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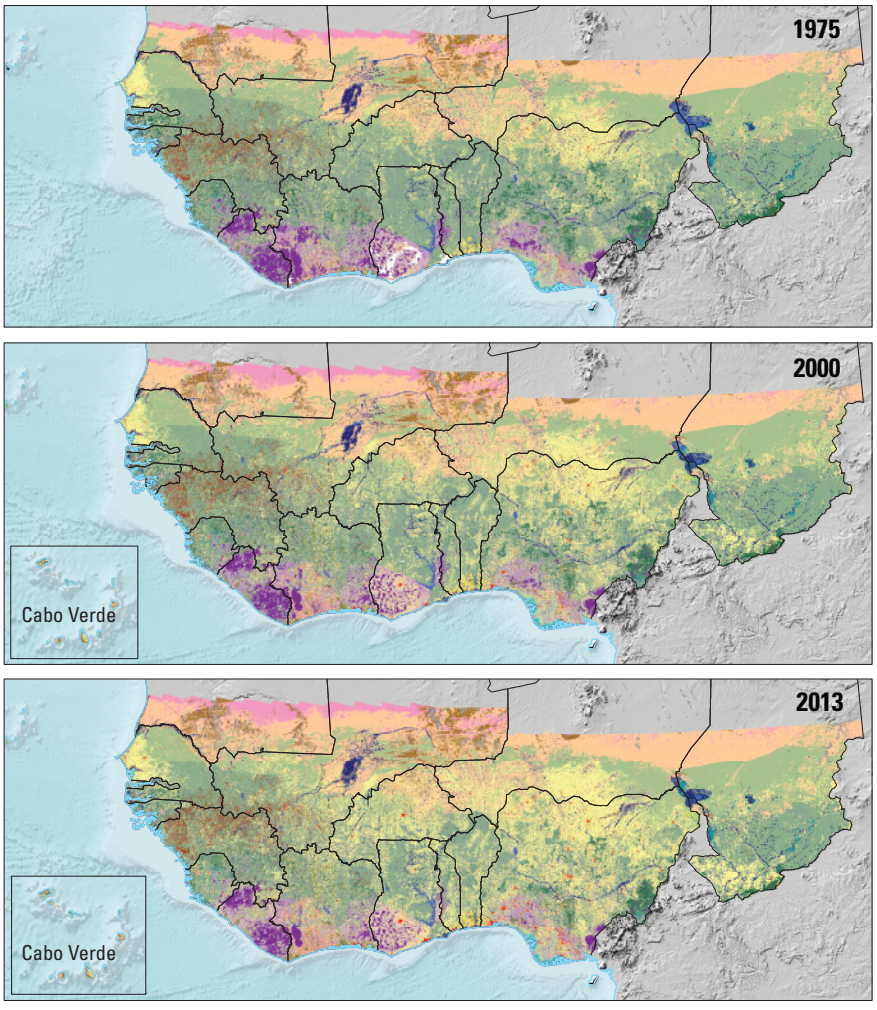
West Africa Land Use Land Cover Time Series

Started in 1999, the West Africa Land Use Dynamics project represents an effort to map land use and land cover (LULC), characterize the trends in time and space, and understand their effects on the environment across West Africa. The project was carried out through the AGRHYMET Regional Center in Niamey, Niger, with partners from 17 participating countries, the Sahel Institute, and the U.S. Geological Survey (USGS), with major support from the U.S. Agency for International Development/West Africa (USAID/West Africa) (Comité permanent Inter-états de Lutte contre la Sécheresse dans le Sahel [CILSS], 2016). The overarching goal of the West Africa Land Use Land Cover Time Series dataset (Tappan and others, 2016) is to promote the awareness of landscape and land resource changes and trends, and to inform national and regional decision makers. All West Africa LULC products are available to the public for download at no charge from the project website at https://eros.usgs.gov/westafrica.



Base from U.S. Geological Survey Global Multi-resolution Terrain Elevation Data, 2010 (GMTED 2010)

0 375 750 1,500 KILOMETERS

0 200 400 800 MILES

EXPLANATION

Land use land cover (LULC) class

- Forest
- Degraded forest
- Gallery forest and riparian forest
- Woodland
- Swamp Forest
- Mangrove
- Plantation
- Thicket
- Sandy area
- Savanna
- Sahelian short grass savanna
- Herbaceous savanna
- Shrubland
- Steppe
- Wetland—flood plain
- Water bodies
- Bowe
- Agriculture
- Agriculture in shallows and recession
- Cropland and fallow with oil plams
- Irrigated agriculture
- Rocky land
- Bare soil
- Settlements
- Open mine

Figure 1. The West Africa Land Use Land Cover Time Series dataset maps. These baseline maps at a 2-kilometer resolution provide a complete and highly accurate record of the LULC for three time periods (Tappan and others, 2016).

