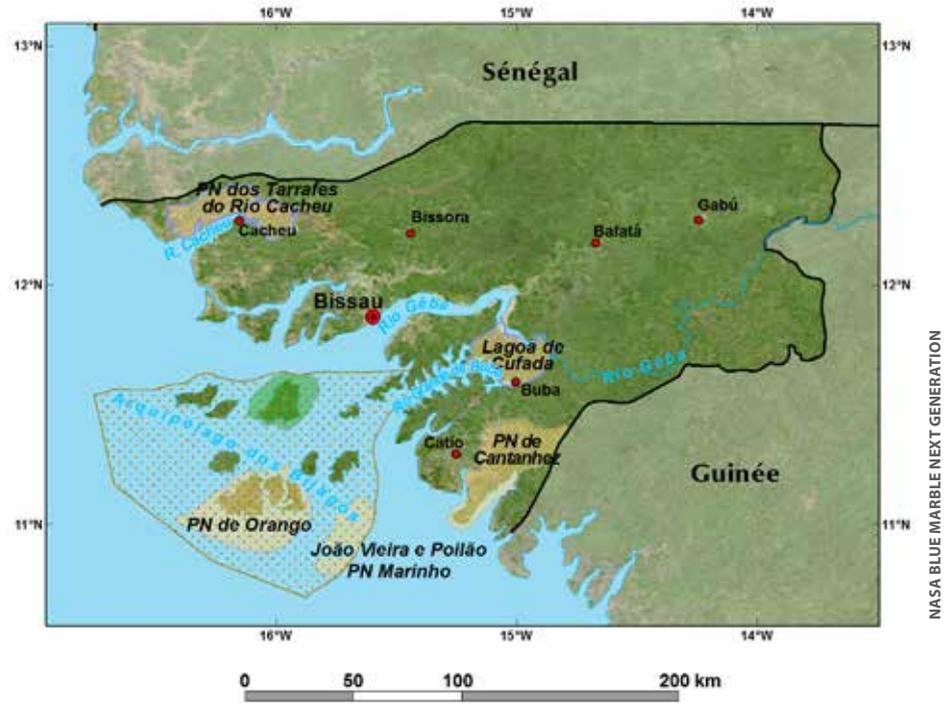


Republic of

Guinea-Bissau

Total Surface Area: 36,120 km²
Estimated Population in 2013: 1,757,000

At just over 36,000 sq km in area, Guinea-Bissau is one of the smallest West African countries. Most of its generally flat terrain averages just 20 to 30 m above sea level, with low-lying plateaus in the east rising to 150 m. Guinea Bissau has an intricate shoreline on the Atlantic Ocean, with numerous estuaries that penetrate inland. Coastal valleys flood regularly, making them conducive to rice cultivation. Half of the population of this former Portuguese colony is found in the coastal zone and has been living for centuries in a tight relationship with the mangrove ecosystem and its rich fisheries. Not far offshore, the Bijagos Archipelago, which includes 18 islands and numerous islets, is regarded as one of the world's most beautiful island groups. Listed in 1966 by UNESCO as a biosphere reserve, the Bijagos Archipelago provides a refuge for abundant marine flora and fauna, including sea turtles and sea hippopotamuses. Some of the islands are also protected as a National Park and as a Community Marine Protected Area. The Bijagos Archipelago is economically important for tourism, fishing, and exploitation of native palm trees. Guinea-Bissau's economy also depends on farming and agro-pastoral activities, as well as on logging for timber. The country ranks fourth in Africa for cashew nut production, with exports from cashews accounting for 60 percent of the national income (FAOstat, 2015).



