Landscapes of West Africa

A Window on a Changing World

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A Window on 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

Preface

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.

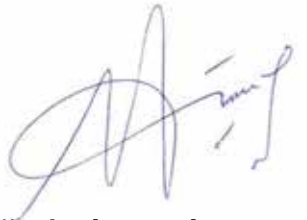
The West Africa Land Use Dynamics (LULC) Project is emblematic of this cooperation. Initiated in 1999, the LULC project has had several phases including training national experts to extract pertinent information from satellite images to characterize vegetation cover and producing tools and supporting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



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USAID | WEST AFRICA
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.

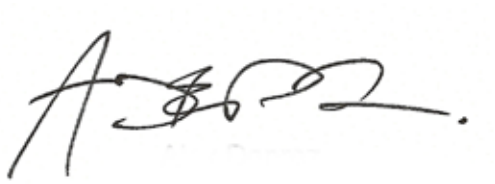
Rapid changes are occurring across West Africa's natural and human landscapes and balancing the need to preserve natural ecosystems with the need to grow more food, together with ensuring resilience in the same ecosystems, is a challenge. USAID West Africa's (USAID/WA) Environmental Threats and Opportunity 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.



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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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The national teams from across West Africa who provided valuable content for the maps and case studies.

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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:

Yendouhame John Kombaté, Responsable Suivi Evaluation et Communication, Agence Nationale de Gestion de l'Environnement, Ministère de l'Environnement, Togo;

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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.

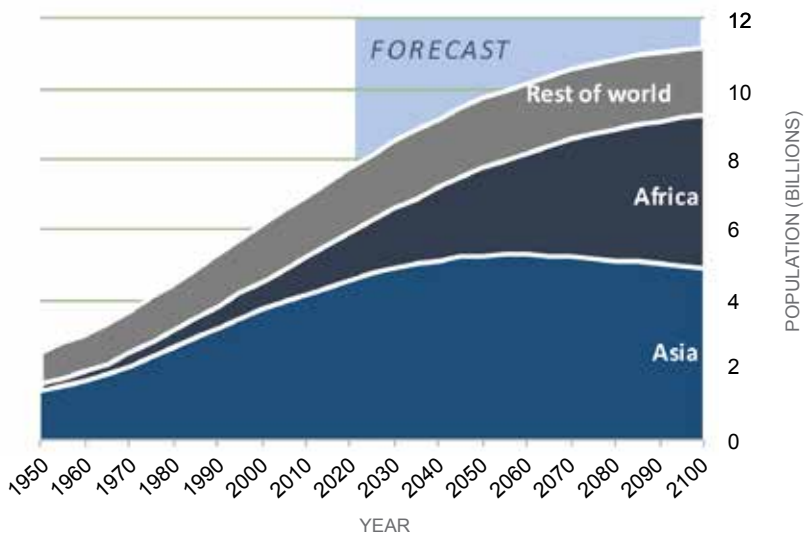
When humankind appeared on Earth around 200,000 years ago the influence of human activity on the environment must have been small and localized. The influence of scattered small groups of people on the global ecosystem would have been overwhelmed by the forces of natural systems (Steffen and others, 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

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



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)!

PHOTO (OPPOSITE PAGE): SUZANNE COTILLON / SGT

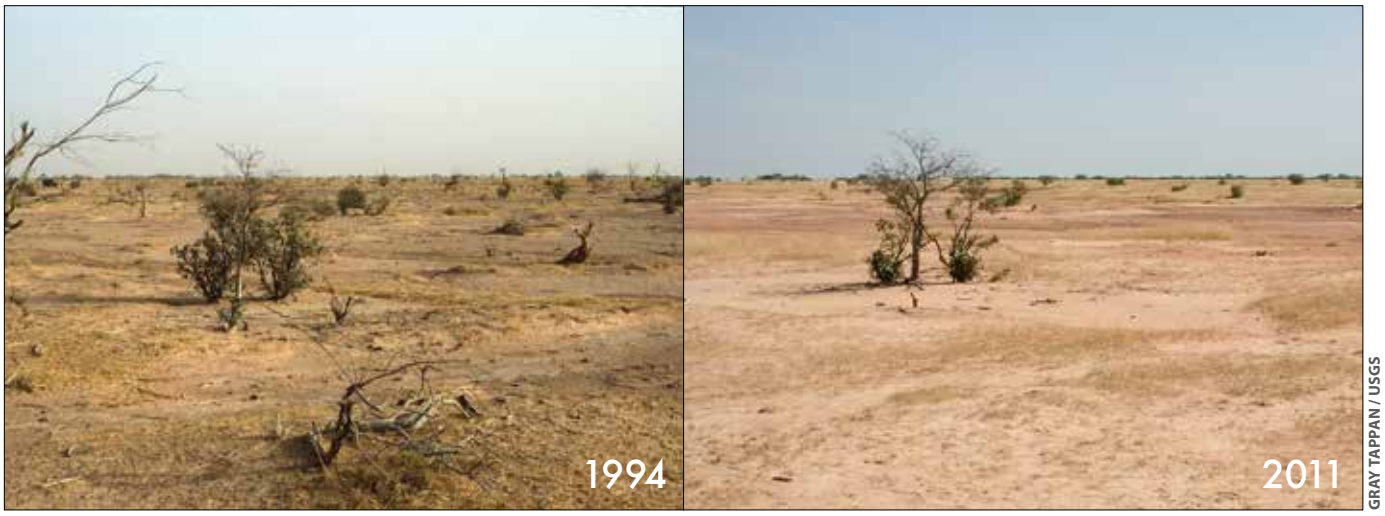
Wooded landscape fragmented by agriculture expansion in western Burkina Faso

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.

