Landscapes of West Africa

A Window on a Changing World

Back of cover

Landscapes of West Africa

A Window on a Changing World

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USGS 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.

Source: NASA, Lunar Reconnaissance Orbiter

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.

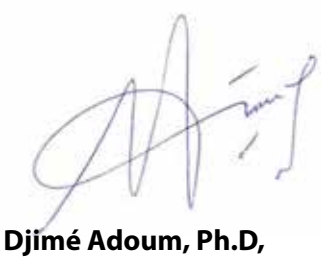
The West Africa Land Use Dynamics (LULC) Project is emblematic of this cooperation. Initiated in 1999, the LULC project has had several phases including training national experts to extract pertinent information from satellite images to characterize vegetation cover and producing tools and supporting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



Djimé Adoum, Ph.D,
Executive Secretary
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FROM THE AMERICAN PEOPLE

Alex Deprez

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
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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:

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In Memory

Our thoughts are with three colleagues and friends who are no longer with us. All three contributed significantly to the success of the West Africa Land Use Dynamics Project, including major content contributions to this atlas:

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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.

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

– Hausa proverb

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)!

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

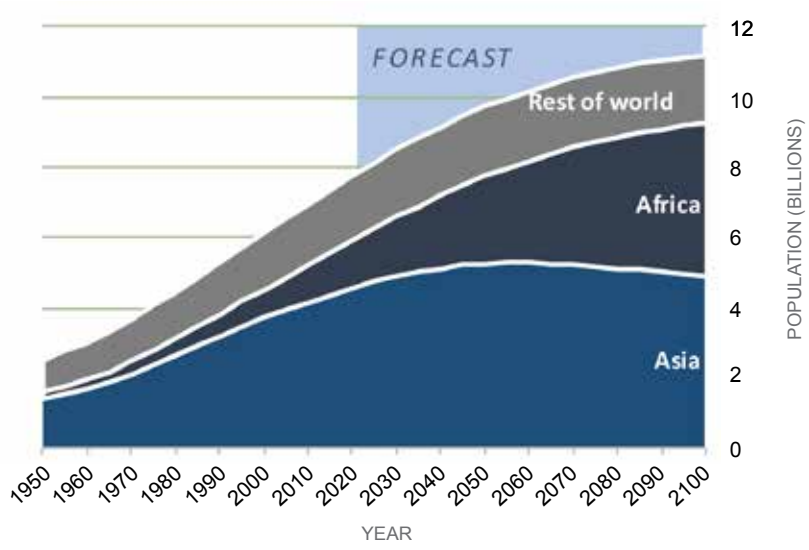


PHOTO (OPPOSITE PAGE): SUZANNE COTILLON / SGT

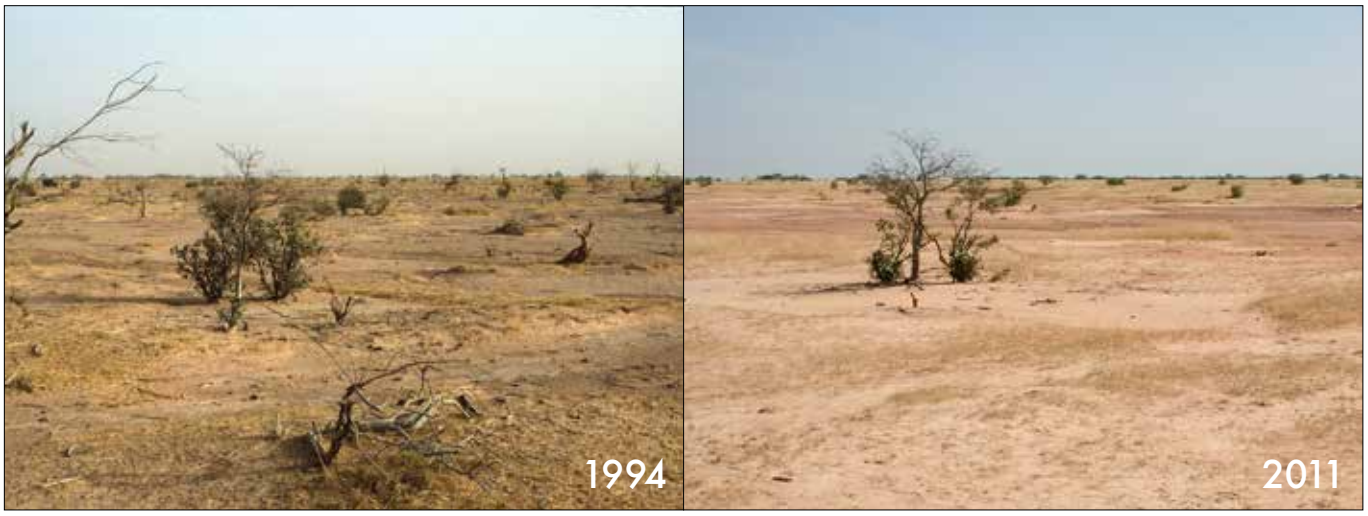
Wooded landscape fragmented by agriculture expansion in western Burkina Faso

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.

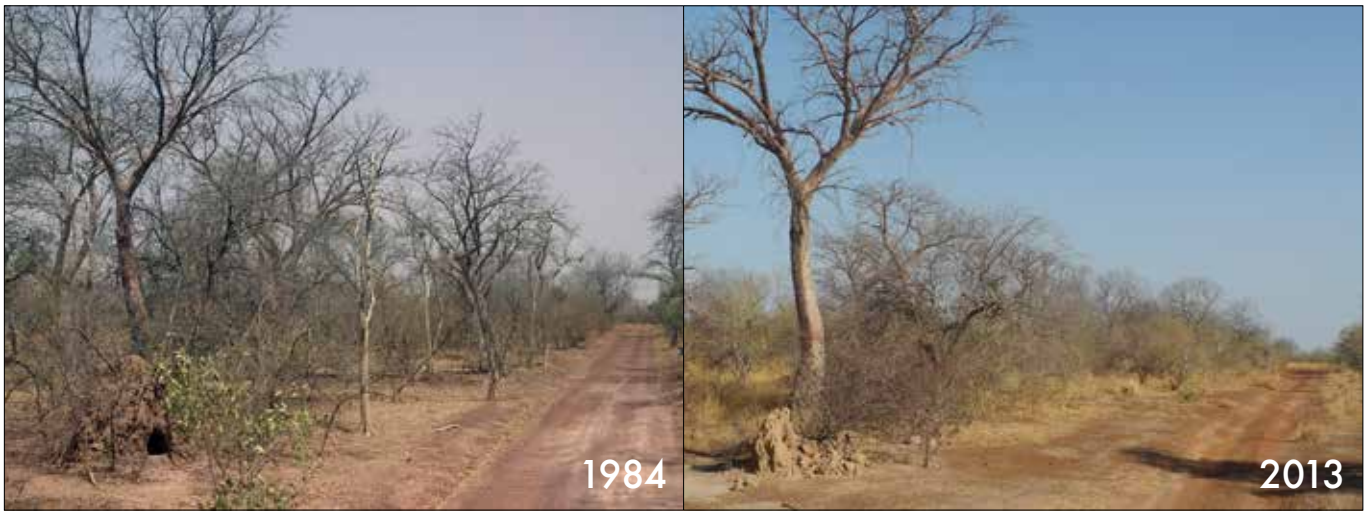
Conversion of the natural landscapes of West Africa to agriculture greatly reduces the natural biodiversity, and exposes the soil to wind and water erosion. The savanna, woodland, forest, and wetland ecosystems that are lost have some relatively tangible impacts such as the loss of natural ecosystem 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