-  **Biosphere Reserve / Réserve de Biosphère**
-  **Ramsar Site / Site Ramsar**
-  **Parc National / National Park**
-  **Réserve Naturelle / Nature Reserve**
-  **Capitale nationale / National capital**
-  **Autre Ville / Other City**

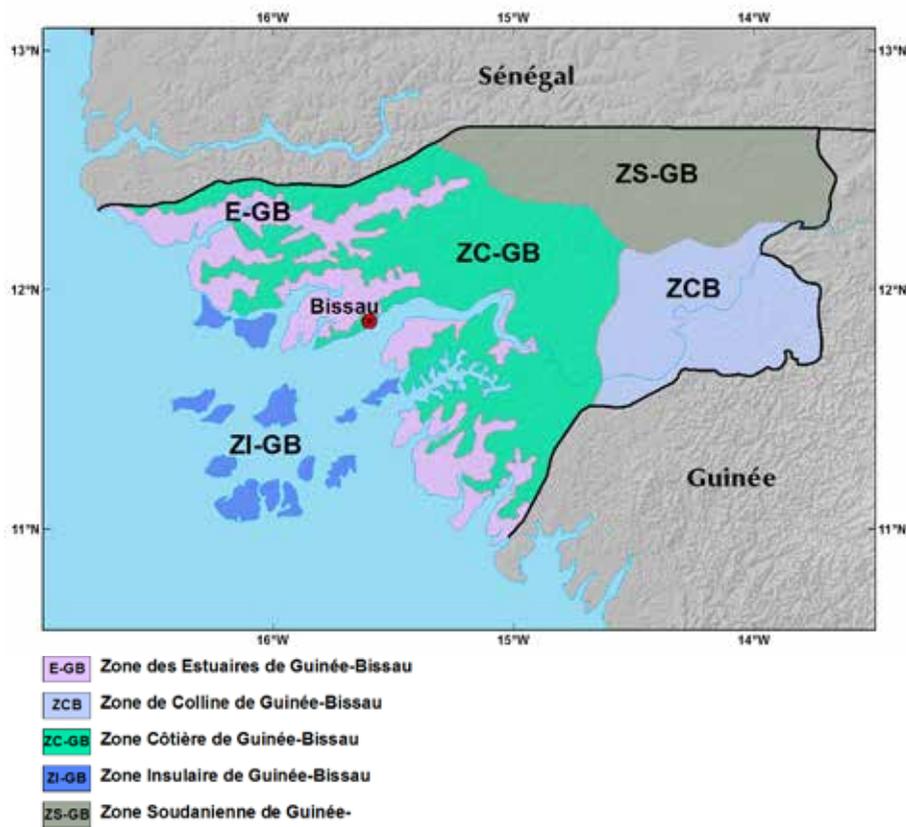
Environmental Highlights:

- Deforestation
- Overfishing
- Diverse mangrove ecosystem
- Ecological richness of the Bijagos Archipelago