U.S. Department of the Interior
U.S. Geological Survey

Fact Sheet 2017–3004
February 2017

The West Africa Land Use Land Cover Time Series—1975, 2000, and 2013

The West Africa Land Use Land Cover Time Series dataset (Tappan and others, 2016) includes LULC for three time periods (years)—1975, 2000, and 2013—across the Sub-Saharan region of West Africa, including the Cabo Verde archipelago. The regional dataset has been created at a 2-kilometer resolution, with the exception of the large country of Chad, which was mapped at a 4-kilometer resolution, and the small countries of The Gambia and Cabo Verde, which were mapped at 1-kilometer and 500–meter resolutions, respectively (table 1). Substantial parts of northern Mauritania, Mali, Niger, and Chad are within the Sahara Desert. In this arid landscape, land cover and vegetation are quite stable through time. For this reason, only the southern areas of these four countries were mapped (about below 18 degrees north latitude).

The classification system used to map and monitor LULC in West Africa was largely inspired by the "Yangambi Classification" (Trochain, 1957)—the standard guide to the nomenclature of vegetation types of intertropical Africa since 1956, particularly for West and Central Africa (CILSS, 2016). The Yangambi Classification applies mainly to the descriptions and understanding of vegetated land cover types; however, LULC maps integrate vegetated and nonvegetated surfaces. Accordingly, the 24 LULC classes (LULC class description are provided here: https://eros.usgs.gov/westafrica/land-use-land-cover-map) used in the West Africa Land Cover Dynamics project integrate Yangambi classes for the vegetated surfaces with other classes commonly used in West Africa to represent various other land uses (fig. 1).

Approach to Mapping Land Use and Land Cover Through Time

Mapping LULC of all West Africa for three time periods (1975, 2000 and 2013) required hundreds of Landsat images and careful consideration of methodology. The goal was to generate accurate land cover maps that are consistent from one time period to the next, enabling reliable analysis of land cover change. In this project, a visual photo-interpretation approach was applied using a Geographic Information System mapping tool—the Rapid Land Cover Mapper (RLCM)—that was developed to facilitate the interpretation process and create accurate land cover maps quickly (Cotillon and Mathis, 2017).

Thousands of aerial photographs and high-resolution satellite images were used to validate the interpretations. From the initial datasets produced by national teams, the USGS completed an independent, detailed review of the interpretations. In concurrence with the respective country teams, the data have been revised by several images interpreters to produce an accurate and consistent LULC assessment of the countries and respective transboundary areas.

For more information on the methodology and the RLCM add-in, see the project website (https://eros.usgs.gov/westafrica/mapping-land-use-land-cover) or Cotillon and Mathis (2017).

NASA photograph ISS042-E-244403 taken by an astronaut on board the International Space Station on February 12, 2015. This east-looking photograph includes Lake Chad, visible at left, and the Tibesti Mountains at upper right. This photo was modified to include a NASA artist's rendition of Landsat 8 in orbit.

Table 1. Mapping resolution by country and imagery sources.

[km, kilometer; m, meter]

Countries	Mapping resolution	Imagery source
Chad	4 km	Landsat Multispectral Scanner (MSS) 1972–79.
		Landsat Thematic Mapper (TM) or Landsat Enhanced Thematic Mapper (ETM) 1999–2002.
		Landsat Operational Land Imager (OLI) 2013–14.
Benin, Burkina Faso, Côte d'Ivoire, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, and Togo	2 km	Landsat Multispectral Scanner (MSS) 1972–86.
		Landsat Thematic Mapper (TM) or Landsat Enhanced Thematic Mapper (ETM) 1999–2003.
		Landsat Operational Land Imager (OLI) 2013–14.
The Gambia	1 km	Landsat Multispectral Scanner (MSS) 1972–79.
		Landsat Thematic Mapper (TM) or Landsat Enhanced Thematic Mapper (ETM) 1999–2000.
		Landsat Operational Land Imager (OLI) 2013.
Cabo Verde	500 m	Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) TerraLook 2000–2002.
		Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) TerraLook 2012–14.
		No comparable sources of imagery were available to complete a map for the 1975 period.