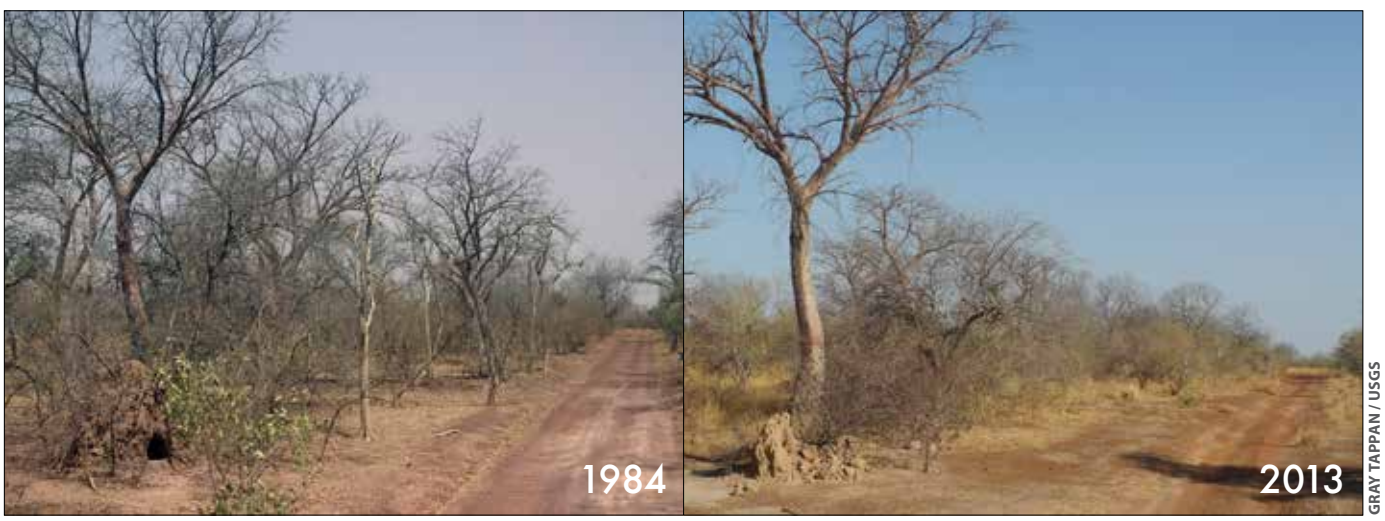
Conversion of the natural landscapes of West Africa to agriculture greatly reduces the natural biodiversity, and exposes the soil to wind and water erosion. The savanna, woodland, forest, and wetland ecosystems that are lost have some relatively tangible impacts such as the loss of natural ecosystem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

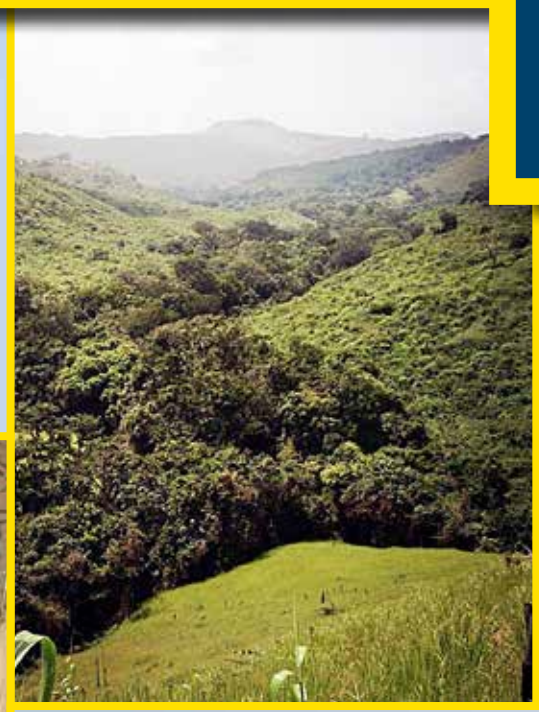


GRAY TAPPAN / USGS

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

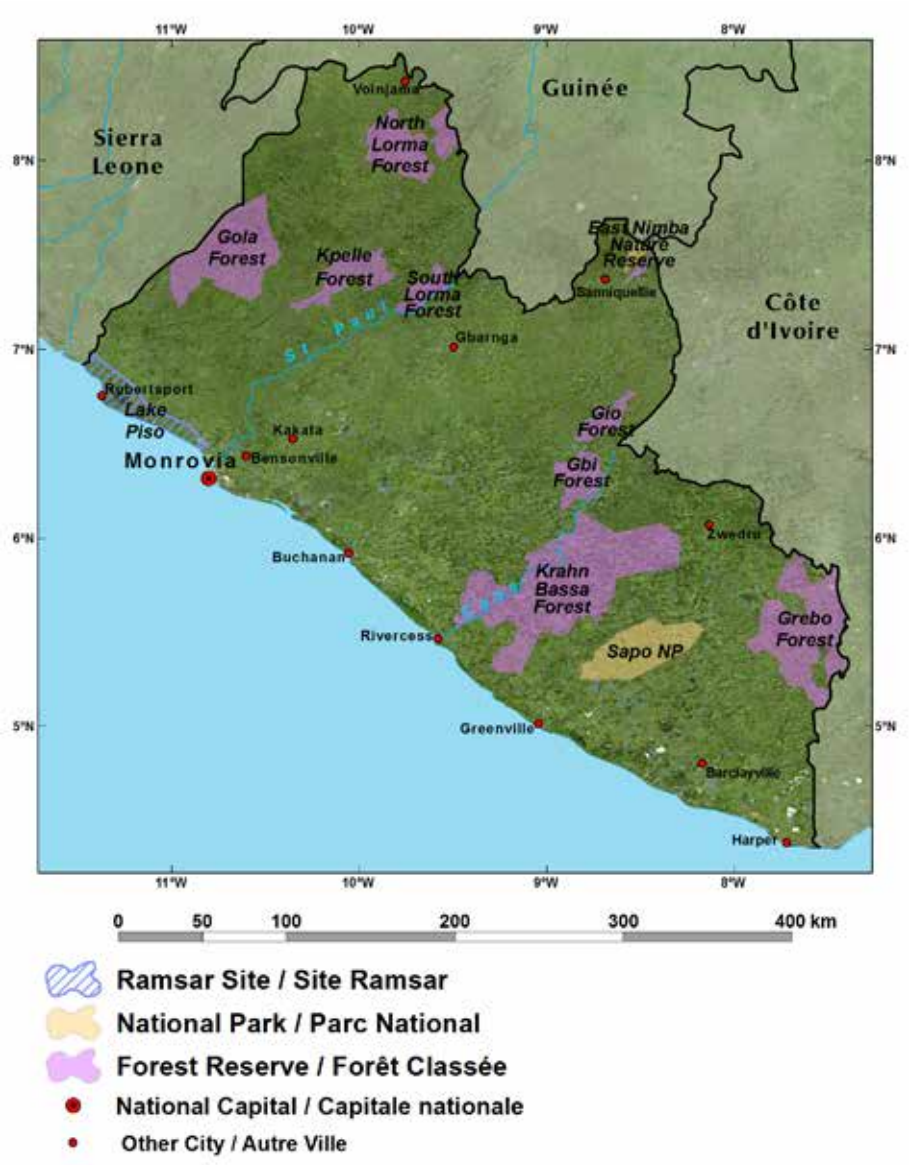
Country Profiles, Land Use and Land Cover, and Trends