GRAY TAPPAN / USGS

Decline in vegetation cover and biodiversity in east-central Senegal



GRAY TAPPAN / USGS

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 II

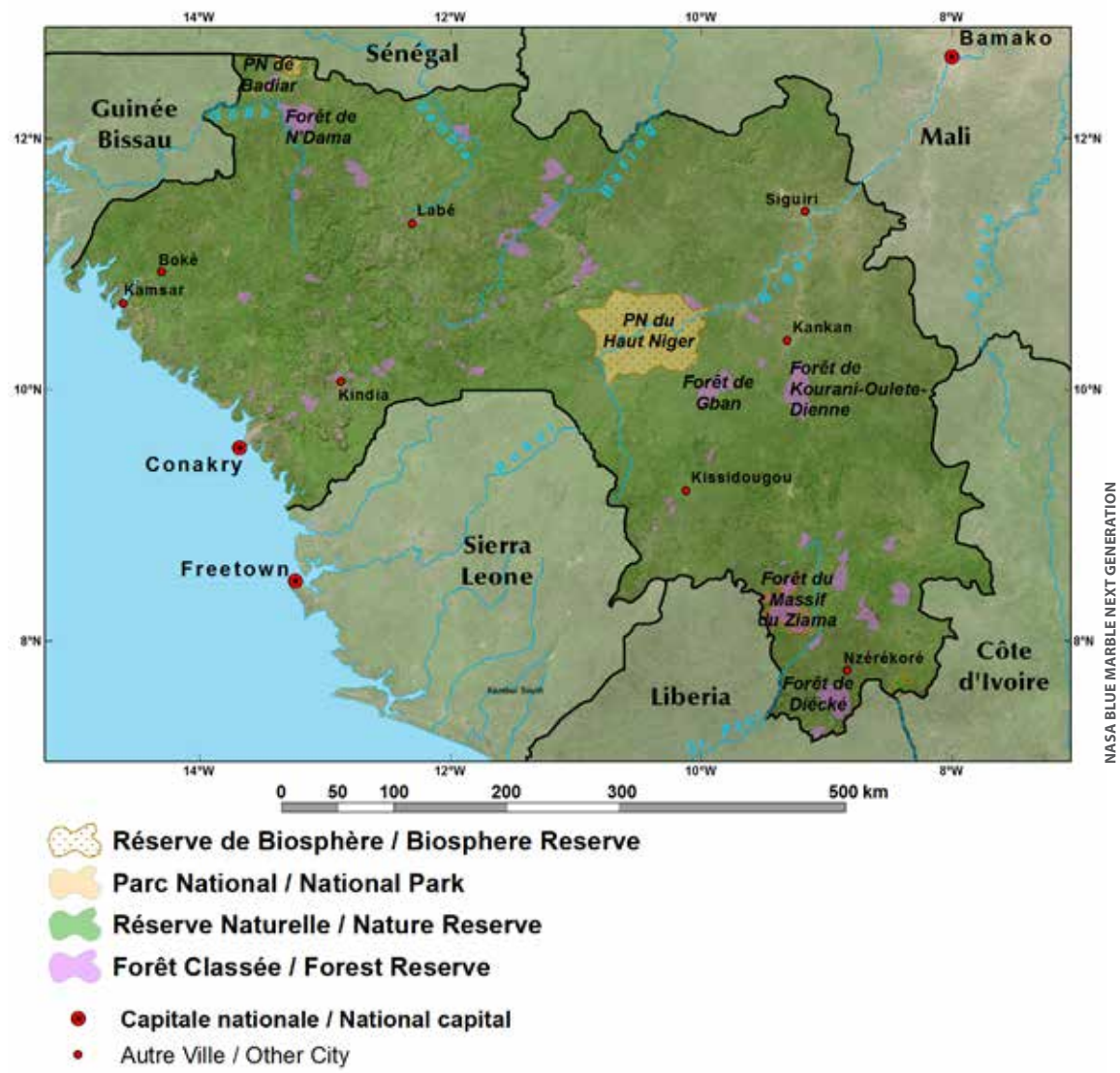
Country Profiles, Land Use and Land Cover, and Trends

Republic of

Guinea

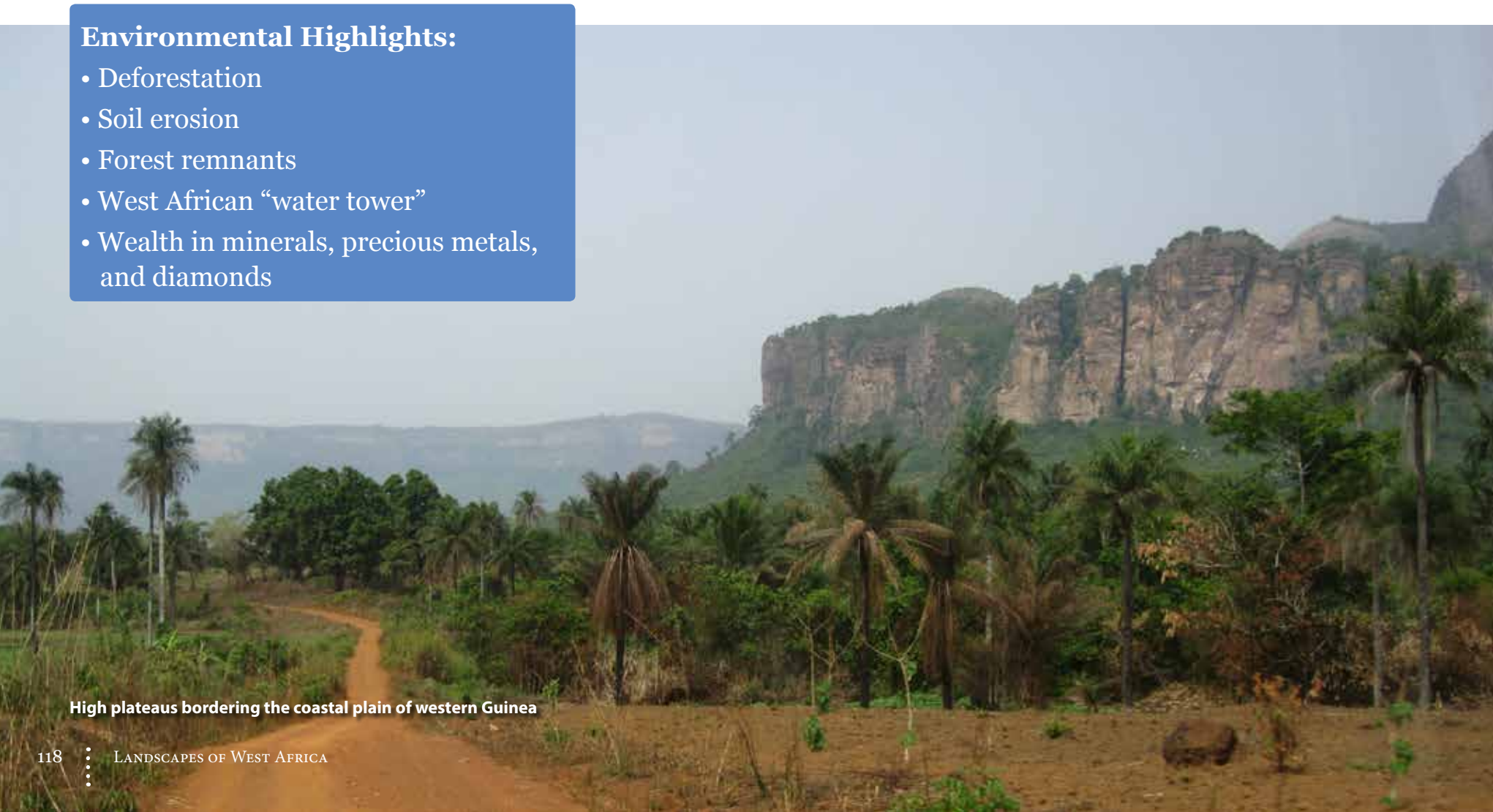
Total Surface Area: 245,857 km²
Estimated population in 2013: 11,949,000

Guinea extends southeast in a crescent from the Atlantic coast of West Africa. Its topography varies from coastal plains to inland mountains that account for about 60 percent of the land area. Several of the region's major rivers, in particular the Niger, Senegal, and Gambia, all originate from these highlands, making Guinea the "water tower" of West Africa. These rivers drain vast arable plains, and upstream offer important potential for hydroelectric energy. Guinea's forests are now mostly limited to a few mountainous areas in the south (Ziama and Nimba), and to gallery forests along watercourses. Guinean landscapes also have the largest extent of lateritic plateaus, called bowé, creating natural clearings of treeless meadows. They are a common feature in the north and west of the country. In addition, Guinea is endowed with huge deposits of mineral resources. It has the largest deposits of bauxite and iron ore in the world and is a gold and diamond producer. Thanks to these mineral resources, Guinea has the potential of being one of Africa's richest countries. Its Atlantic shoreline supports a large-scale fishing industry and has developed large commercial harbors, such as Conakry and Kamsar.