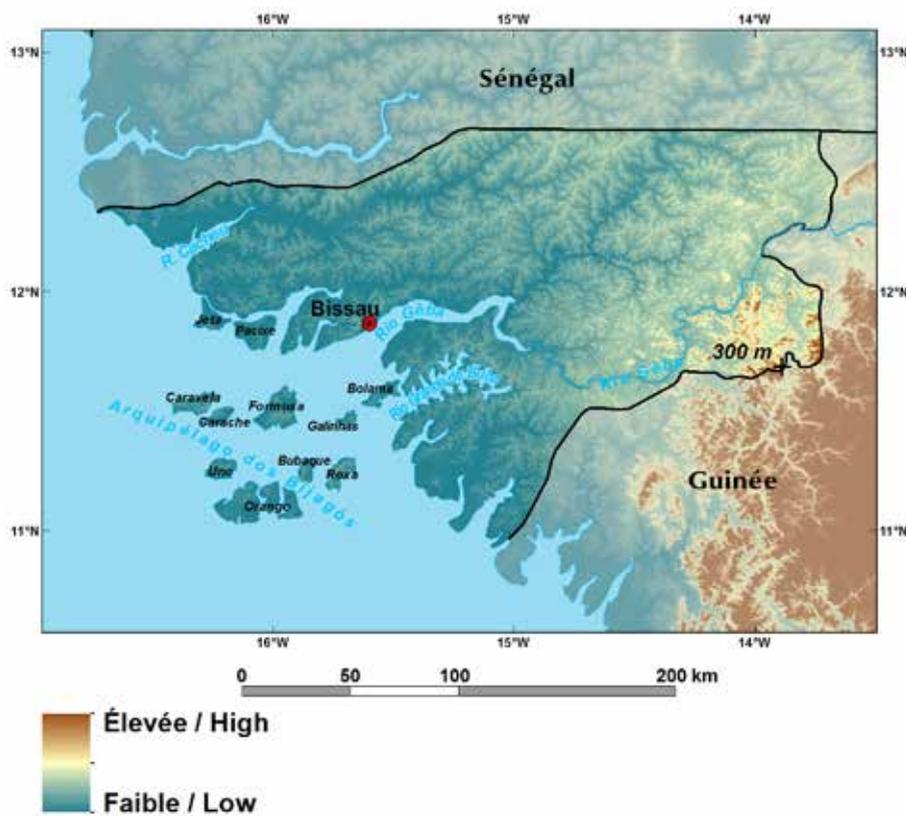
Rice fields and fringing forest

Ecoregions



The Bijagos Archipelago constitutes the first of five ecoregions — the Zone Insulaire de Guinée-Bissau (ZI-GB – Guinea-Bissau Island Zone). On the mainland, two distinctive ecoregions make up the coastal area. The first is the Zone des Estuaires de Guinée-Bissau (E-GB – Estuaries of Guinea-Bissau) where the narrow land-water interface presents a complex system of estuaries, lined with mangrove forests, tidal flats, and herbaceous savanna fringed with palm groves. Just inland is the Zone Côtière de Guinée-Bissau (ZC-GB – Guinea-Bissau Coastal Zone), a low, rolling plain and broad valleys devoted in large part to agriculture, carved out of remnants of Sudanian and Guinean Zone woodlands. In the northeast is the Zone Soudanienne de Guinée-Bissau (ZS-GB – Guinea-Bissau Sudanian Zone), a transition zone of wooded savannas on ancient bedrock between the high Fouta Djallon in Guinea and the coastal lowlands. In the southeast lies the relatively remote Zone de Colline de Boé (ZCB – Boé Hill or Upland Zone), a dissected upland capped by extensive laterite soils and herbaceous bowé formations.

