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.

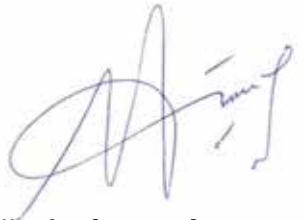
The West Africa Land Use Dynamics (LULC) Project is emblematic of this cooperation. Initiated in 1999, the LULC project has had several phases including training national experts to extract pertinent information from satellite images to characterize vegetation cover and producing tools and supporting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

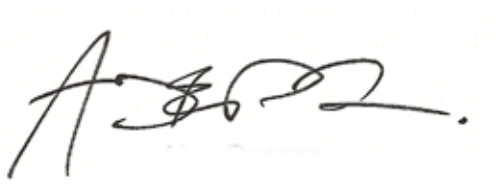
Rapid changes are occurring across West Africa's natural and human landscapes and balancing the need to preserve natural ecosystems with the need to grow more food, together with ensuring resilience in the same ecosystems, is a challenge. USAID West Africa's (USAID/WA) Environmental Threats and Opportunity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

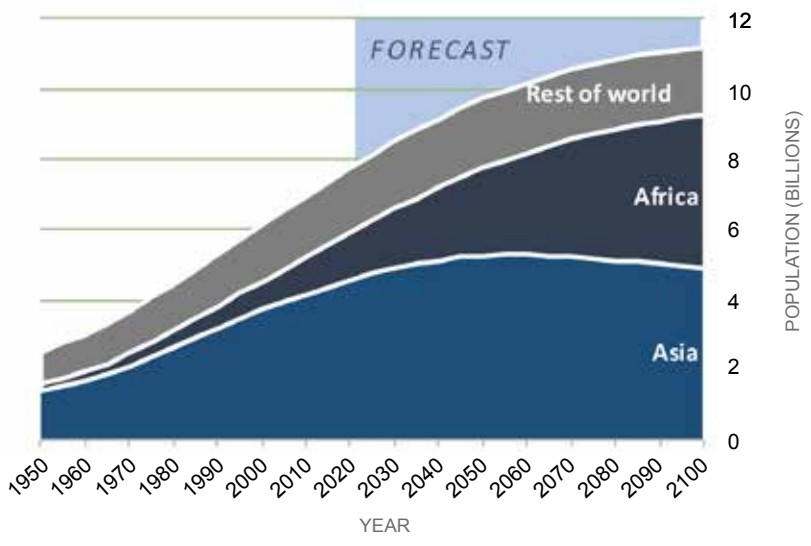
When humankind appeared on Earth around 200,000 years ago the influence of human activity on the environment must have been small and localized. The influence of scattered small groups of people on the global ecosystem would have been overwhelmed by the forces of natural systems (Steffen and others,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

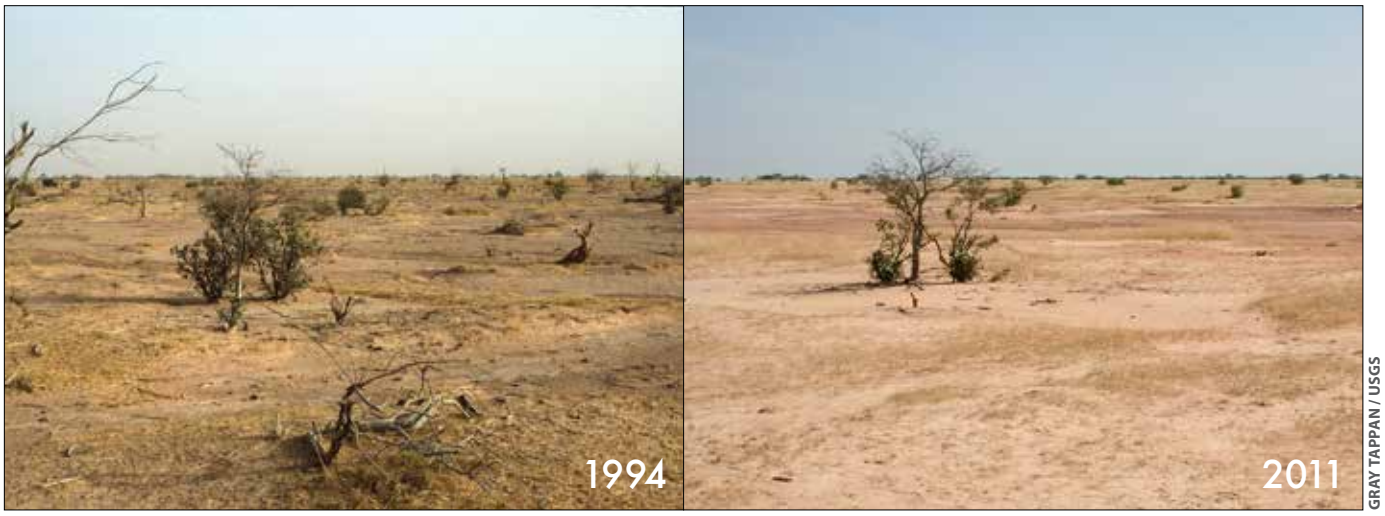
Wooded landscape fragmented by agriculture expansion in western Burkina Faso

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.