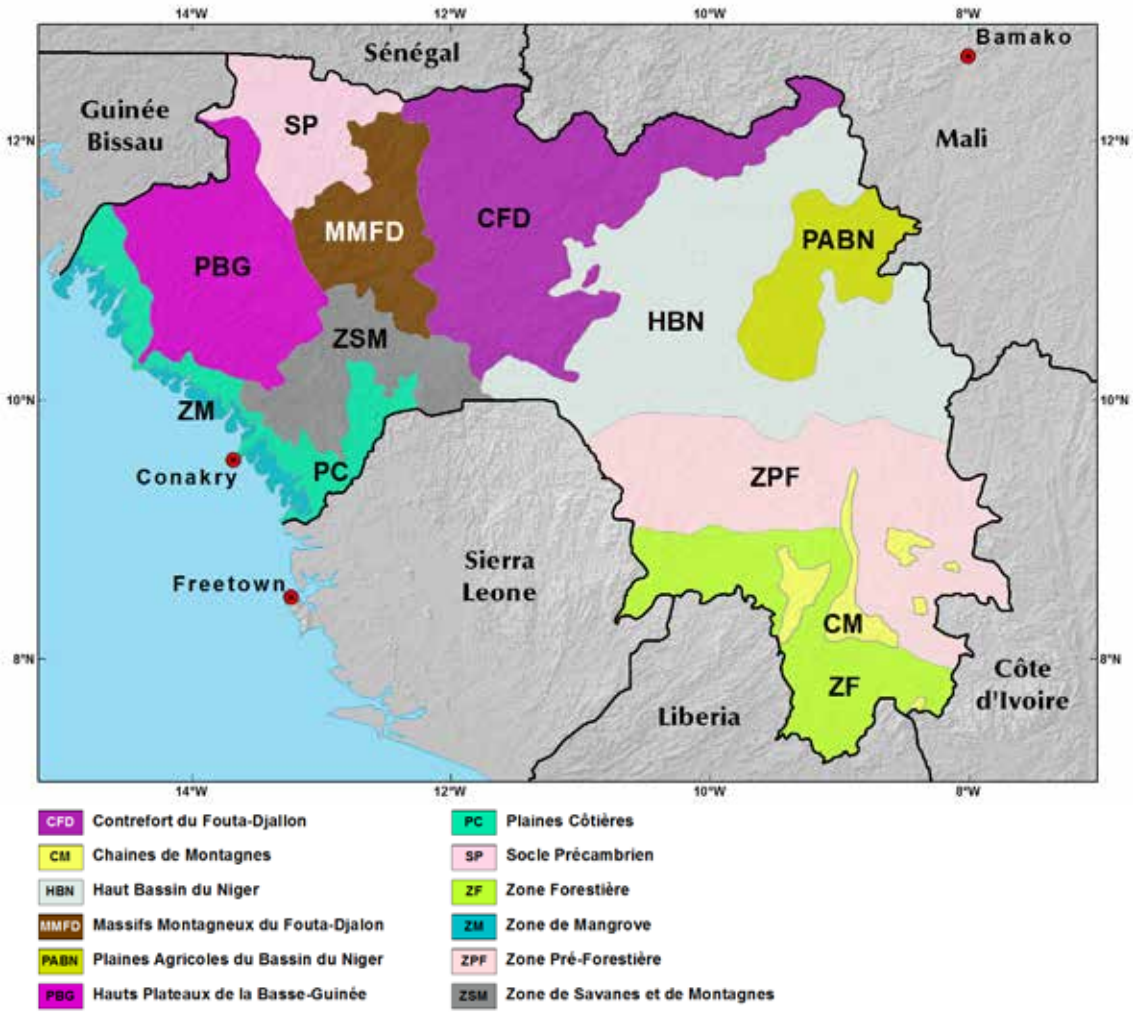
Environmental Highlights:

- Deforestation
- Soil erosion
- Forest remnants
- West African "water tower"
- Wealth in minerals, precious metals, and diamonds

