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#13 — Monitoring Forest Cover in Central Africa Why, What, How and When to Monitor

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Key Concepts

- Central Africa contains the second largest rainforest in the world, with relatively low annual rates of deforestation compared to Asia or Amazon.
- Estimates of Central African rainforest extent, based on early 1990s AVHRR satellite

observations, are approximately 1.8 million km², but recent model predictions suggest that disturbed forest will dominate by 2030.

- Information on forest state and forest uses is not gathered systematically nor made public.
- More access to information does not necessarily mean resources will be managed for benefit of the majority. But, lack of information almost ensures that forest resources will not be used equitably.
- The goal is to provide timely and reliable information on forest composition, condition, and extent, as a basis for informed decision making.
- National forest and mapping agencies are plagued by inadequately trained staff with little technical expertise and insufficient resources to perform inventories, and monitor changes.
- The cost of forest monitoring increases with area, frequency, scale and number of attributes to be monitored.
- Monitoring has to be driven by a political process that raises popular demand for environmental information.
- Monitoring schemes have to be developed in collaboration with end-users of the information (e.g. governments, conservation organizations, local communities) to ensure the information meets their needs and is appropriate for adaptively managing policies and practices.

Why Monitor Africa's Rainforests?

The Congo Basin contains the second largest continuous rainforest in the world. It includes the some of the highest biodiversity of Africa and sustains more than 20 million people (Table 1), most of whom depend on natural resources for their livelihoods, including agriculture, non-timber forest products as a source of food, medicines and income, and timber. Collection of, and public access to national and regional scale information on forest types, distribution and rates of conversion is a necessary but insufficient step to greater equity in forest management decision making and benefit sharing. In the 1980's, after publication of the deforestation rates in the Amazon basin, the government of Brazil and the World Bank were accused of promoting deforestation by building new roads and giving away large areas of forestland to settlers. As a result a new policy was adopted that settlers would have to retain at least 40% of their land in forest. Similarly, in Indonesia, forest monitoring proved that, contrary to government assertion, most of the forest burning was not caused by smallholders, but by politically influential industrial plantations. Monitoring does not always lead to new forest policies, but is a fundamental step in managing natural resources.

Africa's national forest agencies have been under-funded for long time and have had to rely on collaboration with foreign institutions to overcome the lack of up to date information on forest cover and forest conversion. The combination of high population growth and increased world demand for forest products necessitate the development and implementation of innovative and

sustainable forest management plans that will help ensure that forest uses benefit the majority and do not compromise access to these benefits in the future.

What Should Be Monitored?

What is monitored must be determined by the demand for environmental information. For example, local communities might be interested in tracking the expansion of immigrant farmers into their traditional territories, national forest agencies may want to know where timber companies are logging particularly if they are taxed based on their concession area, protected area managers may be keen to monitor the location and size of gold and diamond mining camps, biologists may want to track tree mortality and regeneration rates under different management regimes, and global climate modelers would like to monitor rates of carbon accumulation and emissions within forests of different types.

"The goal is to provide timely and reliable information on forest composition, condition, and extent, as a basis for informed decision making."

Supplying forest information in the absence of demand is, however, unlikely to result in changes in forest policies and practices. After five years, the logging company that collaborated on the API-Dimako project was uninterested in making use of the vast supply of research results for improved forest management, because more efficient harvesting offered it no competitive advantage. Similarly, the influence of FORAFRI and REIMP two other donor projects, on forest management by making environmental information more available to governments, has yet to be assessed.

That said, increasing public rather than simply public-sector access to information may empower latent constituencies for forest policy reform, and consequently build demand for more and better forest information. Providing nascent civil society institutions with environmental information with which to lobby government for changes in forest policies and practices may be a more effective use of environmental information than providing it directly to uninterested ministries.

How and When to Monitor

Different characteristics of forests can be monitored at different spatial and temporal scales to address different management concerns. Moreover, information can be gathered both physically by people on the ground, or remotely using cameras and other sensors flown on airplanes and satellites. To monitor compliance with forestry laws, information on the location and extent of logging may only need to be gathered once a year within and bordering a concession, over an area of typically less than 200,000 ha, and could be accomplished either by forestry staff visiting the concession, or by using remote sensing to record the location of new logging roads and the number of new canopy gaps associated with felled trees. To establish a sustainable forest

management plan information on tree fruiting times, seedling mortality, recruitment, and mortality would have to be collected monthly by field staff, over an area of at least 10 ha. Agricultural expansion into forested areas, and forest fragmentation by roads, could be monitored on a yearly basis using satellite imagery over relatively vast areas.