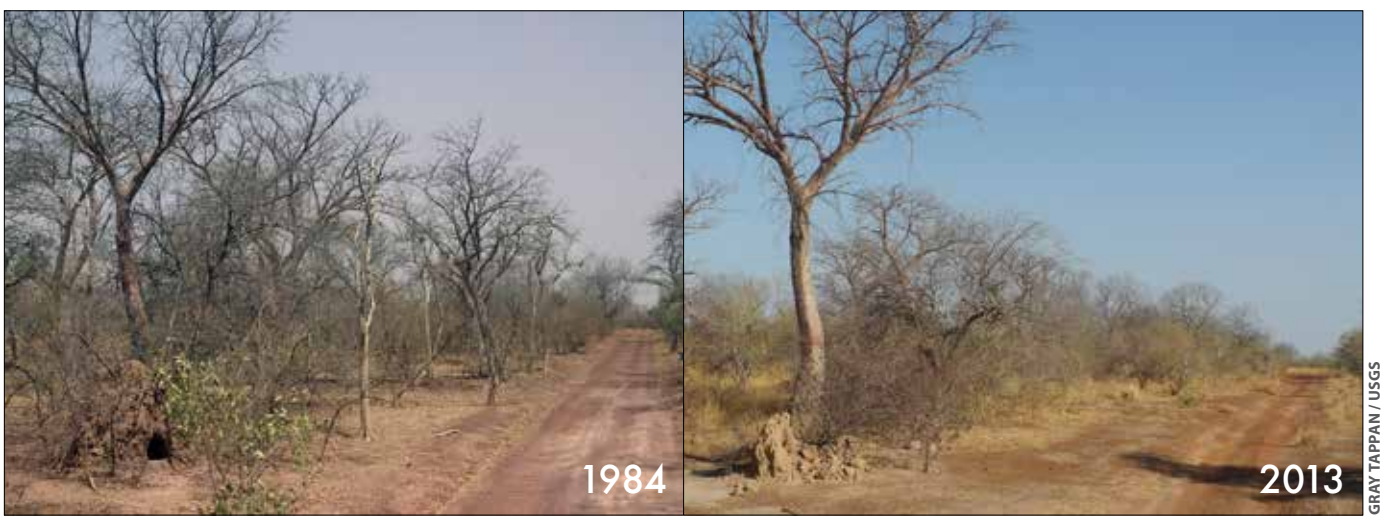
Conversion of the natural landscapes of West Africa to agriculture greatly reduces the natural biodiversity, and exposes the soil to wind and water erosion. The savanna, woodland, forest, and wetland ecosystems that are lost have some relatively tangible impacts such as the loss of natural ecosystem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