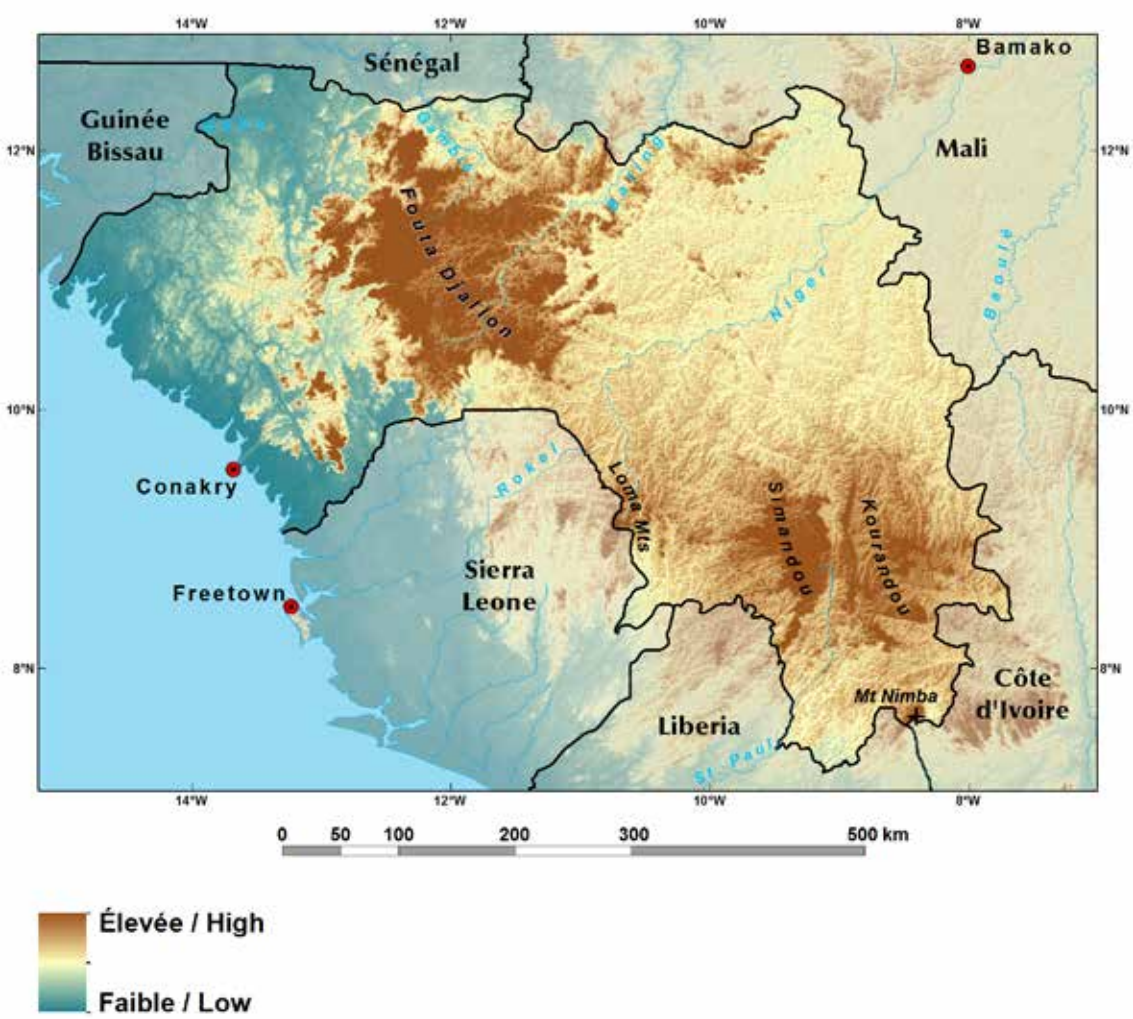


High plateaus bordering the coastal plain of western Guinea

Ecoregions



Shaded Relief



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

In western Guinea, two ecoregions characterize some 300 km of Atlantic coastline and coastal plains — the Plaines Côtières (PC – Coastal Plains) and Zones de mangroves (ZM – Mangrove Zones). Eastward of the coastal lowlands the land rises, at times in the form of spectacular escarpments, into two major ecoregions, the Plateaux de Basse Guinée (PBG – Lower Guinea Plateaus) and the Zone de Savane et de Montagne (ZSM – Savanna and Mountain Zone). Guinea's famous interior highlands are captured in two ecoregions, the scenic Massifs Montagneux du Fouta Djallon (MMFD – Mountainous Blocks of Fouta Djallon) and the Contrefort du Fouta Djallon (CFD – the Foothills of the Fouta Djallon). Both the MMFD and the CFD are made of rugged high plateaus, often capped by laterite (bowé), and dissected by deep valleys. Most of Guinea's rivers originate here, fed by the abundant rainfall of the highlands. Descending to the east, the Niger River and its tributaries have fashioned the low, rolling landscapes of the Haut Bassin du Niger (HBN – Upper Niger Basin) with its broad plateaus and alluvial plains once covered by extensive savannas and gallery forests. This relatively dry part of Guinea falls into the Sudanian climate zone. The south part of the country is home to Guinea's forest zone (ZPF – Zone Pré-Forestière and PF – Zone Forestière), whose ecoregion names derive from the Upper Guinean forest that formerly covered large swaths of this region. The Zone Forestière is made of a ridge, which is a spur of the Fouta Djallon highland, extending as far south as Mount Nimba (1,752 m). The forest is now limited to the high valleys and eastern flanks of these mountainous zones (CM). Although prone to erosion on steeper slopes, the soils of the Zone Forestière are highly fertile, supporting cultivation of food and cash crops, such as coffee, tea, cocoa and rubber.

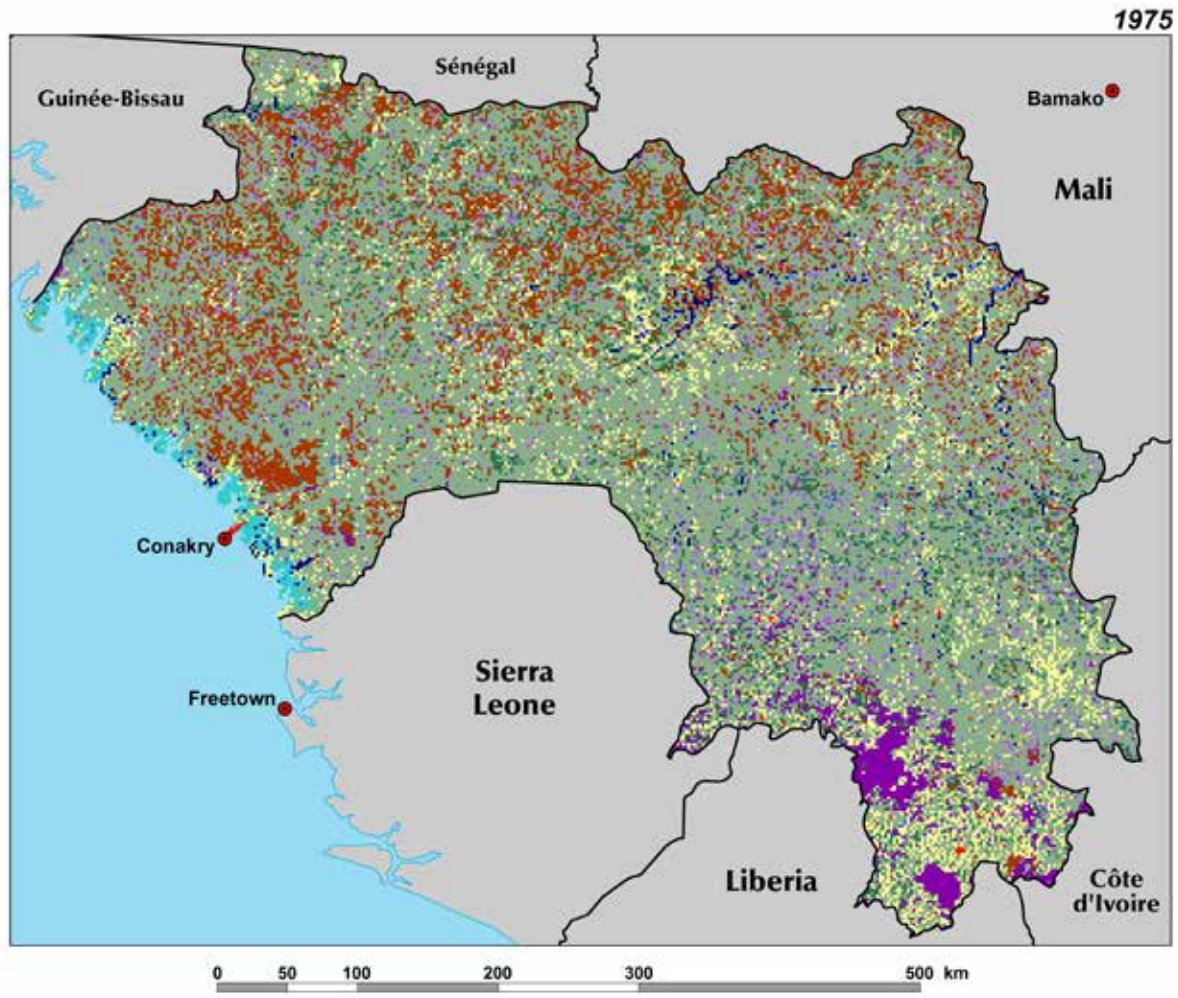
GRAY TAPPAN / USGS

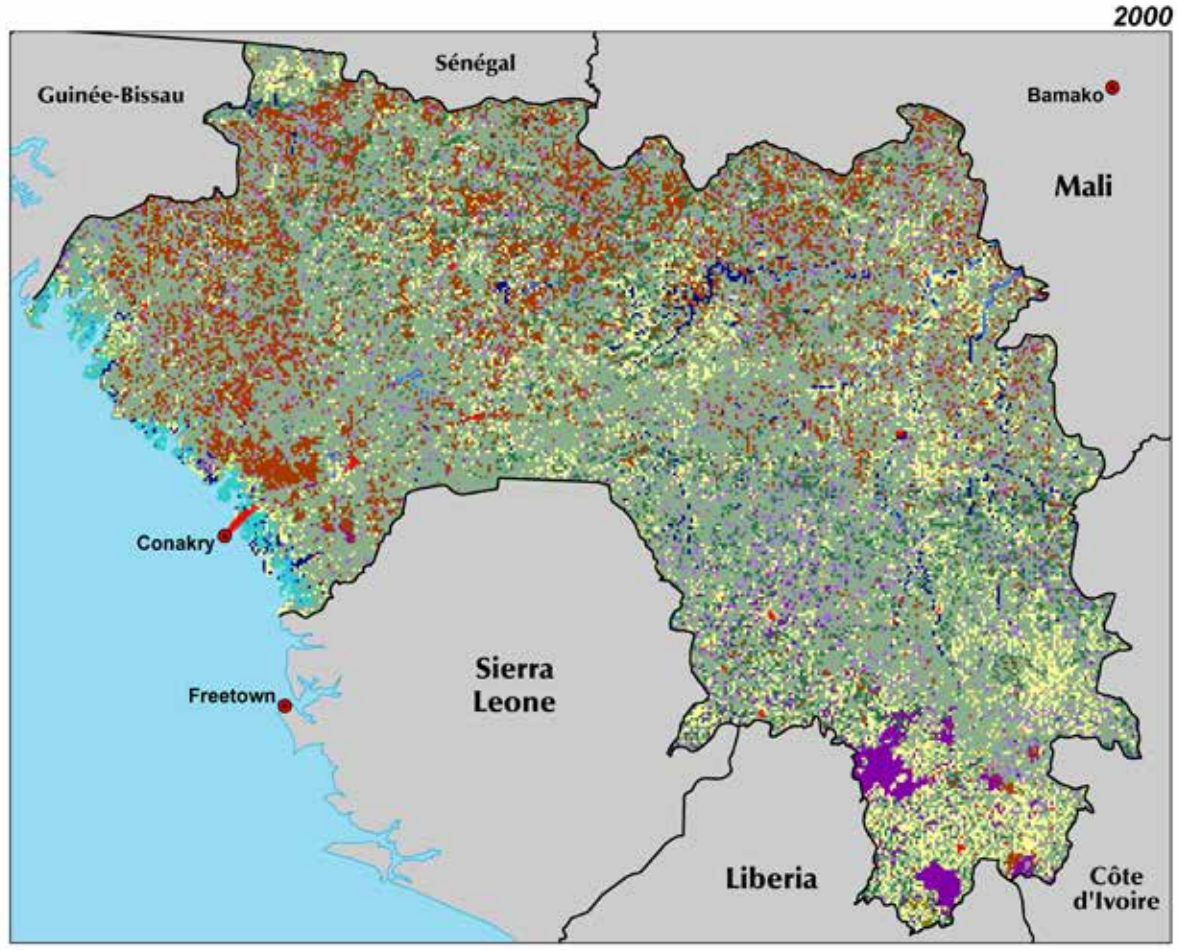
Bowé with characteristic mushroom-shaped termite mounds