Field-based monitoring is, not surprisingly, more expensive than using remote sensing data. In general monitoring costs increase with spatial scale, level of detail and accuracy, and the frequency of data collection (Table 2).

Table 1: Central African Statistics on Forests and Population					
	Population¹ (millions)	Population Density	Deforestation Rate 80-90s²	Forest Cover⁴ (%)	Agriculture and Fallow⁴ (%)
Cameroon	12.80	27.5	0.6	37.0	14.0
Central African Republic (CAR)	3.20	5.2	0.4	10.0	10.0
Dem. Rep. of Congo (DRC)	42.60	18.3	0.6 0.4 ³	48.0	4.0
Equatorial Guinea	0.39	15.6	0.4	65.0	23.0
Gabon	1.30	4.9	0.6	80.0	9.0
Rep. of Congo	2.50	7.3	0.2	66.0	11.0
<p>1 - Bahuchet (1995) estimates the forest population to be 24 million. 2 - Annual rate in percent from FAO Tropical Forest Assessment (FAO 1993). 3 - Annual rate in percent from CARPE-Landsat Pathfinder Project (1984-98). Details in Brochure "Deforestation in Central Africa?" 4 - Derived from AVHRR analyses of the 1990s, see Figure 1 for illustration (Laporte et al. 1998)</p>					

National and Regional Scale Forest Cover Monitoring

Traditionally Africa's national forest services have provided inventories and monitored forests for timber exploitation using expensive, time consuming, and intermittent aerial surveys. High cost of aerial photography and photo-interpretation limited these surveys to only small areas. In most countries, lack of demand, high cost, and insufficient technical staff and operating budgets, has meant that forest assessments have not been updated for decades, if at all.

Remote sensing imagery provides Central African nations with an alternative, timely and cost-effective approach to monitoring changes in forest cover at multiple scales. Satellite imagery and aerial-videography are now an essential part of most large area forest monitoring systems. However, remote sensing images are not a substitute for field-based data collection, which is essential for accurate image interpretation and to provide the necessary data on forest characteristics that are undetectable by air- and space-borne sensors.

What Are the Existing Remote Sensing Tools for Forest Cover Monitoring?

Given the immense area covered by Africa's rainforests (approximately 1.8 million km²), and their relative inaccessibility, a combination of remotely sensed data used and targeted field-based forest inventories will produce the most accurate and timely estimates of forest cover type, relative distribution and rates of change, at local to regional scales.

At the regional level, optical image data from NOAA-AVHRR sensors, and the new MODIS and SPOT VEGETATION instruments are the primary systems for gross differentiation between forest, savanna and agriculture. These systems have neither the spatial nor spectral resolution to discriminate multiple forest types.

At the national or local level, Landsat or SPOT imagery can provide finer scale information on forest type distribution and agriculture expansion.

Optical sensors like the Landsat Enhanced Thematic Mapper offer good spatial coverage for most of the Democratic Republic of Congo and Central African Republic. However, wall-to-wall mapping of Cameroon, Gabon and the Republic of Congo is difficult because of perennial cloud cover. Radar systems such as JERS and Radarsat are not affected by clouds, and are useful for determining the extent of forest and non-forest landscapes where topographic relief is not substantial (<200m). Radar imagery is, however, unable to differentiate between high woody biomass old-growth or unlogged forests from degraded lower biomass forest types.

Moving Toward an Operational Forest Cover Monitoring System in Central Africa

International efforts are underway to improve operational forest monitoring as part of the Global Terrestrial Observing System. At the first Global Forest Observation of Forest Cover (GOFC, 2000) workshop held in central Africa (February 2000 in Libreville, Gabon), several issues limiting the development of operational forest monitoring systems were identified by national forest services and their international partners. These included: (1) lack of human and financial