Main Trends of Land Cover Change

The West Africa Land Use Land Cover Time Series dataset (Tappan and others, 2016) offers a unique basis for characterizing and analyzing land changes across the region, systematically and at an unprecedented level of detail. The analysis of the three LULC time periods revealed that about 13.7 percent (673,472 square kilometers [km^2]) of the total mapped area changed between 1975 and 2000 (this change area does not include Cabo Verde because the country was not mapped for the 1975 time period), and 11.8 percent (583,012 km^2) changed between 2000 and 2013. The highest proportion of changes were in Togo, Burkina Faso, Ghana, and Benin. Across the region, agricultural expansion accounted for the most dramatic form of landscape change (fig. 2). By 2013, savanna and Sahelian short grass savanna had lost 406,432 km^2 and 119,424 km^2, respectively. Whereas rainfed agriculture covered 10.7 percent in 1975, by 2013 it had become the second largest land cover, reaching a total of more than 1.1 million km^2, or about 22.4 percent of the land surface. Net gain was observed not only in all four agricultural classes (rainfed agriculture, agriculture in shallows and recession, irrigated agriculture, and plantations) but also in the developed classes (open mines and settlements). The area devoted to human settlements increased by 140 percent, mostly in the coastal corridor. From 1975 to 2013, forest, degraded forest, and gallery forest (that is, forest that forms as corridors along rivers) had a total net loss of 100,176 km^2, or 24.6 percent of their 1975 area (fig. 3). West African countries have lost—and are still losing—large extents of their natural land cover, replaced by a heavily human-influenced landscape dominated by agriculture (CILSS, 2016).

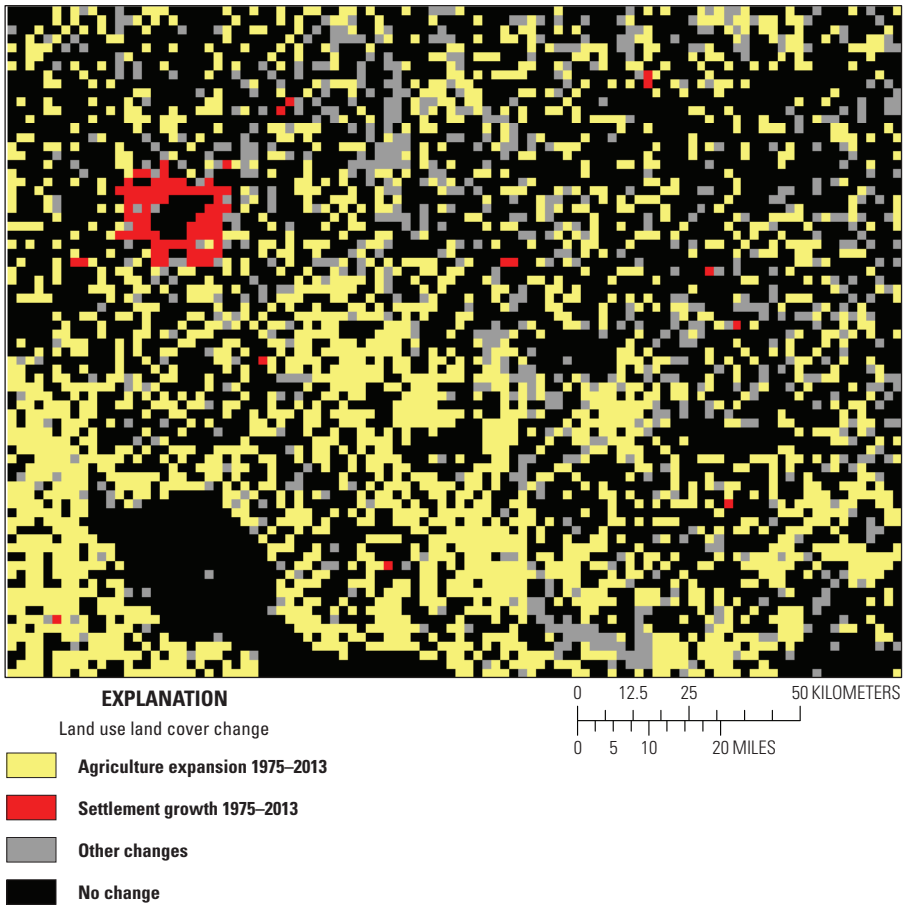


Figure 2. An example of land cover change from 1975 to 2013 around Ouagadougou, Burkina Faso. Most of the land change in this area is the expansion of rainfed agriculture (yellow), and the growth of the city (red).