PHOTO (OPPOSITE PAGE): GRAY TAPPAN /USGS

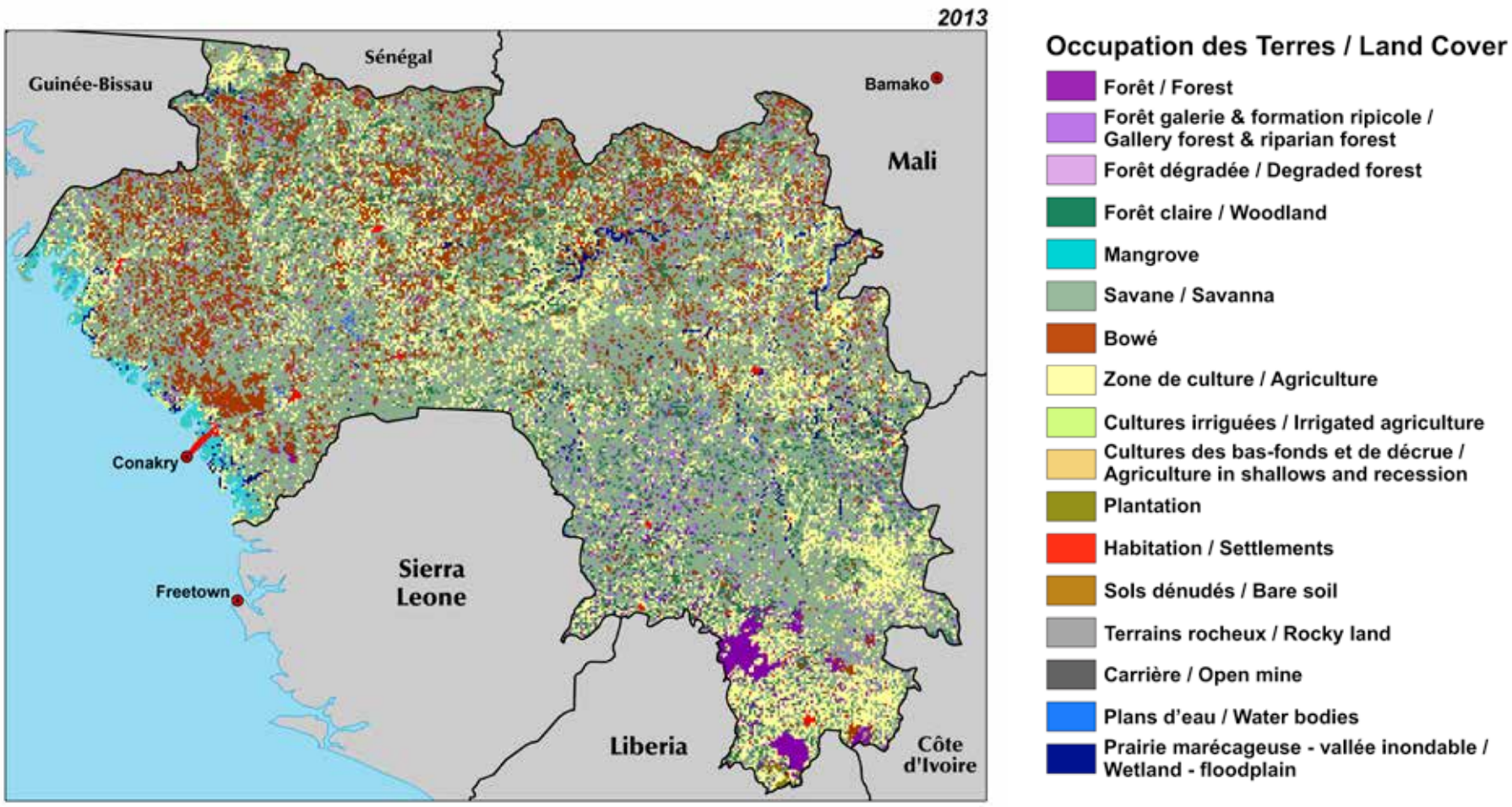
Despite a significant reduction in land area since 1975, savannas still dominate the Guinean landscape, accounting for 54 percent of the national land surface. Savanna loss is mainly due to agricultural expansion, with cropland area having doubled over 38 years. Driven by population growth, the mean rate of agricultural expansion rose dramatically from 1.3 percent per year during the 1975–2000 period to 4.7 percent per year between 2000 and 2013. However, agriculture expansion was not equal throughout the country. Southern ecoregions, especially the Zone Forestière (ZF – Forest Zone), the eastern Zone Pré-Forestière (ZPF – pre-forest Zone), and the Fouta Djallon massif have experienced the greatest expansion. In these zones, the practice of slash-and-burn on steep slopes increases their vulnerability to erosion. However, agricultural practices, such as terrace cropping and rock lines have helped to mitigate soil erosion. Farther westward, on the Plateaux de Basse-Guinée (PBG – Lower Guinea Plateaus), in the Zone de Savanes et de Montagnes (ZMS – Savana and Mountain Zone), and in the ecoregion of the Socle Précambrien (SP – Precambrian Shield) where soils are rocky, non-productive, and relatively unsuitable to cultivation, agricultural development is limited to alluvial valleys and low plateaus. Irrigated agriculture has also doubled since 1975, especially in the Plaines Agricoles du Bassin du Niger (PABN – Agricultural Plains of the Niger Basin), which lend themselves to rice cultivation.