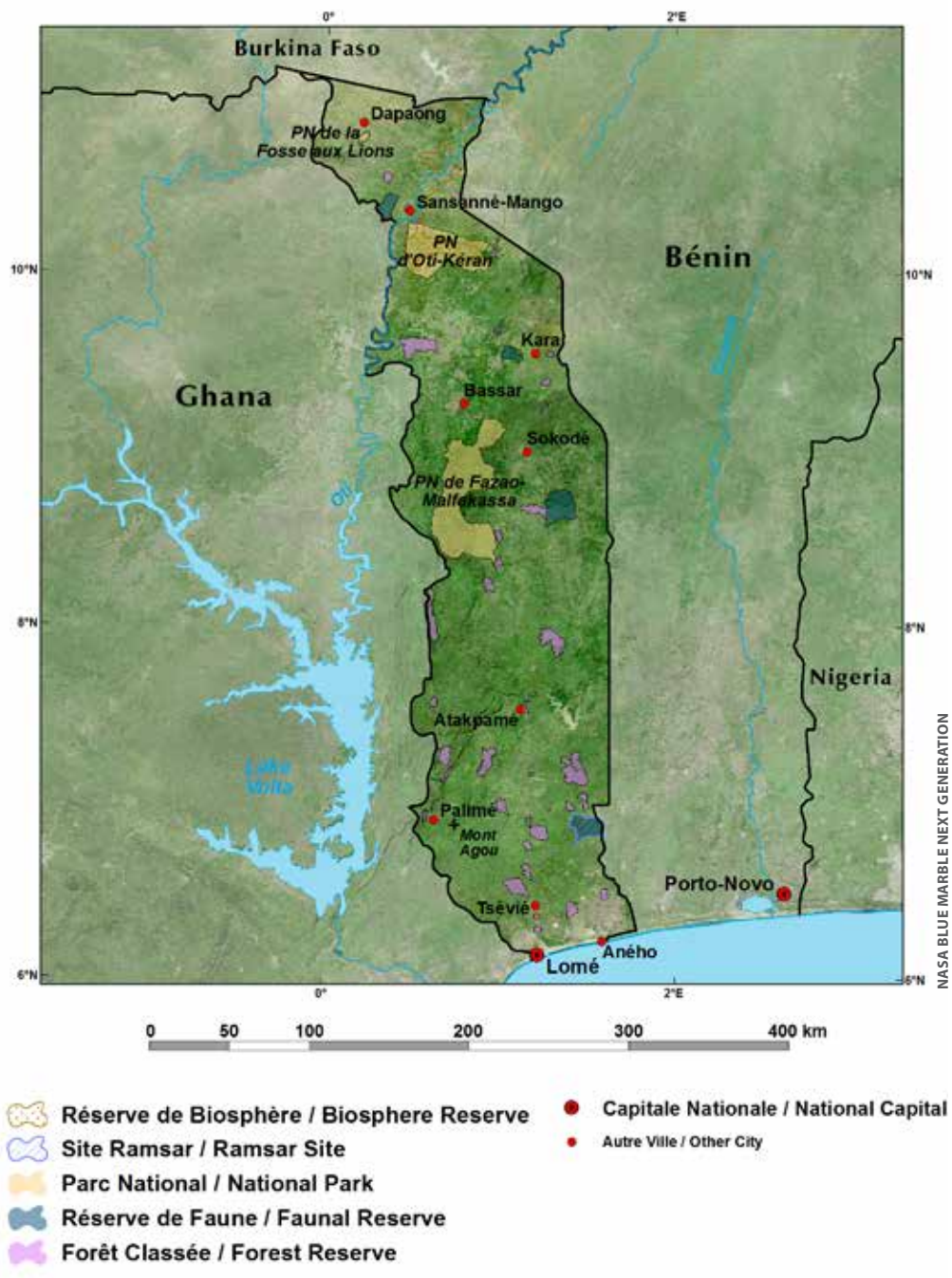
Togolese Republic

Total Surface Area: 56,785 km²
Estimated Population in 2013: 6,929,000

Togo is one of the smallest countries of West Africa. Nevertheless, Togo has a variety of landscapes and straddles several bioclimatic regions. Northern Togo is characterized by the seasonal Sudanian climate, with a single rainy season. Woodlands and savannas still predominate in the north, but they are losing ground to agriculture. This region is exposed to dry Harmattan winds and prone to drought. The Atacora Mountain range crosses central Togo, with more wooded landscapes, and a few isolated remnants of dense tropical forest. These forest relicts form the eastern limit of the Upper Guinean forest ecosystem. The southern half of Togo falls into the Guinean climatic region, characterized by two rainy seasons. The coastal area, however, is part of the Dahomey Gap, a relatively dry savanna zone that separates the high rainfall regimes outside of Togo to the east and west. The coast receives an average of only 900 mm of rainfall per year. Agriculture and mining are key economic activities in Togo. Food crops and cash crops such as cocoa, coffee, and cotton are the main sources of income for 80 percent of the population. Togo is also one of the world's five leading producers of phosphates.

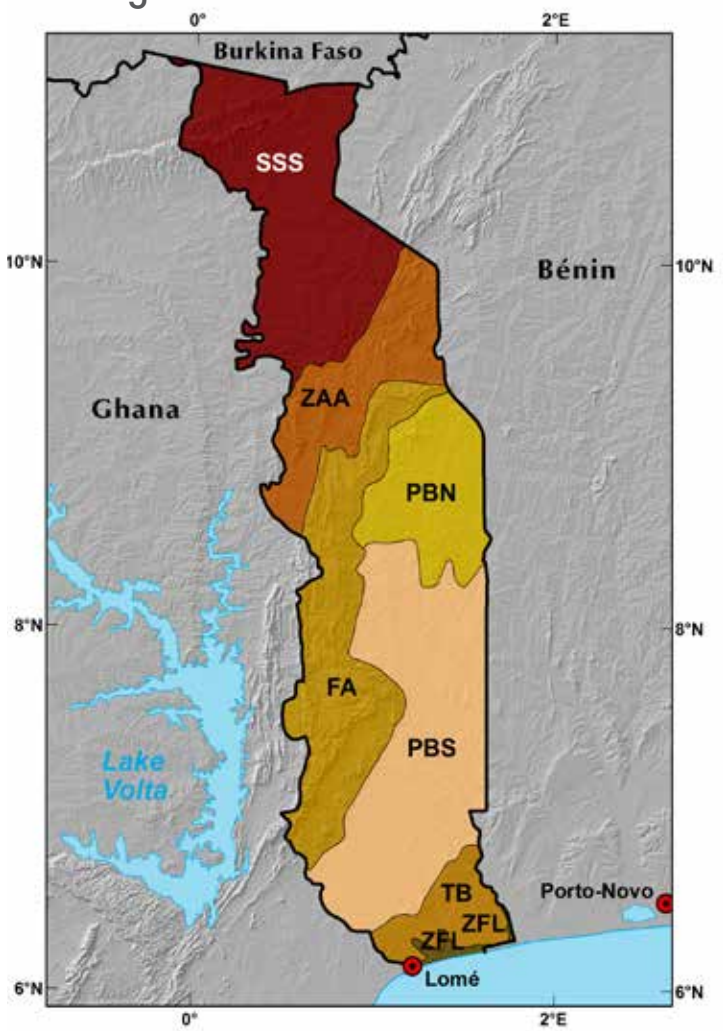
Environmental Highlights

- High rate of agricultural expansion
- Fragmentation and loss of natural landscapes
- Soil degradation
- Coastal erosion



Landscape east of Dapaong, northern Togo

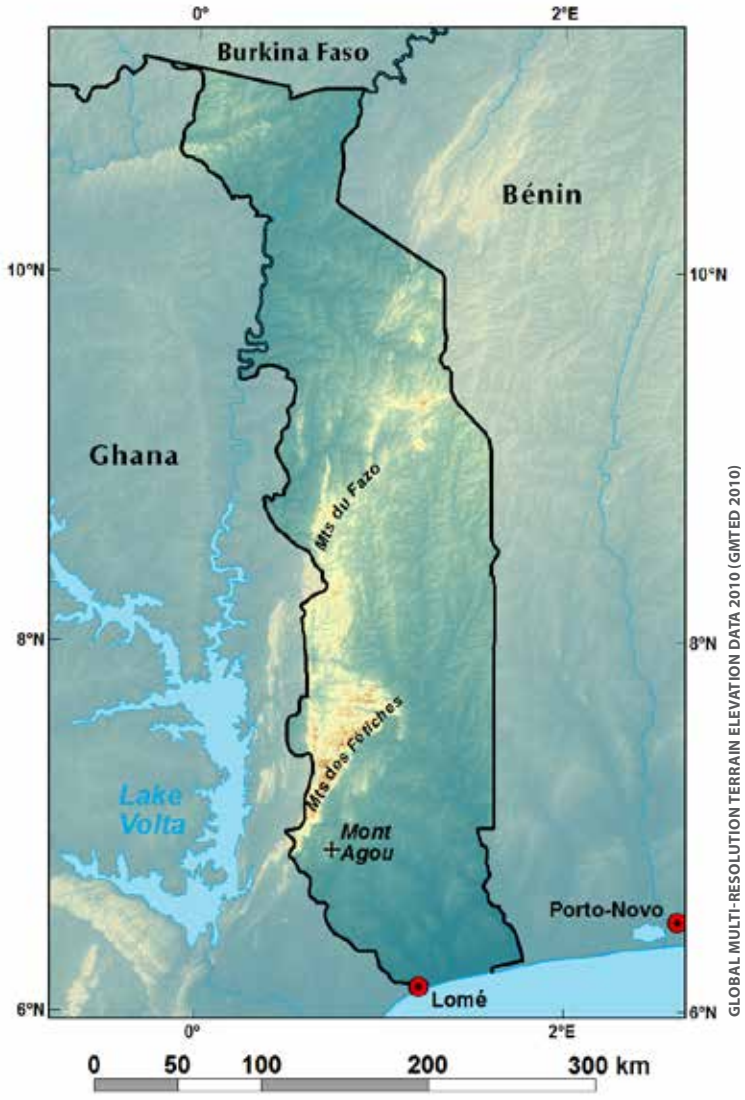
Ecoregions



FA Forêt sur Atakora
PBN Pénéplaine bénino-togolaise nord
PBS Pénéplaine bénino-togolaise
SSS Savane Soudanienne
TB Terre de Barre
ZAA Zone Agro-pastorale de
ZFL Zone Fluvio-lagunaire