Photographs by Gray Tappan, USGS.

Cropland surrounding a villlage, central Senegal.

Photographs by Gray Tappan, USGS.

Clearing of a wooded savanna for cropland, southern Senegal.

Land Cover Applications

The West Africa Land Use Land Cover Time Series dataset (Tappan and others, 2016) provides a comprehensive "wall-to-wall" view characterizing the landscapes at three time periods and permitting analysis of trends. The map data are portraying objective information to help decision makers understand nearly 40 years of trends and plan for the future. The dataset is a valuable tool for policy makers and government officials of West Africa. The data can be used to understand effects of deforestation and forest degradation, quantify carbon emission trends, and monitor water and agriculture resources for the past 40 years, among many other possible applications.

The analysis of the West Africa Land Use Land Cover Time Series dataset was published in an atlas entitled "Landscapes of West Africa: A Window on a Changing World" (CILSS, 2016). The atlas highlights landscapes that have undergone substantial transformations, such as in the Sahelian savannas and the tropical Upper Guinean forest, and examines the drivers of change and their environmental and socioeconomic effects at the regional and national scales. The atlas and data products are available for download at no charge to the public from the project website: https://eros.usgs.gov/westafrica. Data and products acquired through the West Africa Land Use Dynamics project website have no restrictions on subsequent use, sale, or redistribution.

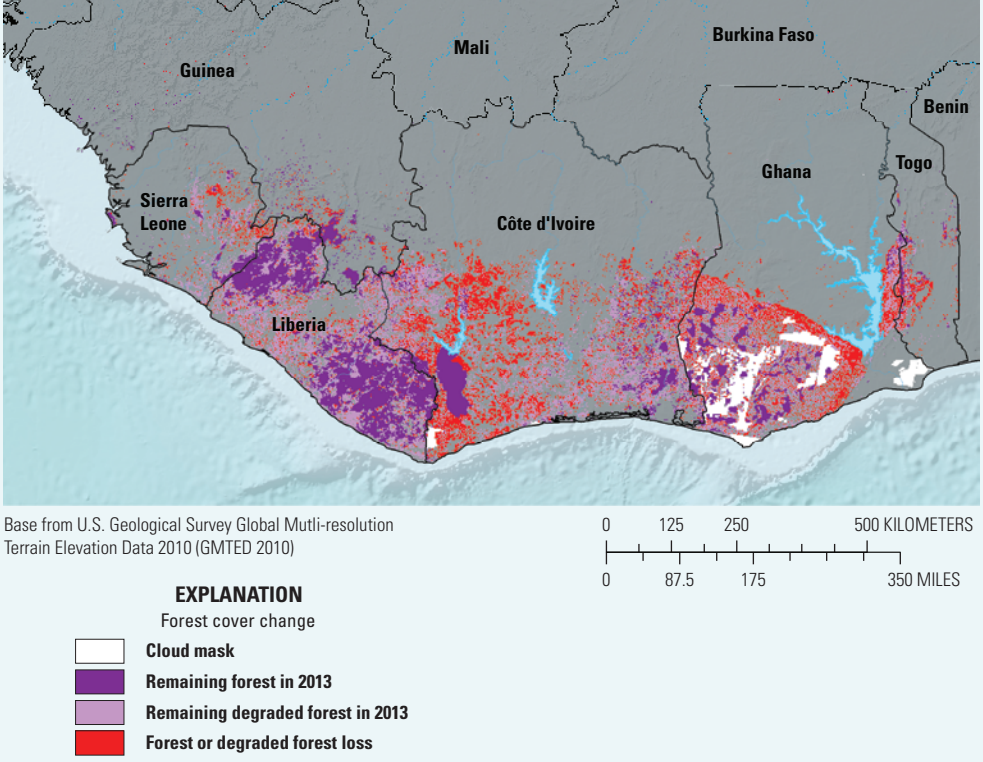


Figure 3. Forest cover change in the Upper Guinean countries from 1975 to 2013.

Photographs by Eric Landwehr, SDSU.

Canopy walk at Kakum National Park, Ghana.

Photographs by Eric Landwehr, SDSU

Dense forest in Ghana.

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ISSN 2327-6932 (online)
https://doi.org/10.3133/fs20173004