Between 1975 and 2013, forest areas decreased by about 33 percent to only 4,440 sq km, found mainly in the Zone Forestière (ZF – Forest Zone). One major cause of this reduction is the significant population growth resulting from a heavy migration from the north and from a huge influx of refugees from Sierra Leone, Liberia, and Côte d'Ivoire. Non-protected forest areas have been severely degraded by uncontrolled logging for both local and commercial uses, and by slash-and-burn cultivation. While Guinea's national forests are receding, there is remarkable stability among Guinea's forest "islands" (Fairhead and Leach, 1994). Many hundreds of forest islands — areas of high forest around villages — have been encouraged and managed by villagers for centuries. Several ethnic groups in the forest-savanna transition





Capitale Nationale / National Capital

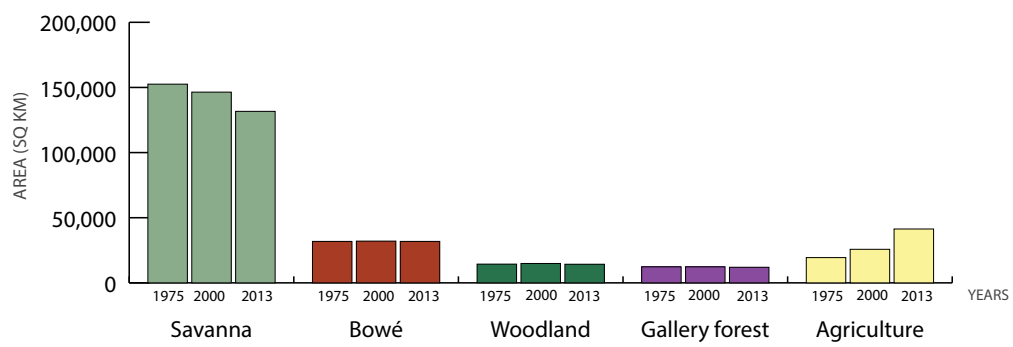


zone maintain these multi-purpose forest islands (see page 57). Woodlands and gallery forests, with a land surface three times higher than that of dense forests, have not experienced the same high level of deforestation as Guinea's dense forests. Woodlands and gallery forests are found in all regions of Guinea and their surface area has only decreased by 0.5 and 2.7 percent, respectively, over the 38 years.

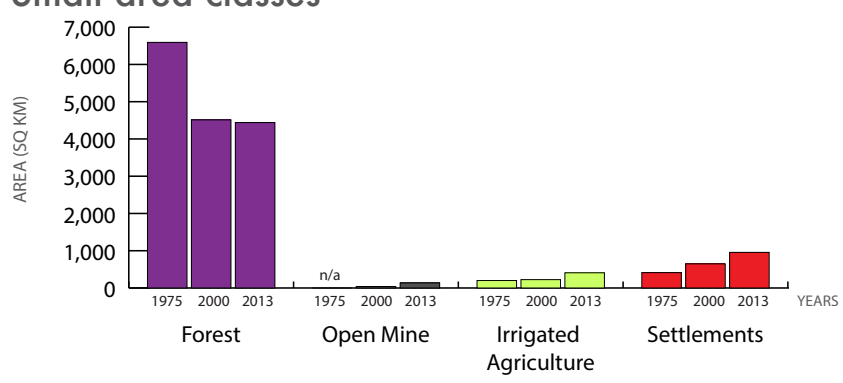
Bowé — laterite-capped plateaus that characterize much of Guinea's landscapes — accounts for 13 percent of Guinea's land surface. Naturally, bowé are very stable over time. While unsuited to cultivation, these treeless grasslands serve as important water catchment areas and as pasture for livestock.

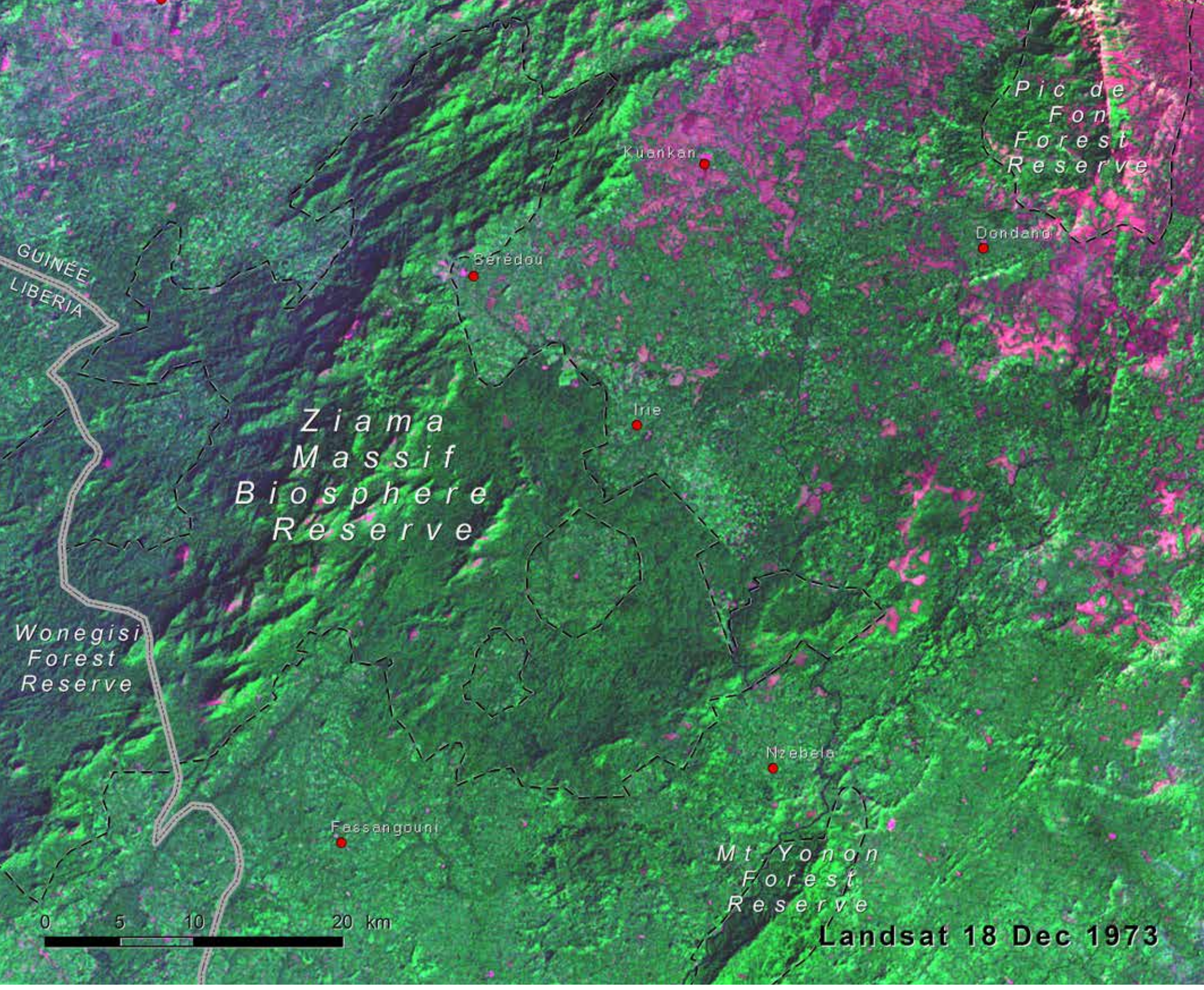
The land area of large industrial mines has tripled between 2000 and 2013, increasing from 40 sq km to 130 sq km. They are testimony to the development of Guinea's growing industrial mining sector. Although local-scale artisanal mining is difficult to map at a national scale, it has also intensified as the price of gold has risen, and has a significant impact on the environment.