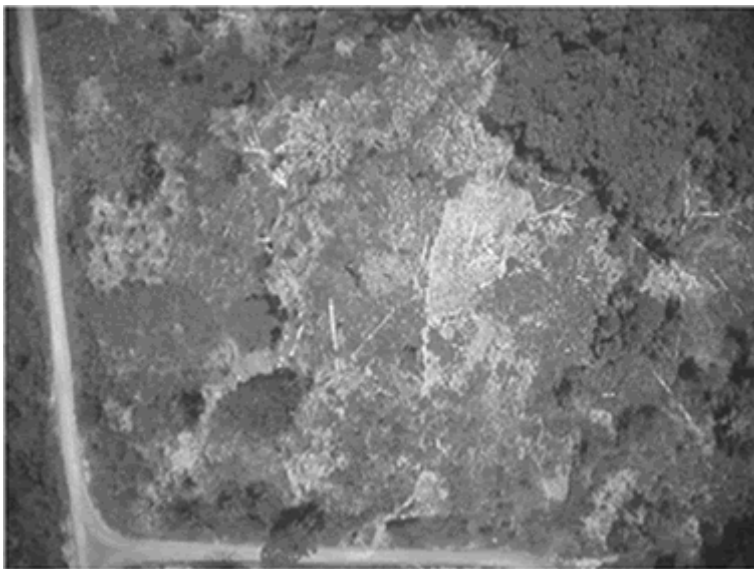
resources; (2) poor access to data and information; (3) poor Internet access; and (4) lack of training facilities and opportunities.

In the Central African region, as part of the international GOFIC initiative, new remote sensing tools and methods will be tested for local and regional scale monitoring. In addition, future workshops, technical exchanges, and collaborative research activities will continue to strengthen national capacity for forest monitoring. The latter is particularly important given the paucity of technical expertise in the region.

These activities will foster the growing collaboration between national forest services, universities, conservation organizations and the logging private sector. For example the utility of new high resolution IKONOS imagery (at 1 and 4m resolution) will be evaluated for forest concession management at very fine scales. In Gabon IKONOS data will be tested for mapping recolonization of Okoumé in savanna areas. This tree species is important to the nation economy as it represents more than 70% of log exports. Landsat imagery will also be tested for developing a monitoring system for logging activities in Cameroon, Gabon and the Republic of Congo. The FAO Africover Project will be extended into Central Africa strengthening capacity for national forest mapping and monitoring and building on the satellite data sets developed by CARPE, NASA and the ECE.

To improve the access to spatial information for forest monitoring, recent imagery from Landsat 7 will be made available on CDs by CARPE for national forest services, conservation organizations and the CARPE - GOFIC network. Also, the NASA Landsat Pathfinder archive will continue to be available via the Internet and CDs. (<http://glcf.umiacs.umd.edu>; <http://www.bsrsi.msu.edu/trfic/>).

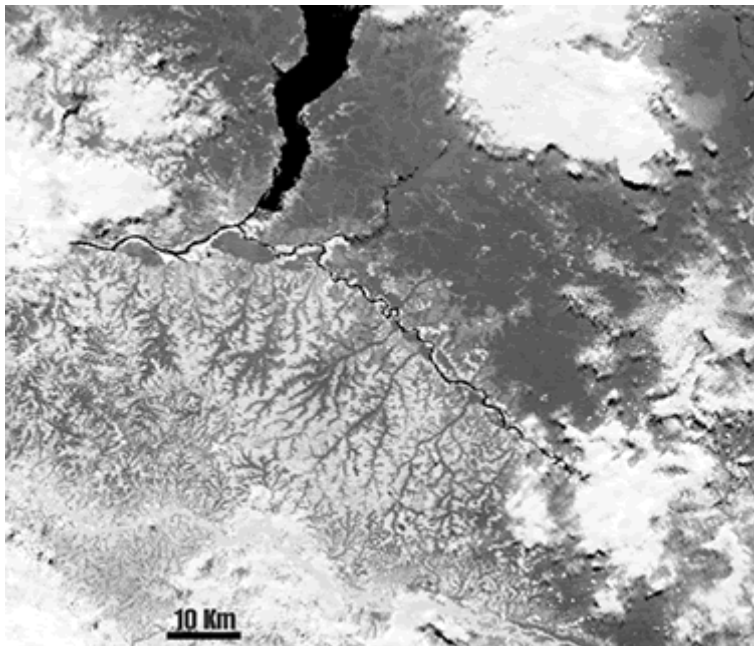
Satellite Imagery



Legend 1: Tracking logging with digital videographies.