Shaded Relief



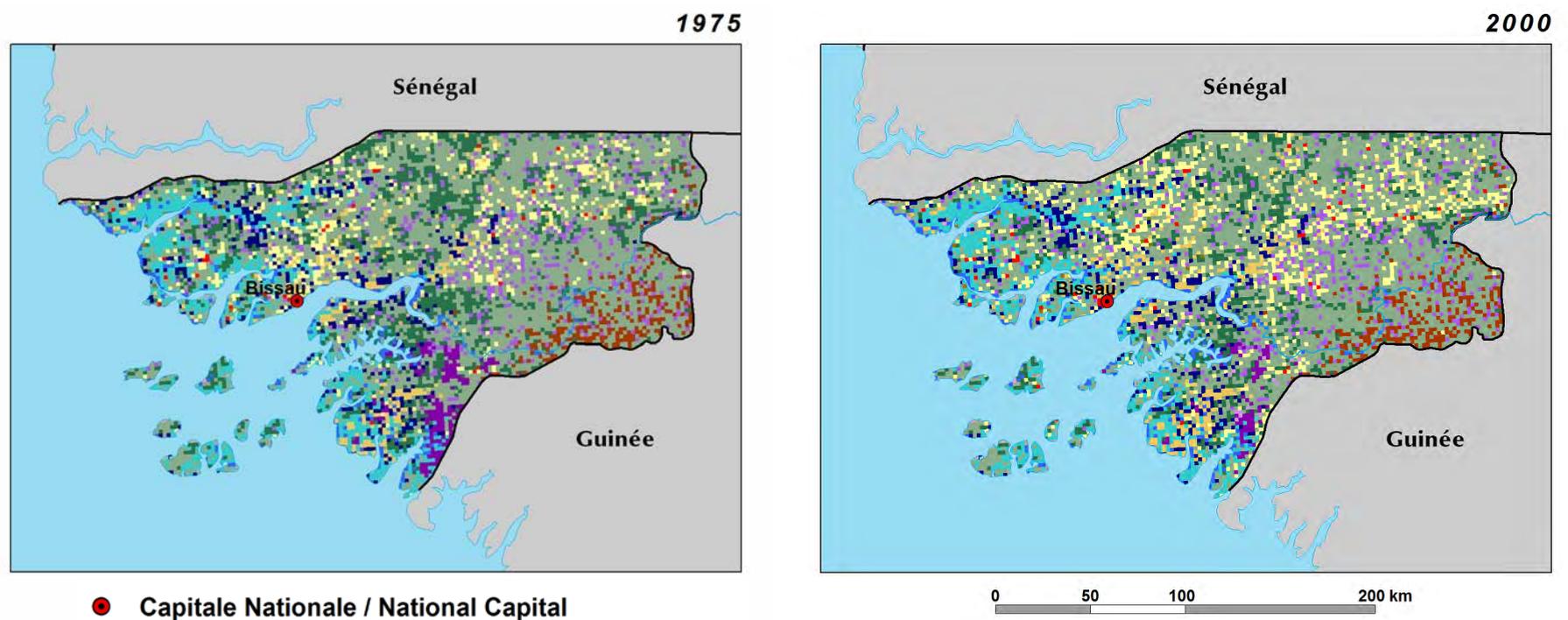
GLOBAL MULTI-RESOLUTION TERRAIN ELEVATION DATA 2010 (GMTED 2010)



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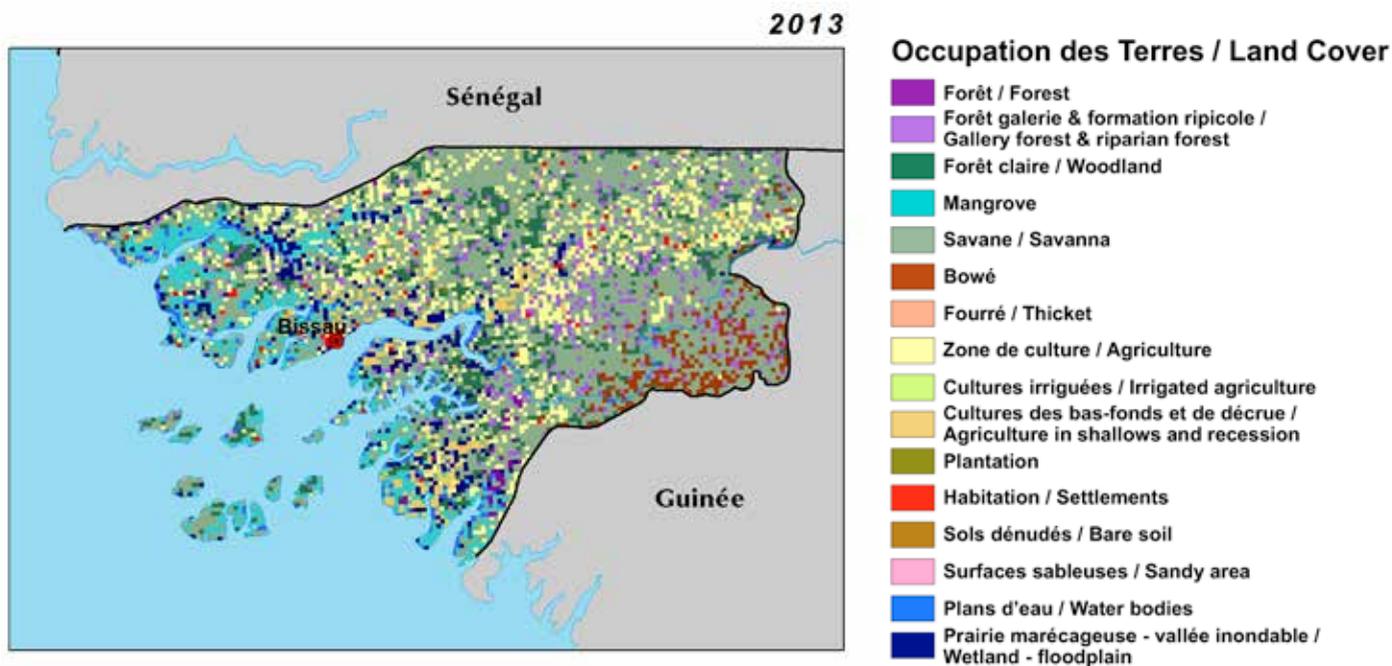
Wetland and mangrove forest in Guinea-Bissau