With the exception of the Atacora Mountain range, Togo's topography is one of gently rolling hills, shallow valleys, and two large alluvial plains. The chaîne de l'Atacora (FA – Atacora range), where natural forest and savanna landscapes can still be found, cuts diagonally across the central part of the country. Northern Togo — the Savane Soudanienne Sèche ecoregion (SSS – Dry Sudanian Savanna) — has become predominantly agricultural. Just south, a broad plain with the meandering Oti River is the setting for a large national park. In the country's southern half, Togo's agro-pastoral region (ZAA) and plateau regions (PBS and PBN) are characterized by a patchwork of savannas, gallery forest, and cropland. Here, too, there is extensive expansion of croplands, supplanting the natural vegetation cover. In the coastal plain, the zone Fluvio-lagunaire (ZFL – Fluvio-lagoon zone), with its complex of lagoons and swamps, is bordered by the Terre de Barre (TB), a plateau of ferruginous and clay soils, often covered by large palm plantations.

Shaded Relief



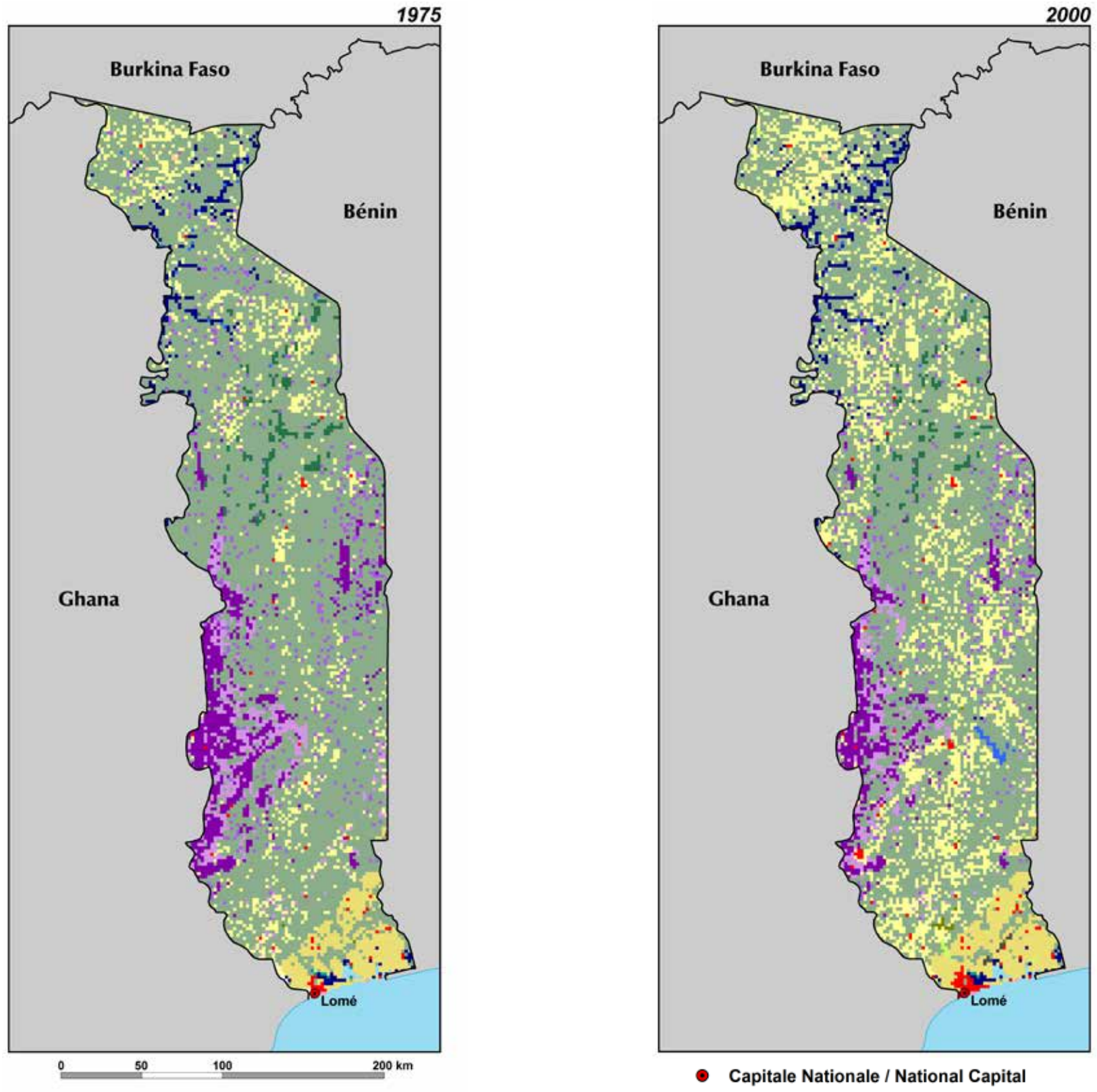
GLOBAL MULTI-RESOLUTION TERRAIN ELEVATION DATA 2010 (GMTED 2010)

Élevée / High
Faible / Low

GRAY TAPPAN / USGS

Steep slopes of the Monts de Défalé, with gallery forest.