Republic of

Liberia

Total Surface Area: 111,369 km²
Estimated Population in 2013: 4,294,000

Liberia, the "Land of the Free", was established as a homeland for freed African-American slaves in the 19th century and was the first African country to gain independence. The coastal country is characterized by humid, tropical climate with mean rainfall ranging from 2,000 mm farthest inland to over 5,000 mm at the coast. Liberia contains the largest part (50 percent) of the remaining Upper Guinean rain forest in West Africa, which is an important hotspot of global biodiversity. Liberia's forests contain approximately 225 timber species and are home to a rich diversity of mammals, birds, reptiles and insects (CIFOR, 2005). According to recent assessments (FAO, 2014), less than 5 percent of Liberia's forests are considered primary forests (no clearly visible indications of human activity); the vast majority are regenerated forests (native species, but with indication of human activity). While Liberia's forests are recognized as a top conservation priority in the entire region, there are currently only two actively protected areas — Sapo National Park and the East Nimba Nature Reserve — and eight forest reserves. This conservation goal, however, competes with extractive economic activities, such as mining and logging, which account for large portions of Liberia's export income.



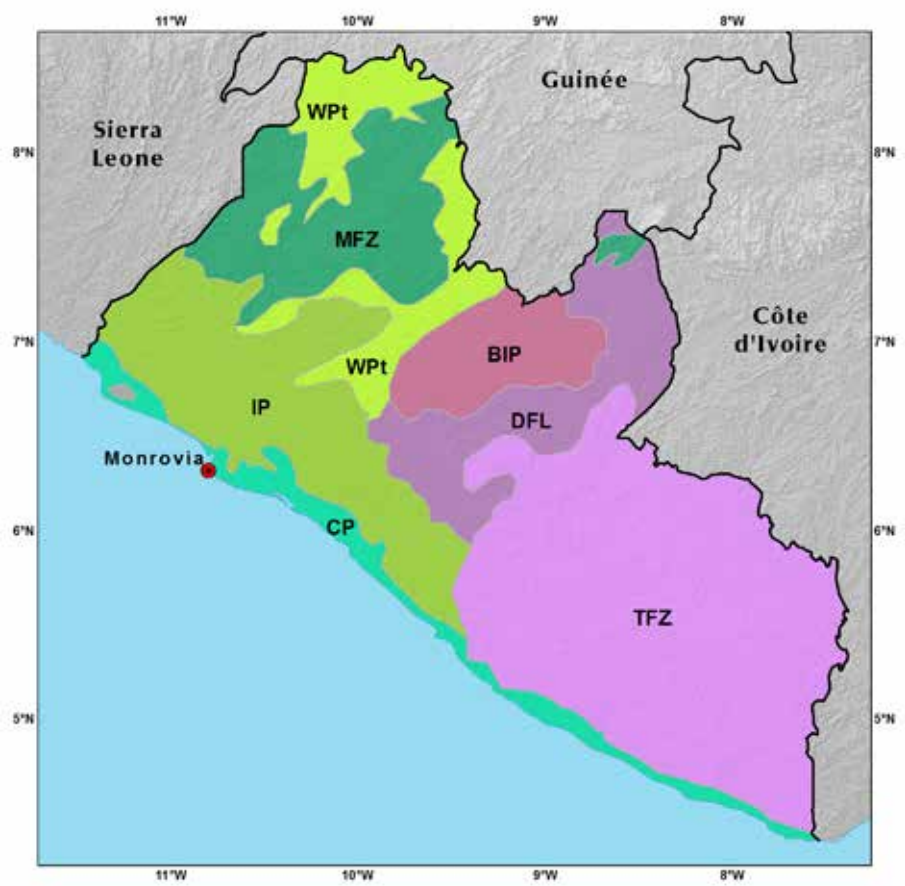
NASA BLUE MARBLE NEXT GENERATION

Environmental Highlights:

- Most forested country in West Africa
- Significant reservoir of biodiversity
- Endangered species hunted for bush meat (poaching)
- Deforestation
- Pollution and waste management