Land Use, Land Cover and Trends



In Guinea-Bissau, savannas dominate the land cover, accounting for about 45 percent of the country's land surface. Although the total savanna land surface has remained nearly unchanged, the underlying dynamic is not so simple. Agricultural areas have doubled since 1975. Covering 13 percent of the national land surface in 2013, agriculture has become the second most extensive land cover class. Clearing for cultivation has encroached into natural habitats in all of Guinea-Bissau's ecoregions except the Zone de Colline de Boé (ZCB – Boé Hill or Upland Zone). Whereas agricultural

expansion explains the loss of about 2,500 sq km of savannas (or 16 percent of their 1975 total land surface), the degradation of woodlands and forests from logging and clearing has produced open landscapes that take on the characteristics of tree and wooded savannas, increasing the area mapped as savanna in the same period. Deforestation for wood production is responsible for 65 percent of forest habitat losses (forests, woodlands, gallery forests), or 1,700 sq km of forest that have become savannas in 2013.



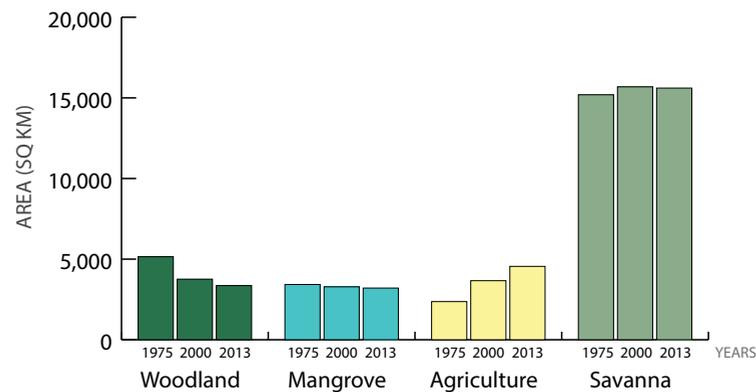
Agriculture in shallows and recession, in particular rice cultivation, colonizes alluvial floodplains in the Zone des Estuaires (E-GB – Estuary Zone) and the Zone Côtière (ZC-GB – Coastal Zone). Rice cultivated areas have slightly increased in Guinea-Bissau since 1975, encroaching into wetlands, gallery forest and mangroves.

Whether from clearing for cultivation, local harvesting of wood, or for external commercial markets, the forest resources have been heavily degraded by rapid exploitation. The rate of deforestation has increased from about 2 percent per year between 1975 and 2000 to 3.9 percent over the 2000 to 2013 period. Overall, Guinea-Bissau lost about 77 percent of its forests between 1975 and 2013; only 180 sq km remain, mainly in the south near the Guinea border. Likewise, woodlands regressed by 35 percent over the 38 years, a loss of 1,750 sq km.