Large area classes



Small area classes

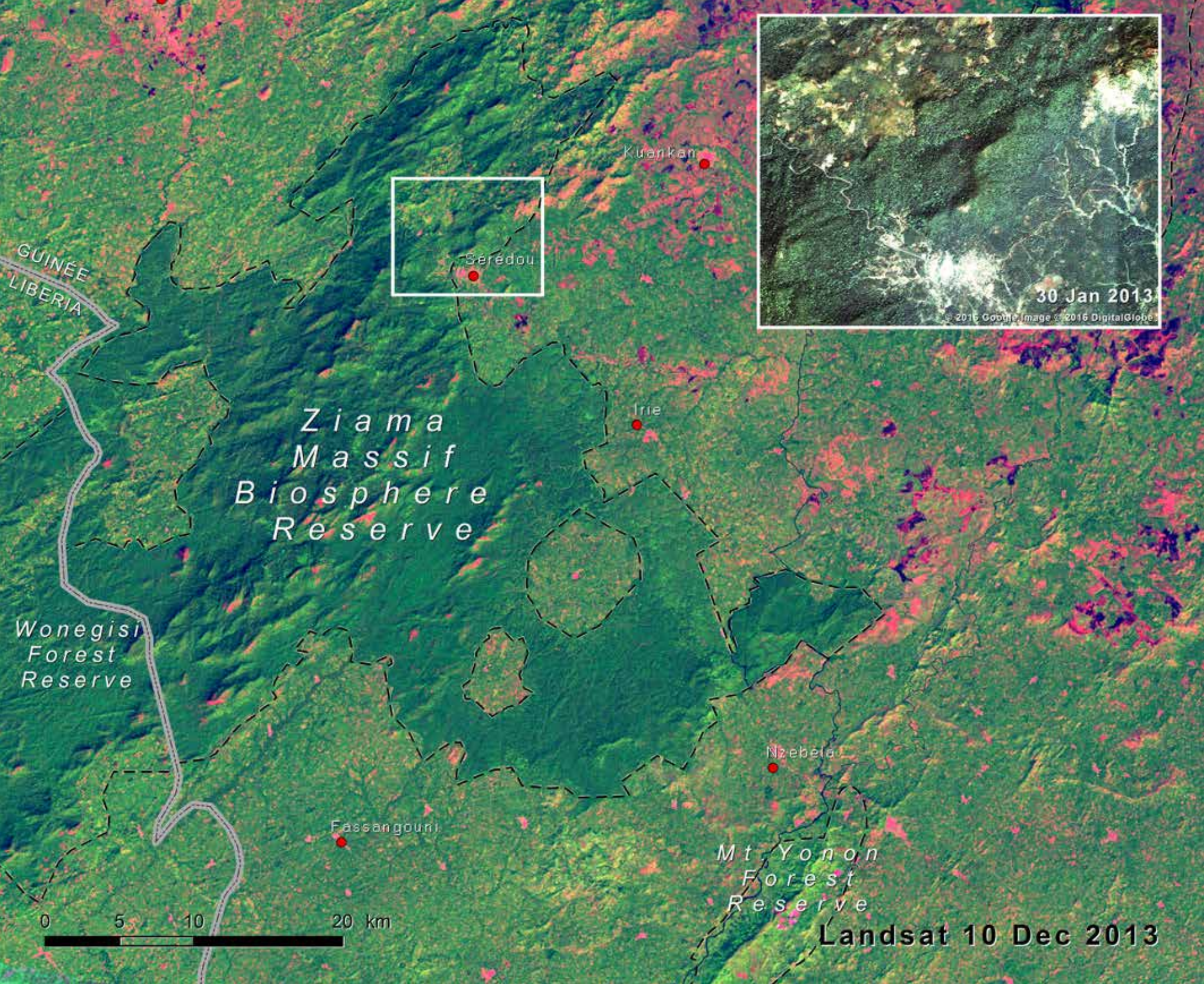




The Ziama Massif: A relic of the diminishing Upper Guinean forest ecosystem

The Ziama Massif is part of the Guinean Highlands region; elevations rise nearly 1,400 m above sea level. This mountain range is characterized by rugged terrain with valleys, plateaus, rocky peaks, cliffs, and granite outcrops. Mean annual precipitation varies from 1,700 mm to 2,000 mm. The vegetation communities on the massif include savanna, primary dense mountain forest, secondary mountain forest, as well as woodland in the northern valleys, plains and swamps. The massif supports a great diversity of Guinean zone tree species.

This highly biodiverse area, with a great number of threatened mammal species (chimpanzee, Diana monkey, pygmy hippopotamus, elephant) and a large diversity of plant species, is one of only four biosphere reserves in Guinea. The Ziama Massif was designated a forest reserve under French colonial rule in 1932, in an effort to stop "savannization," the perceived advance of the savanna from the north. After independence, however, the new state-run economy put major emphasis on agricultural development, with biodiversity conservation given very low priority. As a result, farmers cultivated many of the protected areas established in the colonial period. In 1981, the Ziama Massif was made a Biosphere Reserve. In order to better engage local support, conservation is enforced with decreasing intensity outward from the core and allows increasing rural development activity in the buffer and transition areas (Fairhead and Leach, 1994).

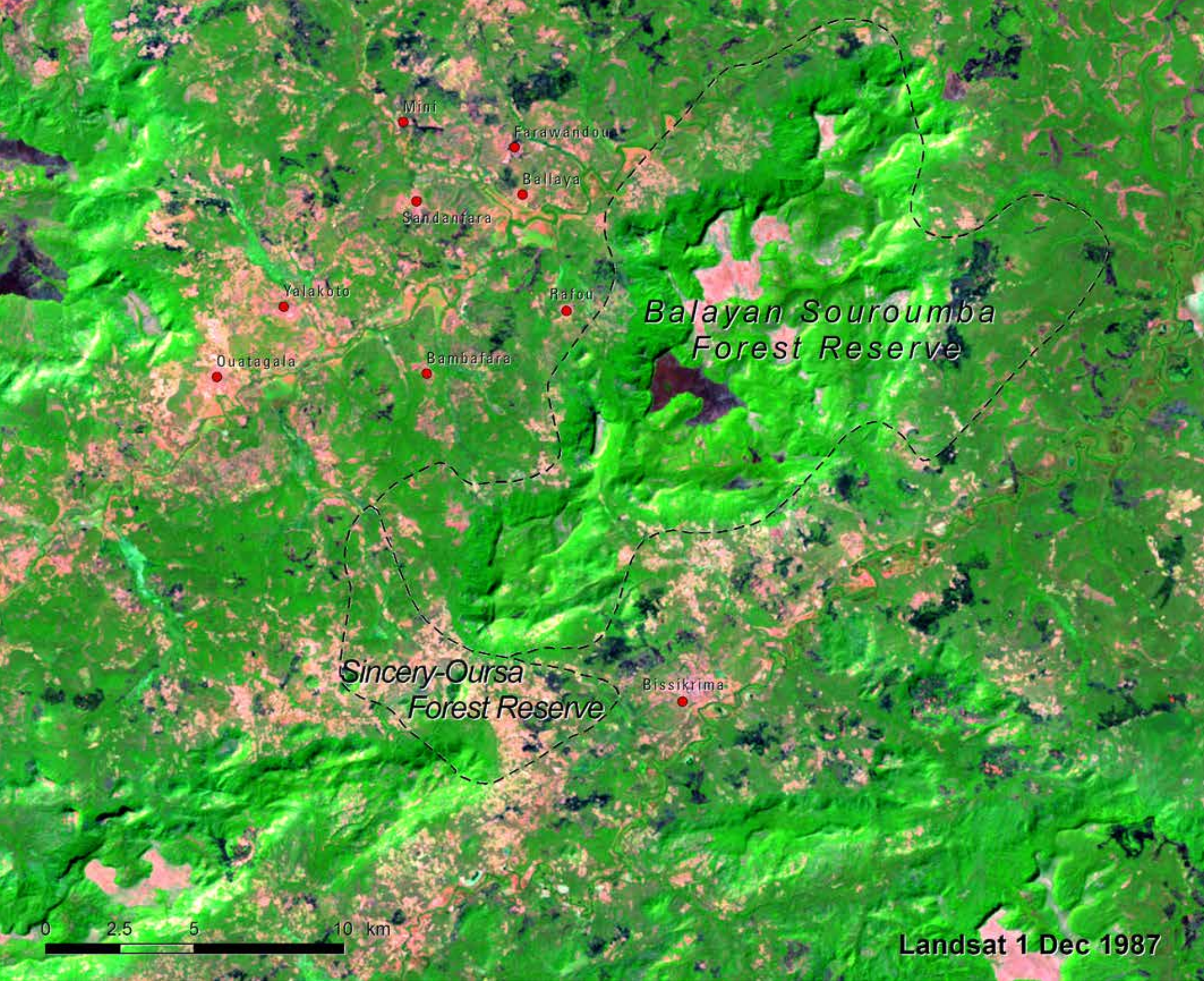


As in the case of the Kangari Hills in Sierra Leone (see pages 188–189), the conservationists' view of a supposedly "pristine" forest stands in contradiction to evidence of abandoned village sites and detailed written and oral accounts of a prosperous agricultural landscape in the mid-19th century, accounts that have shaped local perceptions. Clashes between subsistence needs of a growing population — 29,000 people in 23 villages in and at the margins of the reserve, and in the town of Sérédou — and long-term conservation interests have been exacerbated by the slow start of promised rural development activities in the buffer zone (Fairhead and Leach, 1994). It is unknown to what extent the management plan for timber extraction and agroforestry in the buffer zone is being followed, or to what extent shifting agriculturalists and refugees are exploiting and encroaching the reserve (Brugiere and Kormos, 2009).