View of the Mount Nimba foothills and the railway used to transport the iron ore

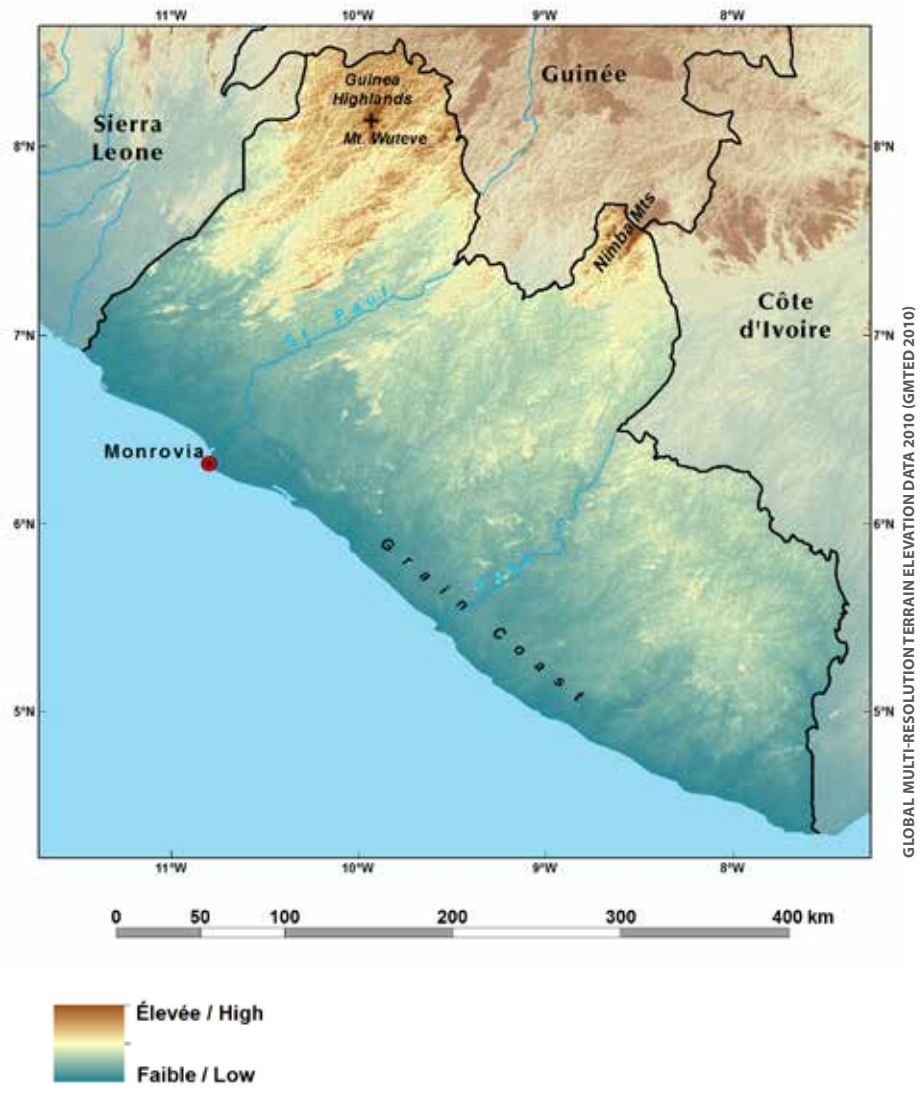
Ecoregions



BIP Bong Interior Plateau
CP Coastal Plains
DFL Degraded Forest
IP Interior Plains
MFZ Montane Forest Zone
TFZ Tropical Forest Zone
WPt Wooded Plateaus

Liberia's landscapes range from flat coastal lowlands with mangroves and swamps, to rolling hills and plateaus further inland, and low mountains in the northeast. The Nimba Mountain range, partially protected as a Nature Reserve, stretches along the Guinea border. The Coastal Plains (CP) are covered by a mosaic of savannas, degraded forest and agriculture. In contrast, the hills of the Montane Forest Zone (MFZ) and Tropical Forest (TF) ecoregions are mostly covered by dense rain forests. Within the Montane Forest Zone (MFZ), Mount Wuteve reaches a maximum of 1,380 m, the nation's highest point. This mountain range is surrounded by the less densely forested Wooded Plateaus (WPt), where woodland and degraded forest dominate. The Bong Interior Plateau (BIP) encompasses most of Liberia's arable land.