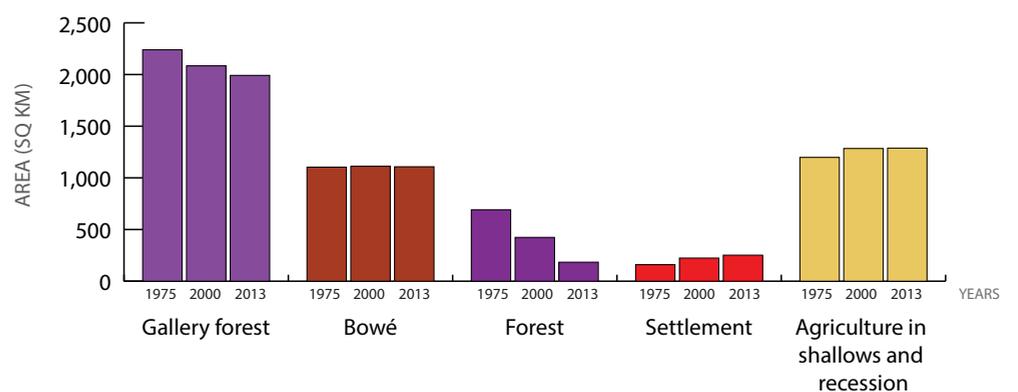
Mangroves are one of the major land cover classes in Guinea-Bissau, accounting for over 9 percent of the country's land surface. This fragile ecosystem is critical to coastal people who take advantage of its rich fisheries and wood resources. They also use the tidal flats for traditional rice cultivation (Corcoran, Ravilious, and Skuja, 2007). Between 1975 and 2013, mangroves decreased by 6.4 percent, or 220 sq km.

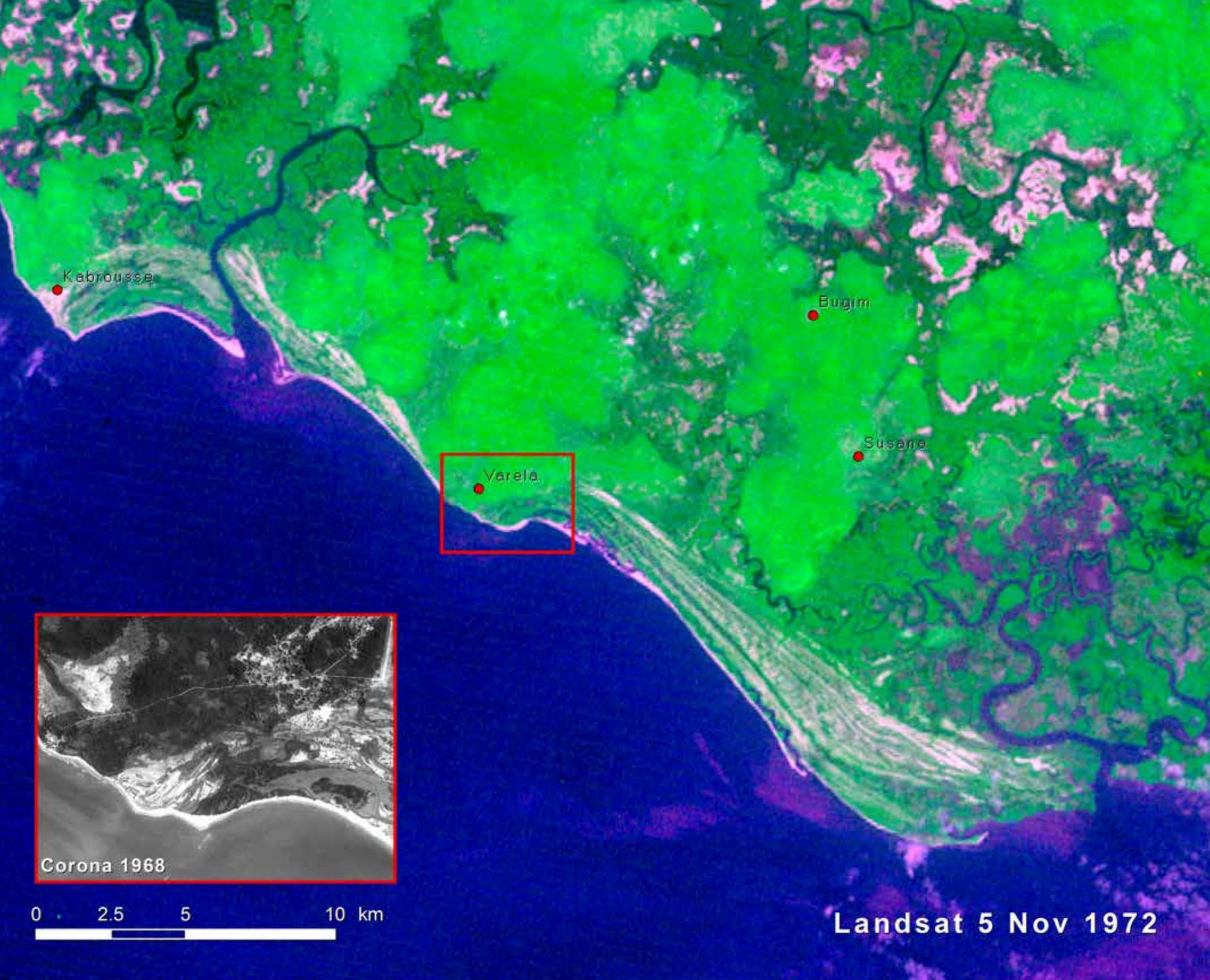
Bowé, lateritic landscapes that characterize Guinean plateaus, cover 3.2 percent of the country's land surface and are mainly found in the Colline de Boé (ZCB – Boé Hill or Upland Zone) ecoregions. These rocky, impenetrable soils are usually devoid of woody vegetation but support a herbaceous cover during the rainy season. As a result, bowé is one of the most stable landscapes in Guinea-Bissau. Bowé is ill-suited to agriculture but conducive to grazing.