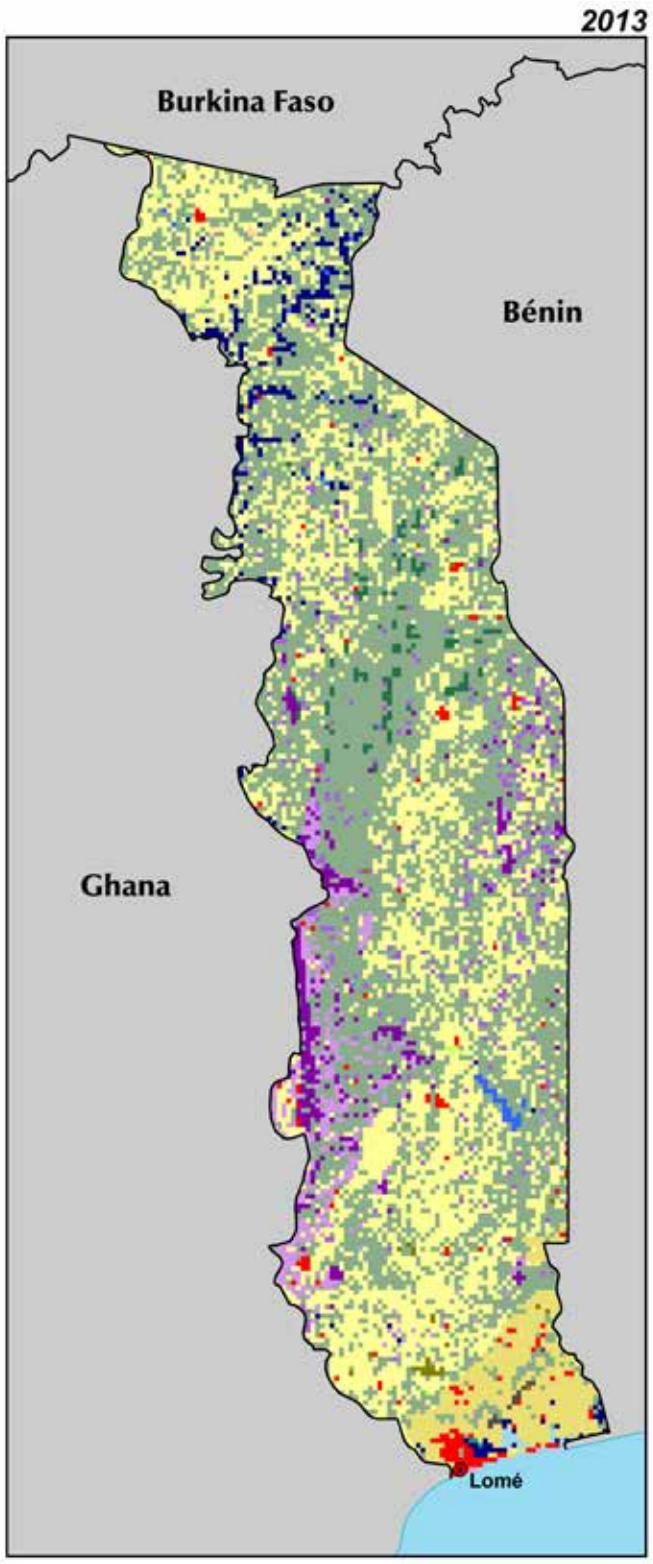
PHOTO (OPPOSITE PAGE): GRAY TAPPAN/USGS



Although savannas remain the dominant feature in Togo's landscapes, agricultural expansion has greatly changed land cover in all parts of the country. In 1975, savannas covered 70 percent of Togo, and cultivated areas were mainly found around urban settlements and along the major roads. Between 1975 and 2013, agriculture increased by 14,000 sq km, or 266 percent. Togo's 7 percent annual expansion rate over this time period ranks as the highest in West Africa. Agricultural expansion occurred at the expense of natural ecosystems such as savannas, woodlands, and gallery forests. The natural landscapes have also become highly fragmented, further degrading ecosystem services. Cultivation has extended beyond the country's most suitable land and is now encroaching into areas of marginal soils. Furthermore, croplands encroach on most protected zones in Togo, including the Oti-Kéran National Park.

The Forêt de l'Atacora (FA – Atacora Forest), which was largely intact in 1975, has experienced a large incursion of cropland, in particular around the towns of Kpalimé and Atakpamé. Dense tropical forest that accounted for 5.9 percent of Togolese land surface in 1975 has now been reduced by half. The deforestation rate in the past decade appears not to have slowed. Without protection initiatives, the current rate will lead to the complete disappearance of Togo's forests by 2025. Degraded forests and gallery forests are also succumbing to deforestation and have decreased by 21 percent and 36 percent, respectively, between 1975 and 2013. Forest disappearance is particularly worrisome because it reduces biodiversity and negatively impacts a variety of ecosystem services that benefit humans.

These trends of land cover and land use changes stem directly from the increasing pressure on natural resources driven by population growth.



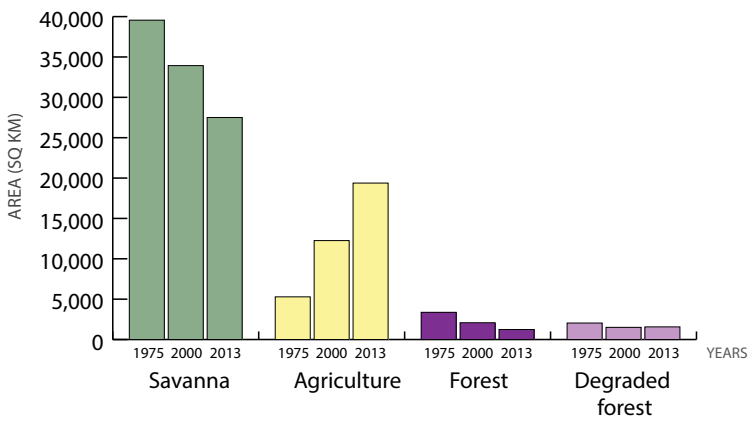
Occupation des Terres / Land Cover

- Forêt / Forest
- Forêt galerie & formation ripicole / Gallery forest & riparian forest
- Forêt dégradée / Degraded forest
- Forêt claire / Woodland
- Savane / Savanna
- Savane herbacée / Herbaceous savanna
- Steppe
- Zone de culture / Agriculture
- Cultures irriguées / Irrigated agriculture
- Cultures et jachère sous palmier à huile / Cropland and fallow with oil palms
- Plantation
- Habitation / Settlements
- Sols dénudés / Bare soil
- Terrains rocheux / Rocky land
- Surfaces sableuses / Sandy area
- Carrière / Open mine
- Plans d'eau / Water bodies
- Prairie marécageuse - vallée inondable / Wetland - floodplain