Shaded Relief

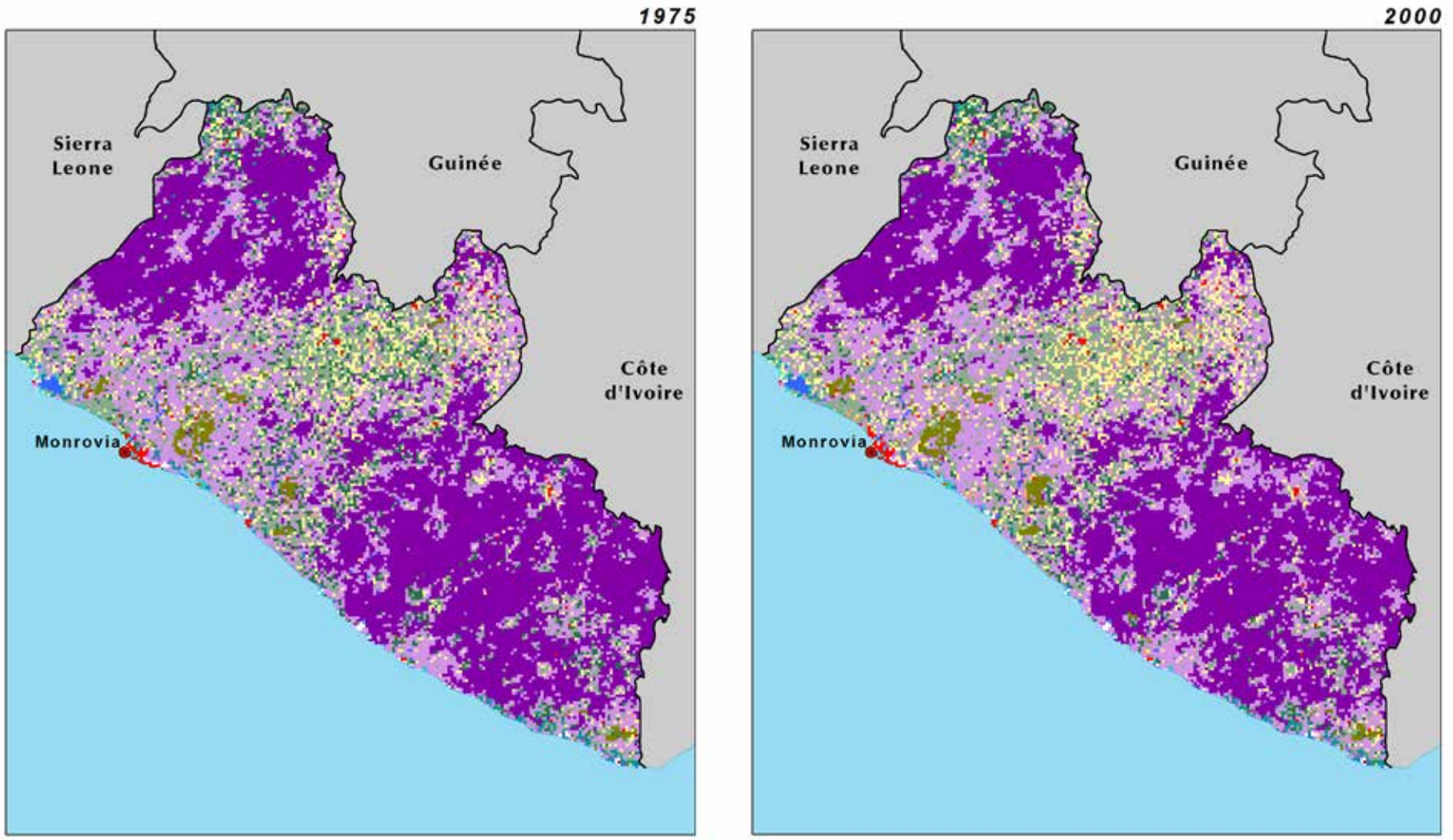


GLOBAL MULTI-RESOLUTION TERRAIN ELEVATION DATA 2010 (GMTED 2010)

A PERFECT HEART / FOTER.COM / CC BY-NC-SA

Village in Liberia

PHOTO (OPPOSITE PAGE): JBDODANE / FLICKR .COM / CC BY-NC 2.0



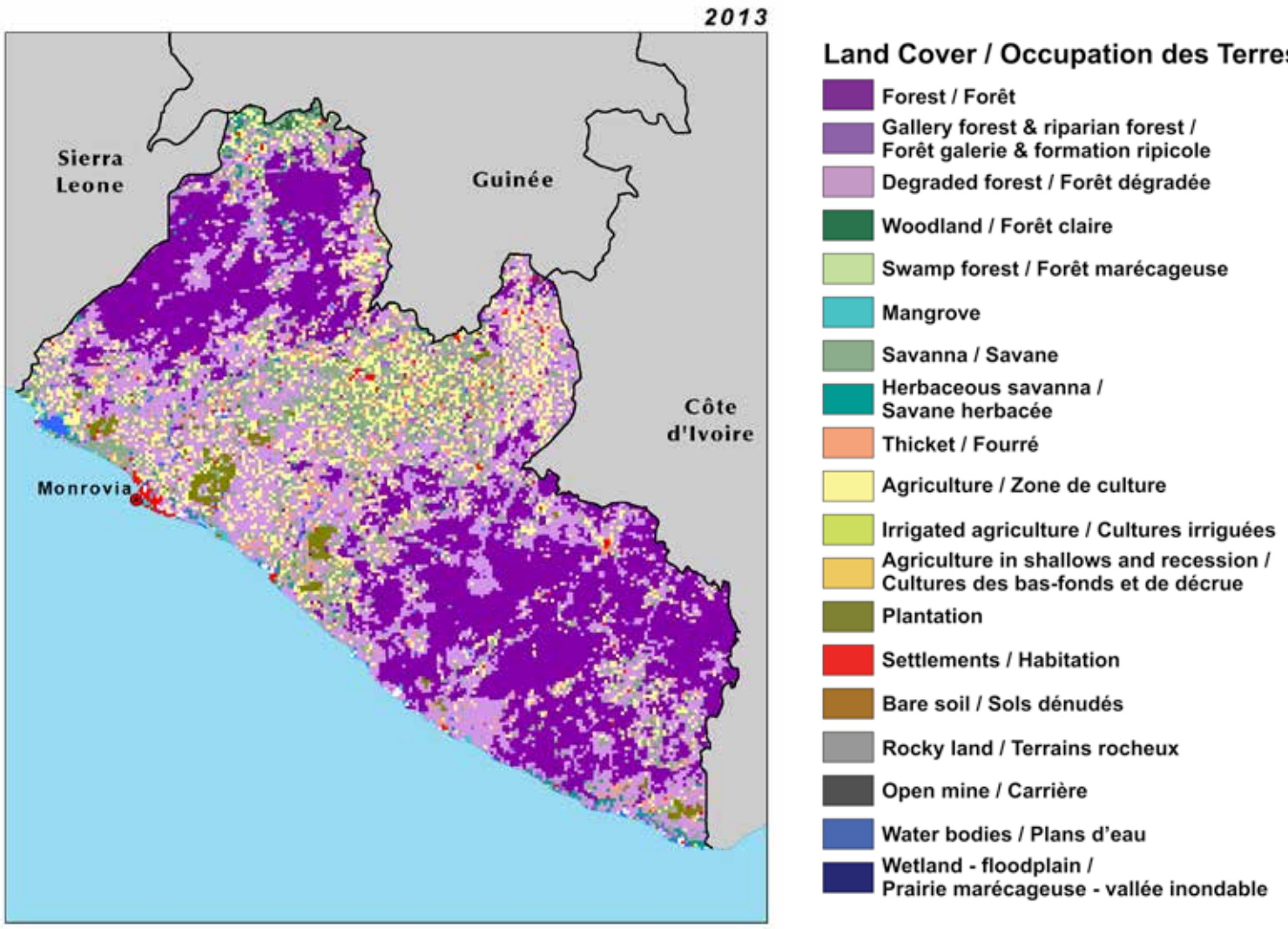
Rubber plantation, Liberia

JBDODANE / FLICKR.COM / CC BY-NC 2.0

Liberia stands out as the most forested country in West Africa. In 2013, forest covered two-thirds of Liberia's land surface, of which less than half (44 percent) was mapped as degraded forest, followed by agriculture (13 percent of the land surface) and savanna (11 percent). Smaller land cover classes include thicket (3 percent), gallery forest (2 percent) and plantations (1.5 percent). The remaining land cover classes each occupy less than 1 percent of Liberia's land surface.

The overall rate of change in land use and land cover has accelerated from 0.5 percent per year between 1975 and 2000 — slightly below regional average — to 1.3 percent per year between 2000 and 2013, which is above the regional average for this time period. While the civil wars (1989–1996 and 1999–2003) slowed down development and as a result land use change, the post-conflict years have seen a surge in land cover transformation.

