Briefing Sheet - Forest Monitoring in Central Africa

Key concepts

- Central Africa contains the second largest extent of 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 ca. 1.8 million km2, but recent model predictions suggest that disturbed forest will dominate the forest zone by 2030
- Information on forest state and forest uses is not gathered systematically nor made public
- More access to information does not necessary mean that resources will be managed for the benefit of the majority. However, lack of information almost assures that forest resources will not be used equitably
- The goal of forest monitoring is to provide timely and reliable information on forest composition, condition, and extent, as a basis for informed decision making for natural resource management and planning.
- National forest and mapping agencies in Central Africa are plagued by inadequate trained staff and technical expertise, and insufficient resources to perform inventories and to monitor changes in forest state and uses.
- The cost of forest monitoring increases with the area, frequency, scale and number of forest 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 close collaboration with end-users of the information (e.g. governments, conservation organizations, local communities) to ensure that the information meets their needs and is appropriate for adaptively managing forest 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 for 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 monitor 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.

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, FORAFRI and REIMP to other donor projects, have also failed to influence forest management by making environmental information more available to governments.

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 a 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 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).

National and regional scale forest 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 monitoring?

Given the immense area covered by Africa's rainforests (ca. 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 or spectral resolution to discriminate multiple forest types.

At the national or local level, Landsat or SPOT imagery can provided 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 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: a) lack of human and financial resources; b) poor access to data and information; c) poor internet access; and d) lack of training facilities and opportunities.

In the central African region, as part of the international GOFC 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 recolonisation 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 nationals forest services, conservation organizations and the CARPE – GOFC network. Also, the NASA Landsat Pathfinder archive will continue to be available via the WWW and CDs. (http://glcf.umiacs.umd.edu, http://www.bsrsi.msu.edu/trfic/)

Related briefs

Deforestation in Central Africa?
What if the forest disappeared?
Simulating future states of the forest.
Timber Tsunami: Tracking logging in the Congo Basin

Author and Contact Information

For more information on forest mapping activities please contact:
Dr. Nadine Laporte & Prof. Chris Justice
University of Maryland
Dept. of Geography
Lefrak,1133
College Park, MD 20742
tel: 301 405 7475

fax: 301 314 9299
e-mail: nlaporte@geog.umd.edu

References – to be made available on the web:

Barber C.V., Shweithelm J.,2000, Trial by Fire, Forest Fires and Forestry Policy in Indonesia's Era of Crisis and Reform, WRI report. Washington DC, USA. ISBN 1-56973-408-9.

De Cauwer V., et De Wulf R.,1997, Potential use of ERS.SAR Data to discriminate natural and degraded woody vegetation types in Central Africa, in the Third ERS Conference Firenze,1997.

Eerens H., Deronde B., Rensbergen J., A land cover Map of Central Africa derived from SPOT4-VEGETATION imagery- Vito,1999, Belgium.

Global Forest Watch (GLFC), 2000, A first look at logging in Gabon, WRI Report. Washington DC, USA. ISBN 1-56973-423-2.

GOFC Report, 2000, Atelier de création du réseau GOFC – OSFAC en Afrique Centrale, Libreville, 22-24 février 2000, Eds. Mayaux J., Justice C., Lumbuenamo R.

Laporte N. , Goetz S.J. , Justice C.O., Heinicke M., 1998, A New Land Cover Map of Central Africa derived from Multi-resolution, Multitemporal AVHRR Data, International Journalof Remote Sensing, 19(18):3537-3550.

Laporte N. , Justice C. , Kendall J., 1995, Mapping the Dense Humid Forest of Zaire and Cameroon Using AVHRR Satellite Data, , International Journalof Remote Sensing., 16(6):1127-1145.

Lawrence, W. T., Privalsky M.V, and B. Bankanza. 2000.Mapping forest cover in the Democratic Republic of Congo. 28th International Symposium on Remote Sensing Environment. Cape Town.

Mayaux, P., T. Richards and E. Janodet. 1999. A vegetation map of Central Africa derived from satellite imagery, Journal of Biogeography 26 (2): 353.

Mayaux, P., Lambin, E.F., 1995, Estimation of tropical forest area from coarse spatial resolution data: a two-step correction function for proportional errors due to spatial aggregation. Remote Sensing of Environment. 53:1-16.

Nigel S., Downes D., Kaimowitz D.,1999, Tree Trade, Liberalization of International Commerce of Forest in Forest Products: Risks and Opportunities, WRI Forest notes, November 1999, ISBN:156973-432-1.

Otodo K., 1991, Norme d'inventaires d'aménagement et de préinvestissement. Office National de Développement des Forêts (ONADEF), Juin 1991, Yaoundé, 32p, + annexes.

Skole D.S., Justice C.O. , Janetos A. and Townshend J.R.G. 1997. A land cover change monitoring program: a strategy for international effort. Mitigation and Adaptation Strategies for Global Change, Kluwer Academic Publishers, The Netherlands, 2, (2-3), 157-175.

Wilkie D., Laporte N., 2000, Forest Area and Deforestation in Central Africa: Current Knowledge and Future Directions, in W. Weber, A. VeddeR, S. Morland, L. White (Eds.), African Rainforest Ecology and Conservation, Yale University Press.

List of Illustrations & Tables

Table 1: Central African statistics on forests & population

	Pop [1] (millions)	Pop density	Deforestation Rate 80-90s [2]	Forest Cover [4] (%)	Agriculture and fallow[4] (%)
Cameroon	12.80	27.5	0.6	37	14
Central African Republic (CAR)	3.20	5.2	0.4	10	10
Dem. Rep. of Congo (DRC)	42.60	18.3	0.6 0.4[3]	48	4
Equatorial Guinea	0.39	15.6	0.4	65	23
Gabon	1.30	4.9	0.6	80	9
Rep. of Congo	2.50	7.3	0.2	66	11

[1] Bahuchet (1995) estimates the *forest* population to be 24 million.
[2] Annual rate in per-cent from FAO Tropical Forest Assessment (FAO 1993).
[3] Annual rate in per-cent from CARPE-Landsat Pathfinder Project (1984-1998) details in Brochure "Deforestation in Central Africa?"
[4] Derived from AVHRR analyses of the 1990's, see Figure 1 for illustration (Laporte et al. 1998).

Table 2: Tools for monitoring changes in forest state

Scale	Data source	Forest attributes	Spatial resolution	Temporal frequency	Mapping scale	Monitoring cost
Regional	AVHRR SPOT vegetation	Forest /Non forest Net primary productivity Seasonality Forest disturbances: - Agriculture	$1\ km^2$	daily	>1/500,000	Low
National	Landsat SPOT	Forest types Forest disturbances: - Agriculture - Logging roads - Plantations	$100\ m^2$ to $900\ m^2$	15-20 days	> 1/50,000	Low to high
Local	IKONOS Aerial-videography	Tree species Human population growth and movements Forest disturbances: - Agriculture - Logging roads - Plantations - Tree gaps	$1\ m^2$ to $16\ m^2$	User defined	> 1/500	High
	Field staff	Species composition Harvest rates Level of degradation	$<1m^2$	User defined	> 1/500	Very high

Note: Due to cloud coverage data availability differs from data temporal frequency

Figure 3: Extent of the rainforest fromTREES and CARPE (1990's)