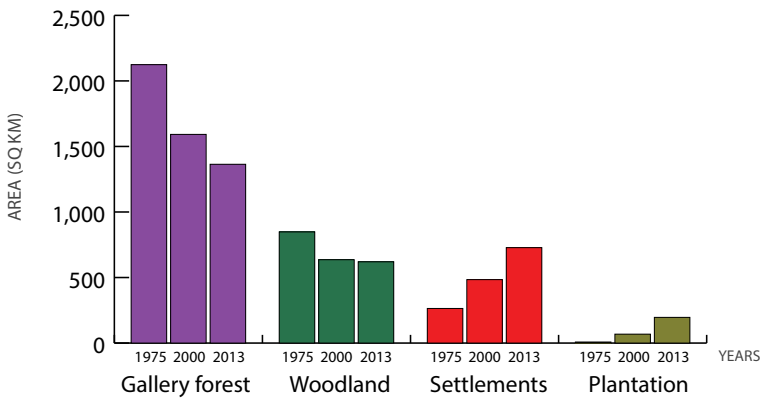
Togo's population grew from 2.4 to 6.9 million between 1975 and 2013, a 288 percent increase. Similarly, the area of Togo's cities and towns increased 176 percent.

At a more local scale, irrigated agriculture and land devoted to plantations have also greatly increased. Irrigated agriculture hardly existed in Togo in 1975; it grew to 108 sq km in 2013. Plantations, formerly concentrated in coastal areas, have expanded greatly over the 38 years, covering almost 200 sq km in 2013. In contrast, wetlands in the Oti River floodplain were quite limited in 1975, owing to years of drought. They increased by 44 percent between 1975 and 2000 and have remained quite stable since then.

Large area classes



Small area classes

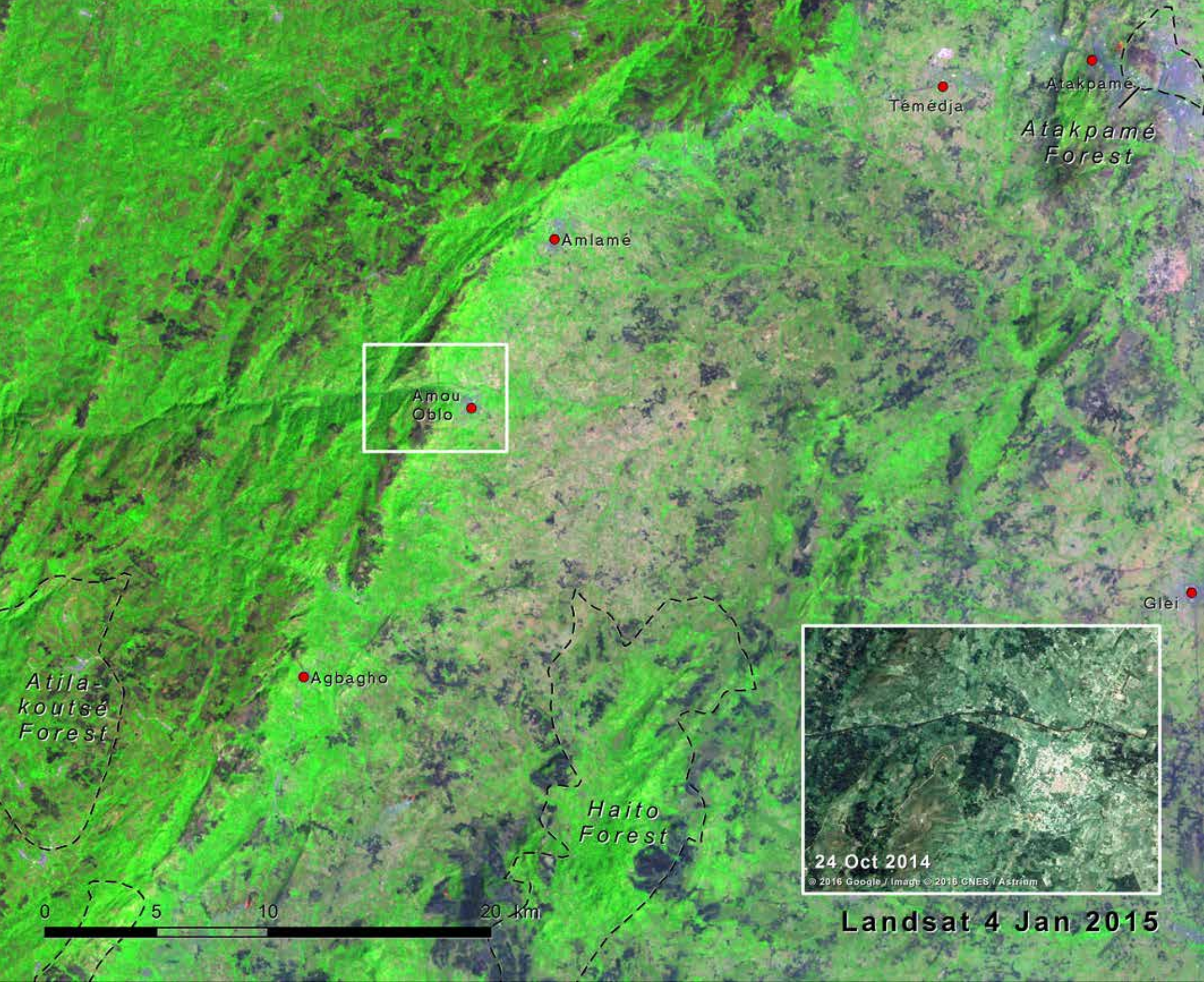


Atakpamé
Témédja
Atakpamé Forest
Amlamé
Amou Oblo
Glei
Agbagho
Atila-koutsé Forest
Haito Forest
0 5 10 20 km
Corona 5 Apr 1967
Landsat 2 Feb 1976