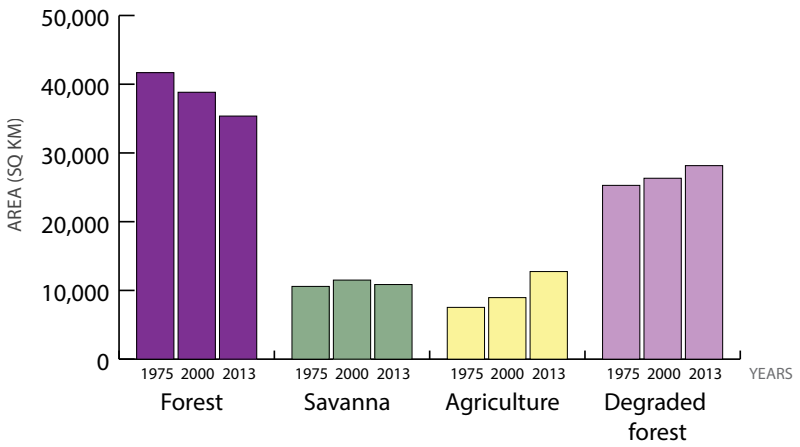
The most important trajectories of land use and land cover change have been associated with loss of forest cover: 3,000 sq km of forest were lost between 1975 and 2000, and another 3,500 sq km between 2000 and 2013,



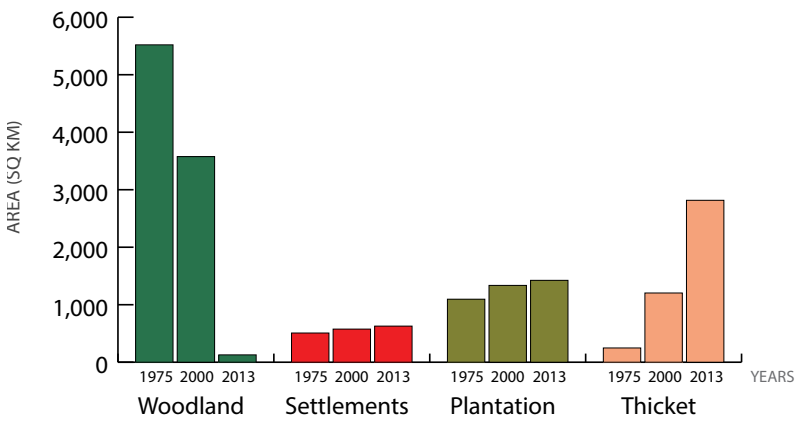
which represents an overall loss of 15 percent of the 1975 forest coverage. Most of the forest loss occurred in the eastern part of the country, in the Tropical Forest Zone (TFZ). Dense forest was mostly converted into degraded forest, savanna, agriculture and thicket, as a result of selective logging and slash-and-burn agriculture. Due to the highly dynamic nature of these land use strategies and the rapid re-growth of vegetation after clearing in this humid tropical environment, the land cover classes of agriculture, degraded forest and savanna show both gains and losses. On the other hand, dense forest, which takes the longest time to fully regenerate, has seen almost exclusively losses.

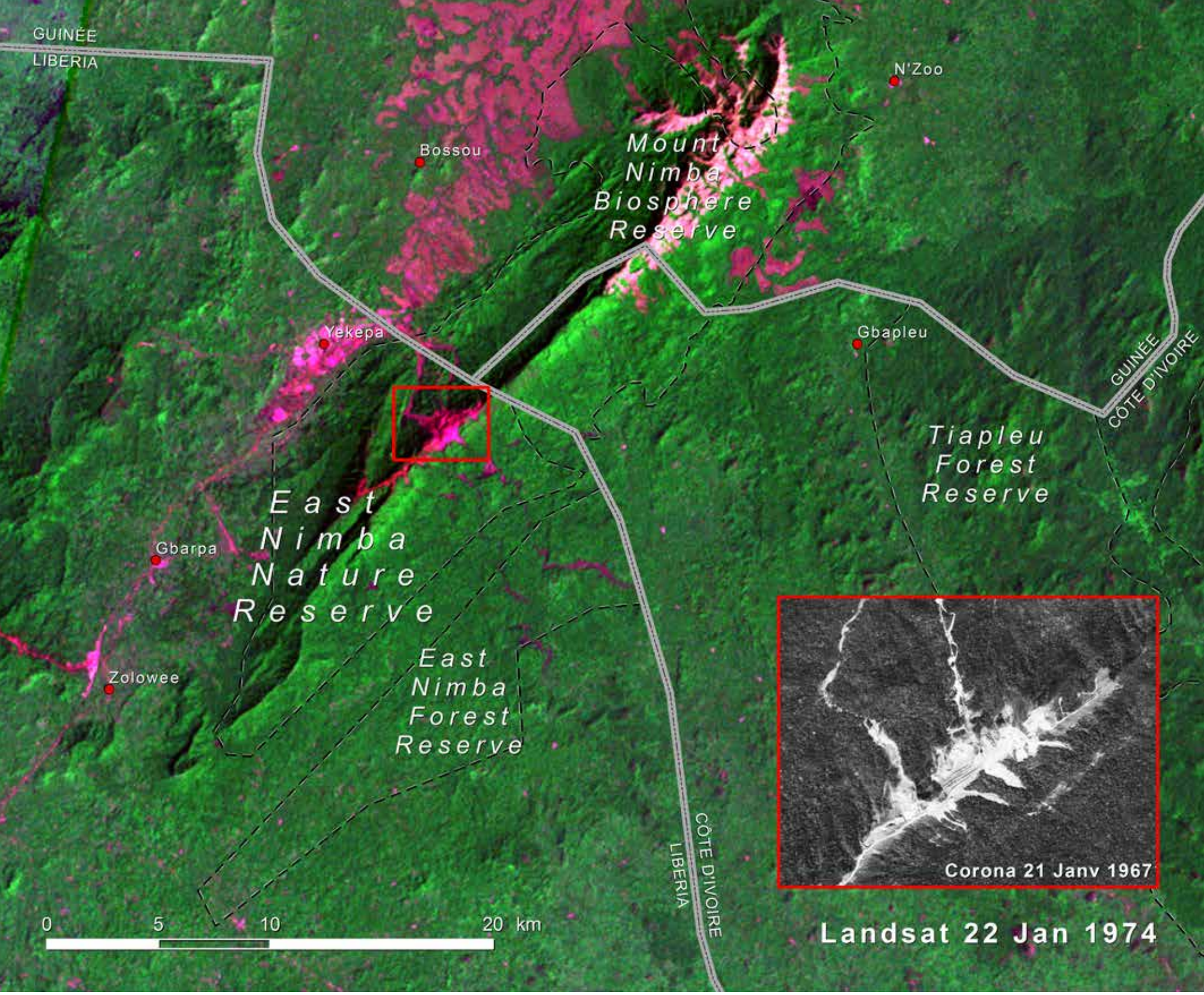
While several of the smaller land cover classes have seen higher losses as a percentage of their 1975 coverage, the 15 percent loss of forest is by far the largest in terms of actual area lost (6,600 sq km) and is the most significant because of the importance of this remnant of Upper Guinean rain forest. Loss of woodlands has been even more dramatic, with a 98 percent loss since 1975, mostly replaced by thickets whose area has grown tenfold during the same time period. Since 2000, agriculture and irrigated agriculture have also expanded rapidly, along with agroforestry (plantations) and mining, all experiencing a revival since the end of Liberia's civil war in 2003.