Legend 2: Tracking logging with digital Landsat TM imagery.



Legend 3: MODIS image of Bandudu province.

Figure 1: Extent of the Rainforest from TREES and CARPE (1990s)

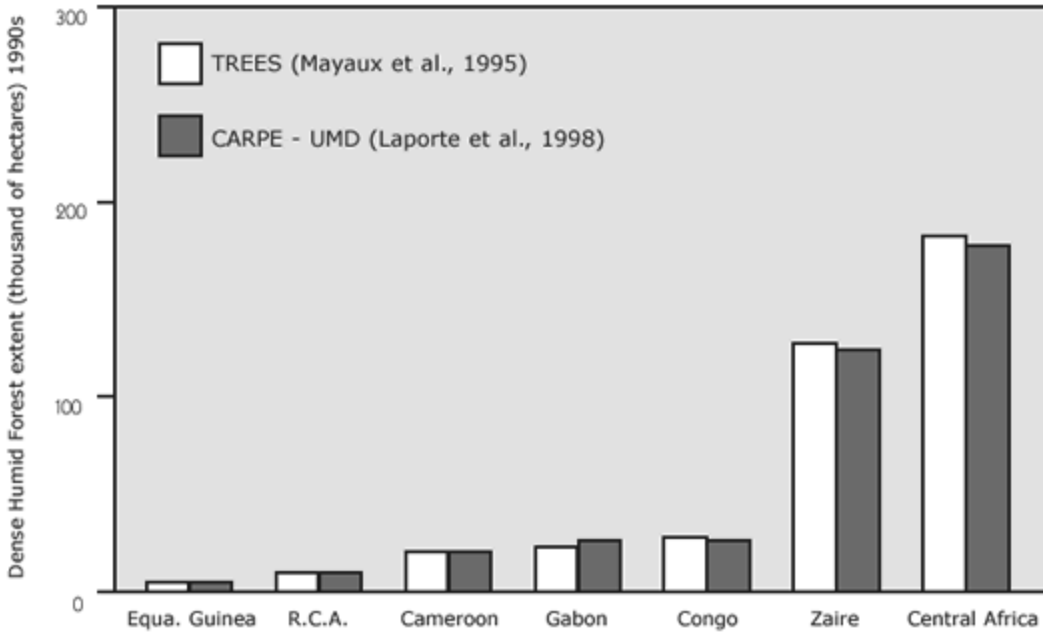


Table 2: Tools for Monitoring Changes in Forest State

Scale	Data Source	Forest Attributes	Spatial Resolution	Temporal Frequency	Mapping Scale	Monitoring Cost
REGIONAL	AVHRR	Forest/Non forest				
	SPOT vegetation	Net primary productivity				
		Seasonality				
		Forest disturbances:	1 km ²	daily	>1/500,000	Low
		Agriculture				
NATIONAL	Landsat	Forest types				
	SPOT					

		Forest disturbances:	100 m ² to 900 m ²	15-20 days	> 1/50,000	Low to high	
		Agriculture					
		Logging roads					
		Plantations					
LOCAL	IKONOS	Tree species					
	Aerial-videography	Human population growth and movements	1 m ² to 16 m ²	User defined	> 1/500	High	
		Forest disturbances:					
		Agriculture					
		Logging roads					
		Plantations					
		Tree gaps					
	Field staff	Species composition	<1m ²	User defined	> 1/500	Very high	
		Harvest rates					
		Level of degradation					
Note: Due to cloud coverage data availability differs from data temporal frequency							

For More Information

Technical Reports

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CARPE...What Is It?

Central African Regional Program for the Environment (CARPE)

Launched in 1995, the *Central African Regional Program for the Environment (CARPE)* engages African NGOs, research and educational organizations, private-sector consultants, and government agencies in evaluating threats to forest integrity in the Congo Basin and in identifying opportunities to sustainably manage the region's vast forests for the benefit of Africans and the world. CARPE's members are helping to provide African decision makers with the information they will need to make well-informed choices about forest use in the future. BSP has assumed the role of "air traffic controller" for CARPE's African partners. Participating countries include Burundi, Cameroon, Central African Republic, Democratic Republic of Congo, Equatorial Guinea, Gabon, Republic of Congo, Rwanda, and São Tomé e Príncipe.

Web site:

<http://carpe.umd.edu>

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