Natural Resources Degradation in the Plateaus Region of Togo

Togo lies in the Dahomey Gap, the part of the forest-savanna mosaic that separates the Upper Guinean forest zone to the west from the Guineo-Congolian forest region to the east. Home to the easternmost fringe of remaining Upper Guinean forest, the Plateaus region has the second largest concentration of people in Togo, after the Maritime region where the capital, Lomé, is located. It was subjected to major deforestation as a result of the socio-political turmoil in the 1990s. Forests have always been rare in Togo, yet in rural areas, more than 80 percent of the local communities use firewood for cooking and fuel. The lack of sound forest management has resulted in overharvesting for woodfuel, building materials, and other forest products. Because the laws consider forest products to be equivalent to other agricultural products, management objectives tend to favor economics, rather than the ecological role of the forests (USAID, 2008).

The pair of satellite images illustrates the drastic deforestation that has occurred over the past 40 years in the Amou prefecture of the Plateaus region, at the edge of the Fétiches Mountains range. In 1976, more than half the area was covered by forested habitats (28 percent forest, 22 percent degraded forest, and 3 percent gallery forest). Dense and degraded forests occupied most of the mountainous zones; a mosaic of savanna (43 percent) and cropland (4 percent), interspersed by thick gallery forests, blanketed most of the lowland. By 2015, unregulated use and exploitation had reduced forest areas by 76 percent, replaced mostly by savanna and degraded forest. Deforestation also occurred within protected forests, with major incursions from agriculture and growing settlements. Within the image area, cropland area increased by a factor of 11 between 1976 and 2013, and is now the dominant land cover. Cultivation of coffee, cocoa, and cotton, as well as subsistence farming, has cleared large tracts of land,



replacing the semi-natural landscapes with large-scale commercial agriculture (see insets) (Tchamie, 2000). The gallery forests that followed lowland watercourses were decimated. The darker areas visible on the 2013 Landsat image are burn scars from bush fires, ignited accidently or intentionally for such uses as agricultural clearing or hunting. Burning occurs over large areas each dry season. These fires can degrade forested habitats, reducing their suitability as habitat for wildlife.

There are numerous forest "islands" throughout Togo, used by local people to perform ceremonies (Kokou, 2008). Many are considered sacred forests which also play an important role as isolated islands of biodiversity. The sacred forests are used for gathering firewood and medicinal products, and in some cases for hunting. Overexploitation of the sacred forests has reduced many in size and ecological complexity. Introduced species are replacing the native vegetation in some locations. Changing cultural and religious traditions are also leading to the abandonment or conversion of sacred forests to other uses, such as agriculture (USAID, 2008).

Forestry development, bush fires, and intensive land clearing, as well as the abusive exploitation of natural resources for human consumption, trade, and tourism, together constitute the principal pressures on the natural resources in the Plateaus region of Togo (Tchamie, 2000). The government and local organizations are now promoting reforestation in the Plateaus region, but the trees being planted are often non-native, high value species, such as the teak and eucalyptus (Kokou, 2008). Despite these efforts, the deforestation rate remains high.