The Landsat images of the Ziama Massif and surrounding area from 1973 and 2013 show relatively stable forest cover inside the Biosphere Reserve. In 1973, agriculture was already present around the reserve, but the surrounding landscape was still wooded and dominated by natural habitats. By 2013, farmland replaced most of the savanna and woodland outside of the reserve boundary. Agriculture started to encroach on the outskirts of the Ziama Massif, especially in the northern part around Sérédou (see inset). With rates of population growth of 2.6 percent per year, an influx of refugees from neighboring countries, and the predominance of itinerant agriculture, there is a need for careful planning and multi-stakeholder management in order to preserve this hotspot of biodiversity.

GRAY TAPPAN / USGS

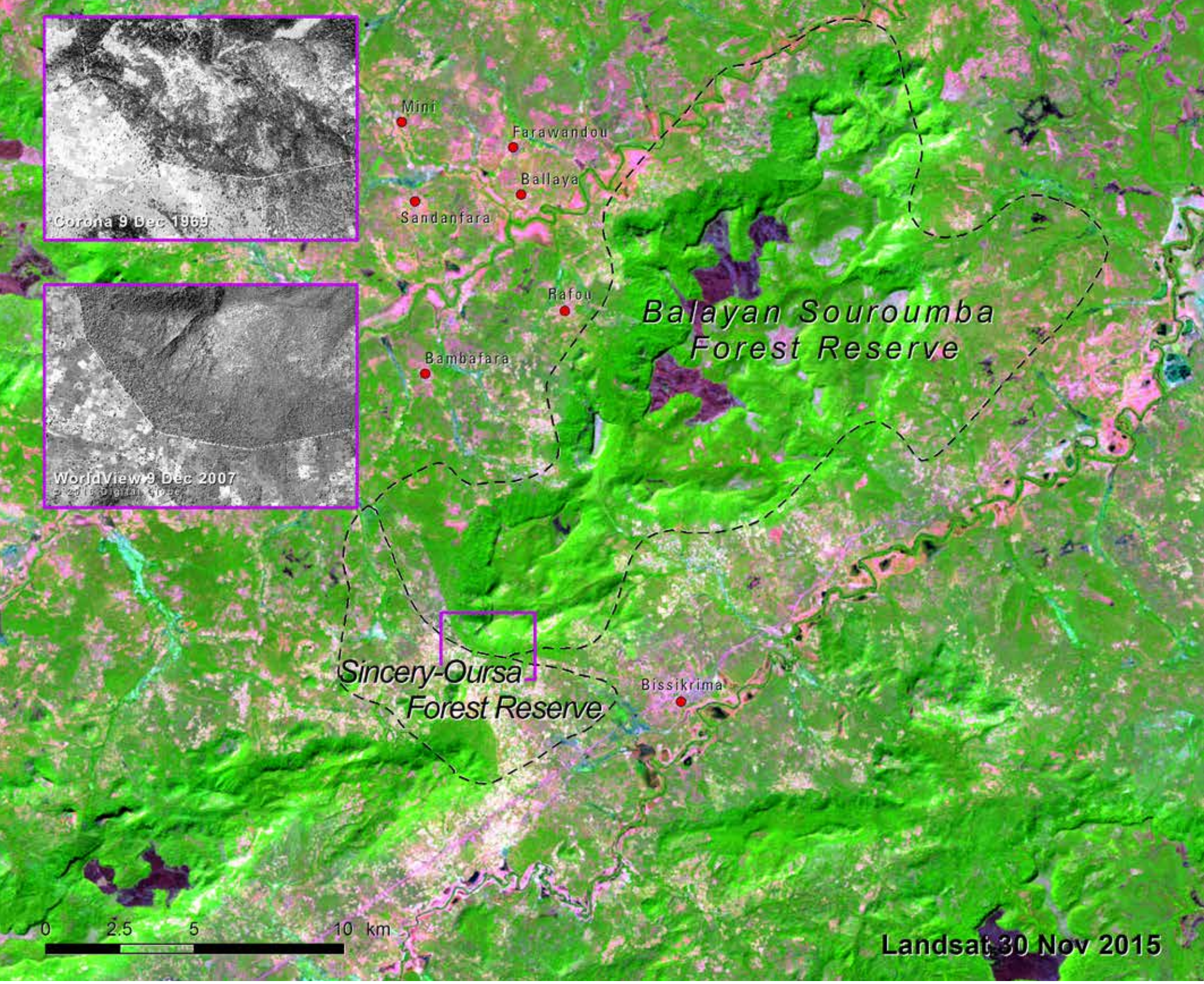
Ziama Massif Biosphere Reserve



Sustainable forest management in Guinea

The remaining forests and woodlands of Guinea play a critical role in preserving biodiversity in West Africa. A number of these forests are found in Guinea's highlands, known as the "water tower" of West Africa because they provide a source of water to many of the region's rivers, including the Niger, Senegal, and Gambia Rivers. Many of Guinea's forest reserves have become degraded as a result of population pressure, slash-and-burn agriculture, and uncontrolled burning. To combat forest degradation, Guinea has adopted a new, more effective approach to forest management. Since 1993, the U.S. Agency for International Development (USAID) and the Direction Nationale des Eaux et Forêts de la République de Guinée (DNEF– Water and Forest National Office of Guinea) have worked together on co-forest management in four forest reserves within the Fouta Djallon highlands of central and northern Guinea. Under this decentralized approach, the DNEF and communities adjacent to these forests enter into a legal contract for the management of the reserves by the local communities. The premise is that if local communities are provided with the authority (and associated benefits) to manage a forest, then the forest will be managed more sustainably. In each case, DNEF forestry agents assisted forest communities in developing a management plan. Consistent with this plan, villagers are often allowed to use sections of the forest for agricultural production or other limited uses. In some cases, both the DNEF forestry agents and the forest communities have worked together to prevent the illegal cutting of forests. One of the DNEF forest agents interviewed said, "We are now educators, not policemen."

But what has been the real impact of over two decades of co-forest management on these forests? To help answer this question, USAID and the DNEF teamed up with the USGS to look at actual forest conditions on the ground



and use satellite images to see how they've changed over time. USGS used a nearly 50-year historical record of satellite images to assess the extent of forest cover and its biophysical condition within the four forests reserves in which USAID and the DNEF have been working. Two of those reserves — Balayan Souroumba and Sincery Oursa — are shown in the images above (the others were Nyalama and Souti-Yanfou).

The scientists analyzed satellite imagery from 1969, 1987, 2007, and 2015 to assess forest resource trends over time. No one necessarily expected to see positive changes in the forest, but the results from the USGS time-series image analysis were surprising and encouraging. The extent and condition of all four of the forest reserves have remained quite stable, and in some areas have improved over the past two decades.

Both forest reserves show a significant increase in tree density over the years. Indeed, tree cover is much denser now than in 1967 (see insets). Local forest agents attribute this to the benefits of co-forest management, particularly to improved fire management through early prescribed burning. They also credit relocation of villages and fields from the interior to the periphery of the reserve, tree planting, and the development of a plan for the sustainable management and regeneration of timber.

The local DNEF forestry agents speak positively regarding the benefits of Guinea's co-forest management approach: "We are proud of the interventions of the projects. We can increase the forests of Guinea — we see a way forward. Our victory is if the experiences of co-management are shared and used elsewhere." The Guinea government is doing just that. The Guinean government's forestry and decentralization policies now favor a co-management approach for all of the nation's forest reserves.

GRAY TAPPAN / USGS

Balayan Souroumba Forest Reserve