Large area classes



Small area classes

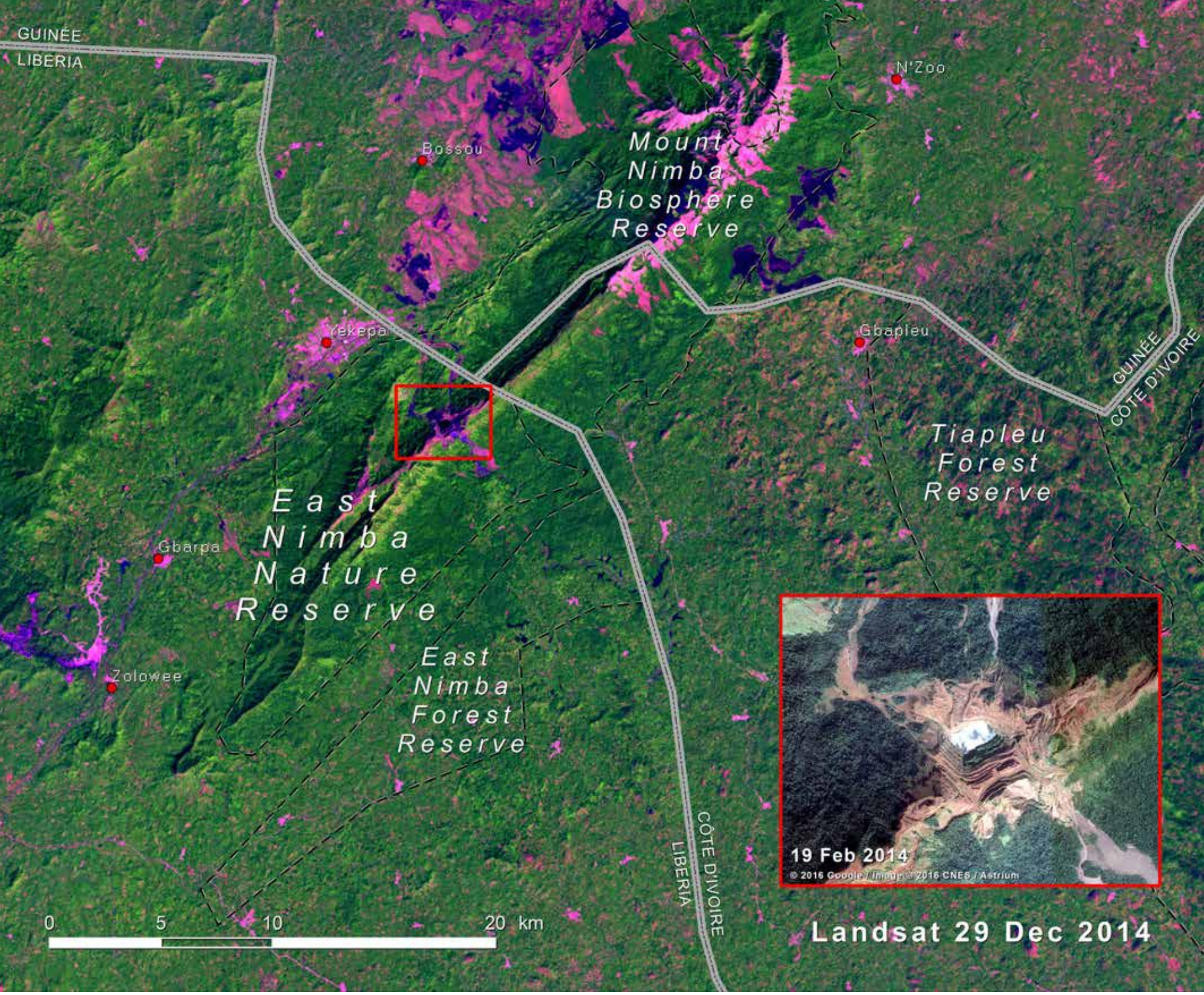




The forest ecosystem of the East Nimba Nature Reserve threatened by human impacts

The Mount Nimba range is a transboundary forested massif which extends from northeastern Liberia into southeastern Guinea and western Côte d'Ivoire. Rising to a maximum altitude of 1,752 m, Mount Nimba is one of the highest elevation forest ecosystems in West Africa. The mountain range encompasses striking landscapes of steep valleys, plateaus, sharp cliffs, and exposed rocks. The Mount Nimba range remained a forest refugium during past glacial periods, when surrounding landscapes became covered by savanna, giving the range biodiversity unparalleled on the continent. It contains original and diverse species of the most remarkable animal and plant populations, notably threatened species such as the Micropotamogale of Mount Nimba, the viviparous toad of Mount Nimba and western chimpanzees. As the source of several important rivers, including the Cavalla and St. John, the mountain range also plays an important role in the regional water cycle.