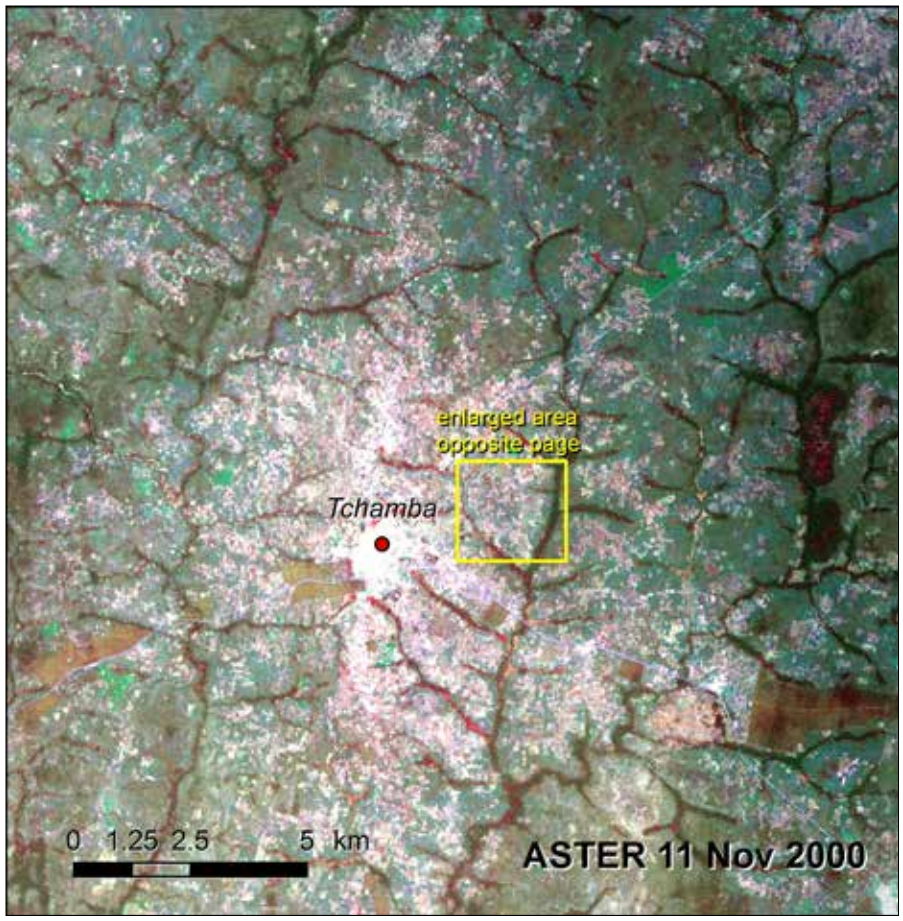
GEOFF LIVINGSTON/FOTER.COM/CC BY-NC-SA

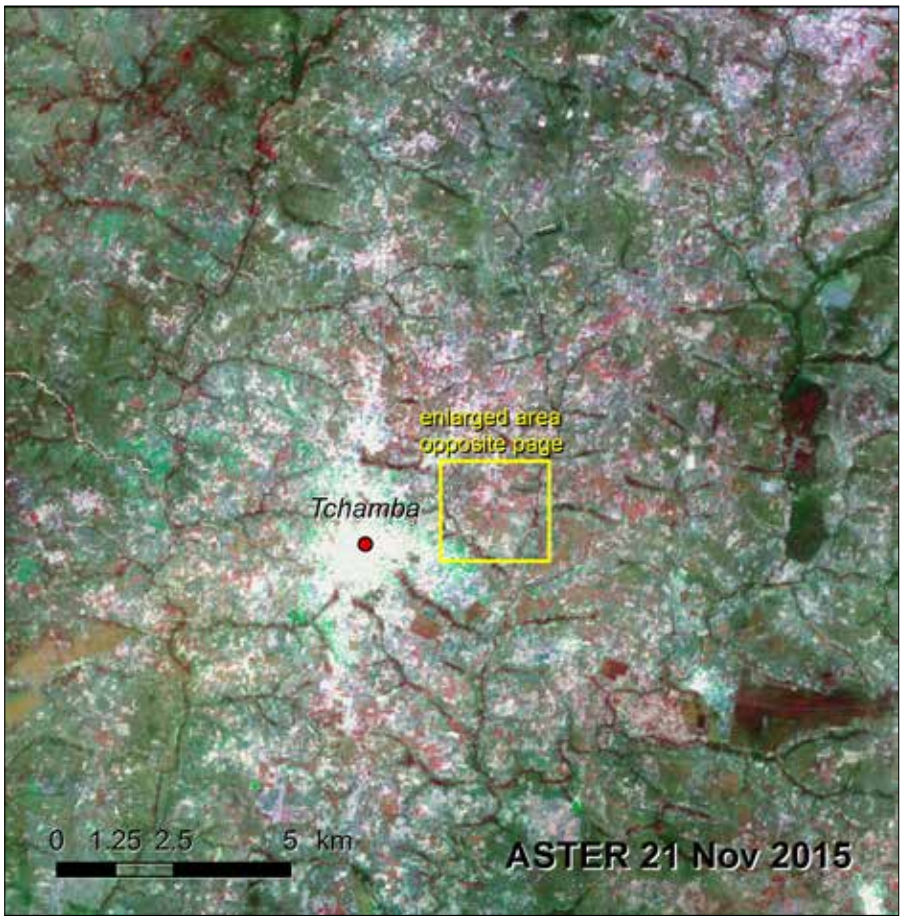
Coffee plant

Forest loss and sustainable agriculture in Tchamba Prefecture

The natural landscapes of Tchamba Prefecture in central Togo are mostly West Sudanian savanna — a mix of savanna, woodland, gallery forests, and some patches of denser forest. Much of the prefecture, including the area surrounding Tchamba town, experienced heavy deforestation during the 1990s as the area's growing population cut trees for timber and energy, and converted areas of wooded savanna to farm fields. In an analysis of land cover changes between 1990 and 2010 conducted by Togolese government agencies and the University of Lomé, Togo measured an 18 percent loss of forest and 7 percent loss of woodland primarily to expanding areas of agriculture, residential growth and bushland (Kokou and others, 2012). However, recent trends measured by analysis of MODIS satellite data show some encouraging signs. Primary productivity (a measure of plant growth, see pages 38–41) showed a positive trend between 2000 and 2010 in some parts of Tchamba Prefecture.

The ASTER image pair (opposite page, top) is focused on one of these positive developments. It reveals several areas of increased woody cover between 2000 and 2015 in the area surrounding Tchamba town. The high-resolution





ISSIFOU ALFARI/AGRHYMET

KOKOU AND OTHERS, 2012

image (opposite page) shows in greater detail what is behind this positive trend. Many of the areas that were being intensely farmed in 2000 with annual crops such as maize, sorghum, millet, rice, peanuts, cowpeas, soybeans, yams, cassava, sweet potatoes and cotton (Kokou and others, 2012) are now covered in trees. In many cases these are small-holder cashew plantations which use a system of integrating annual crops between the cashew trees (Tandjiékpon, 2010). As the trees mature and the amount of light reaching the annual crops diminishes, the crops change from cotton, yams and maize to crops that require less light. This intercropping system has been shown to be profitable for farmers, and the cashew trees help to restore degraded soils and sequester carbon (Opoku-Ameyaw and others, 2011; ACI 2010; Temudo and Abrantes 2014).

Agriculture directly or indirectly employs most of Tchamba Prefecture's population but has been the cause of dramatic unsustainable land cover change over the past decades. Finding sustainable strategies for meeting the development needs of local people while still preserving productive soils and important ecosystem services, biodiversity, natural heritage and beauty of the savanna landscape is a major challenge for Togo's policy makers. The successful intercropping of cashew and food crops may provide both short-term profits and long-term environmental benefits (Opoku-Ameyaw and others, 2011). In addition, a cashew processing facility was built in Tchamba town in 2005 and is providing hundreds of jobs and bringing new economic development to the community (African Cashew Alliance, 2013; Kokou and others, 2012).