Large area classes



Small area classes





0 2.5 5 10 km

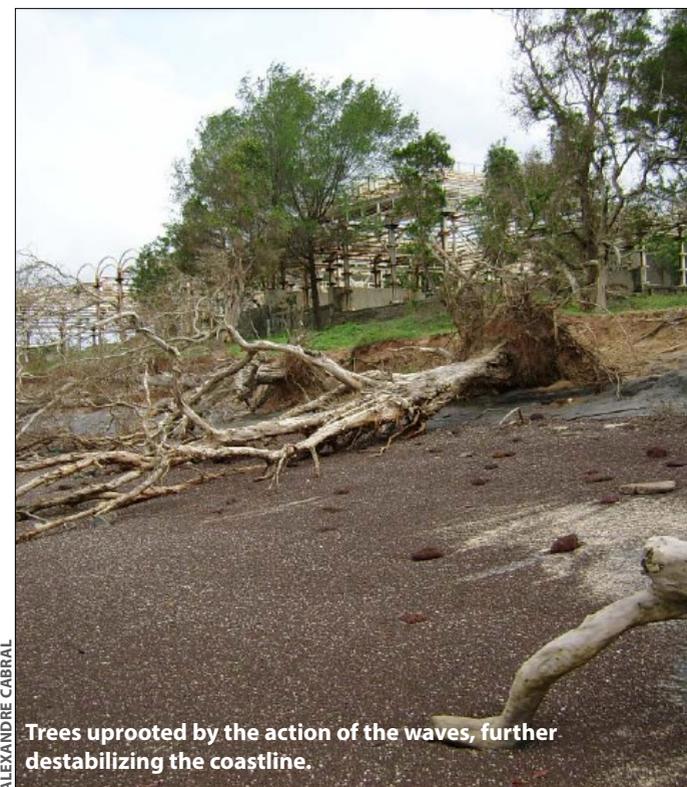
Landsat 5 Nov 1972



Coastal erosion in northwestern Guinea-Bissau

Coastal erosion is a major environmental problem throughout West Africa, but some stretches of the coastline are more severely affected than others. In northwestern Guinea Bissau, coastal zones have eroded rapidly over the past few decades. In Varela, the shoreline has retreated by up to 700 m inland in the past 40 years (see inset above). Both rising sea levels and the destruction of mangrove forests, which act as natural barriers, have been blamed for the loss of land. The loss of mangrove forests is especially visible around Kabrousse and along the coast south of Varela; mangroves have been harvested as fuel wood for smoking fish and for other household needs.