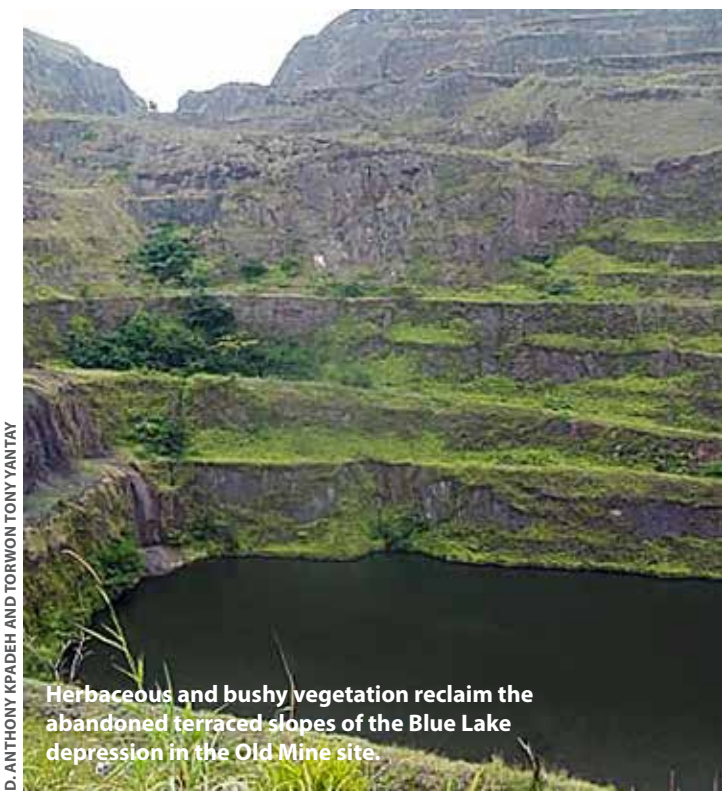
The part of the massif located in Liberia, however, has been greatly degraded by mining. The satellite images from 1974 and 2014 show the impacts of iron ore mining that occurred in Mount Nimba between 1962 and 1989. In 1967, mountaintop mining had already begun (see inset above). Although dense forest still covered most of the East Nimba area in 1974, mining activities also stimulated the development of local and national road infrastructure, further impacting the habitat in the surrounding lowland. The footprints of mining camps and roads in construction are visible along the western boundary of the nature reserve. During the civil wars, the



Mount Nimba region saw an influx of people fleeing the areas of unrest. During that time, in the absence of forestry law enforcement, major logging activities were carried out in the forest, bush meat was hunted on a large-scale, and slash-and-burn agriculture expanded.

By 2014, forest cover had been greatly reduced in the Mount Nimba area. The East Nimba Forest Reserve had lost about half of its 1974 forest cover to encroachment by agriculture and settlements. The slopes of Mount Nimba had been deforested, causing soils and mineral waste to wash downhill and silt the rivers. The legacies of former mining activities, such as the carved terraces and the open pit depression called the Blue Lake, are still visible on the land and altered the landscape of the mountain ridge (see inset above and adjacent picture).

In response to concerns about the pressures from mining operations and population growth, the East Nimba Nature Reserve of Liberia was established in 2003 with the primary conservation objective of preserving Mount Nimba's high and unique biodiversity. Covering over 135 sq km of mostly montane tropical forest, the reserve follows earlier conservation efforts in Côte d'Ivoire and Guinea — Mount Nimba Strict Nature Reserve in 1944 and Mount Nimba Biosphere Reserve in 1980. Field reports indicate a slight recovery of the vegetation cover since the establishment of the reserve.



D. ANTHONY KPADEH AND TORWON TONY YANTAY

Herbaceous and bushy vegetation reclaim the abandoned terraced slopes of the Blue Lake depression in the Old Mine site.

St. Paul River

Mesurado River

Corona 16 Feb 1966

0 2.5 5 10 km

Landsat 21 Jan 1986

Urban growth in Liberia's only metropolis: Monrovia

Liberia was founded in 1822 as a place to resettle freed American slaves, with Monrovia as its capital. Originally divided into two parts — Monrovia proper, south of the Mesurado River with the city's Americo-Liberian population, and Krutown, north of the river, mainly inhabited by ethnic Krus and other local tribes. Old Krutown was demolished in 1945 for construction of new port facilities and its residents resettled. The expanded port remains important to the economic development of Liberia.

In Monrovia's humid tropical climate, obtaining a cloud-free view of the city from satellites is quite rare. The Corona mission returned a partially clear photo of the city in February 1966 (see inset). At that time, the city's growth was limited by an extensive mangrove swamp along the Mesurado River and Monrovia did not expand beyond the peninsula. Monrovia's dramatic growth from 1986 to 2015 is shown in Landsat satellite images of the city. The 1986 image shows that the city grew first around the mangrove swamp and then along the southern coast. By 2015, the city had expanded even farther inland and along the west side of the St. Paul River, outside of the Greater Monrovia district. In the past four decades, the population of Monrovia increased 13-fold, from about 80,000 in the early 1960s to over 1,100,000 in 2015. The land cover maps (see pages 134–135) indicate that its built-up area increased from 100 sq km in 1975 to 176 sq km in 2013. Highest housing densities are found in the historical center of the city; from there, housing density gradually decreases toward the outskirts.

The reasons for Monrovia's population growth include an upsurge in both rural-to-urban migration and inter-urban migration. The present economy of Liberia is very Monrovia-centric, and there are large disparities between Monrovia and other parts of the country in terms of wealth, infrastructure, and possibilities for participation in the political process. Part of this is due to Monrovia's huge population; Liberia's second largest city, Gbarnga, has only 60,000 people. During the civil wars when Monrovia was under control of peacekeeping forces and governed by interim governments, many rural Liberians fled to Monrovia for safety. After the wars ended, many of those internally displaced people chose to remain in the city.

As in many other fast-growing African cities, the development of infrastructure and social services can hardly keep pace with rapid population growth, leaving many of Monrovia's poorer neighborhoods in slum-like conditions. Combined with extensive war damage, Monrovia faces the daunting challenge of rebuilding at the same time as extending its urban infrastructure (Ngafuan, 2010).

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West Point, Monrovia