As a result of coastal erosion, trees and infrastructure have been disappearing gradually. Towns and villages located close to the shoreline, where most of the economic activity takes place, are likewise threatened. The ruins of a tourist resort, built in the 1980s, stand as a poignant reminder of the forces of the rising



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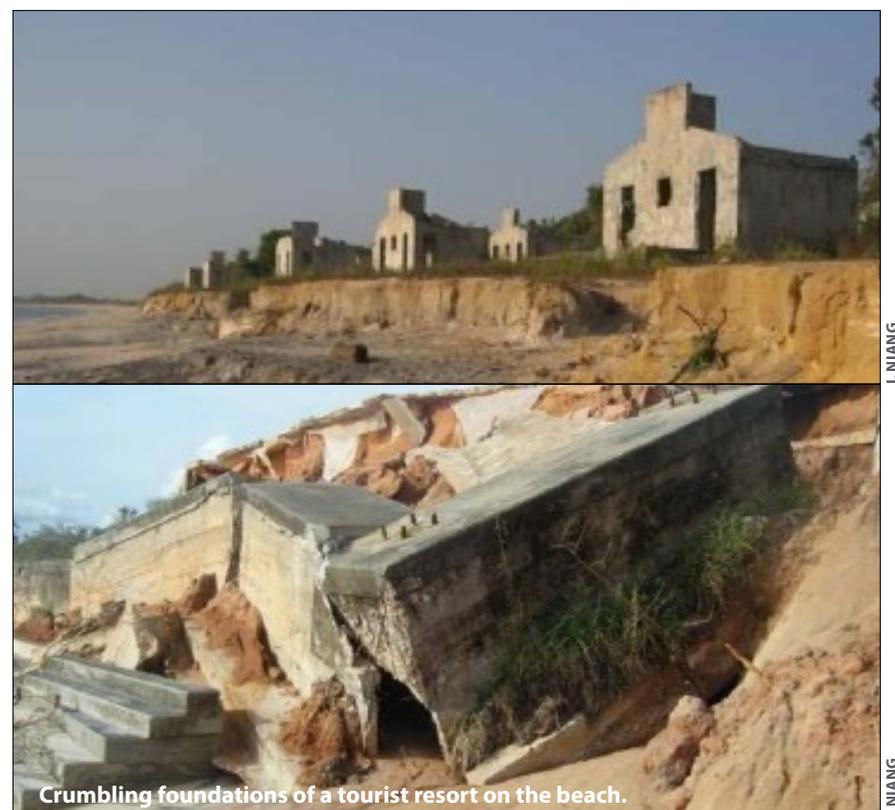
Trees uprooted by the action of the waves, further destabilizing the coastline.



tides (see adjacent pictures). Biodiversity of the coastal ecosystem is also at risk. The habitats of marine turtles and the African manatee, both of whom depend on mangrove forests and sea grass beds, have been shrinking. Saltwater intrusions associated with sea level rise present another threat to the coastal ecosystem.

Due to the severity of coastal erosion in this location, Varela beach was selected as a pilot site for the United Nations' Adaptation to Climate Change in Coastal Zones of West Africa project (UNESCO, 2012). In the course of the project, afforestation and rehabilitation of tourism potential were carried out with the help of the local population, and a biodiversity library was established in the Varela Environmental Audit School. Studies were also conducted of Varela's coastal biodiversity and ecological and economic vulnerability to erosion.

Coastal erosion in Varela is expected to increase due to the sea level rise of over 10 cm since 1950. Hence, preparedness — protection of existing natural barriers, monitoring of the coastline, and creation of alternative income opportunities is paramount (Nicholls and Cazenave, 2010).



Crumbling foundations of a tourist resort on the beach.

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