**Operationalizing GOFC in the Miombo Region and Questions of Carbon**

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## 1. ABSTRACT

This pilot GOFC project for the Miombo Dry Tropical Region of Southern Africa is seeking to understand the role of Miombo in the carbon budget, as well as provide baseline land cover information to support ecosystem assessment and natural resources management. The overarching science goal is to quantify carbon in the Miombo system and estimate carbon fluxes due to land use/land cover changes, and explore the question about whether the Miombo region is a source or sink of carbon over a forest management horizon (10 to 20 years, using the 1990-2000 as an initial test period). Related to this, the project is exploring the feasibility of community-level carbon projects that would satisfy Kyoto forests.

This will be accomplished through

1. Mapping the miombo region using Landsat 7 data by working in conjunction with Southern African national mapping agencies;
2. Measurement of carbon densities in representative land cover/forest cover types of the region, while building upon existing forest inventory and national biomass studies;
3. Development of a carbon accounting model that will quantify carbon pools in the miombo region for 1990 and the year 2000, and the major C fluxes due to land cover changes;
4. Development of a regional spatial database for site characterization; and
5. Development of an information management system that will distribute satellite data for the miombo region, and serve as a database archive for field data about the miombo region, such as forest inventory records and site data for image classification.

The Miombo GOFC project will provide leadership in application of satellite data in the Miombo Network, and expects to engage as many user groups as possible. The acquisition and distribution of satellite data to as many user groups within the Miombo Network is a very important service to the community designed to maximize benefit from remote sensing.

**Keywords:**
1) Research Fields: carbon, land cover change, land use change
2) Geographic Area/Biome: Southern Africa; Miombo Woodlands, Savanna Woodlands
3) Remote Sensing: Landsat, Land Cover Mapping
4) Methods/scales: integrated modeling, landscape scale

## 2. GOALS

This project is addressing the following NASA ESE scientific questions:

a) what are the changes in land cover and/or land use (monitoring/mapping activities),
b) what are the consequences of LCLUC (in terms of carbon).

Proportion of social science used in study: 25%
Themes: Carbon (25%), GOFC mapping and monitoring of forest cover change (75%),

### Goals for this period of performance and accomplishments

For year 1, the main goals/planned activities were:

- *Miombo GOFC Coordination Meeting to discuss classification methods, data needs and distribution mechanisms, and plans for field activities in support of the mapping and modeling*

A regional workshop was held in Maputo, Mozambique during July 18-20$^{th}$, 2000, and papers presented are being prepared for publication as a special issue of the journal '*Forest Ecology and Management*' (Elsevier). Publication is expected in the early summer of 2001. Methods, field sites, data needs, etc, were identified. Workshop report available from http://www.gofc.org.

- *Field Measurements of Forest Biomass*

Field sites identified in Nampula, Northern Mozambique and some measurements taken. Ground control points for mapping recorded extensively using GPS, during October-December 2000. More field sites identified in Chimoio (Central Mozambique) and in Kasungu, Malawi. Field data being prepared for web delivery.

- *Design and implementation of an information gateway for satellite data and other data for carbon modeling*

With reduced workplan after budget revisions, it was decided to collaborate with the Tropical Rain Forest Information Center (TRFIC) at Michigan State University to implement the satellite data distribution for Miombo. This has been initialized, and some data are already available via the TRFIC site at http://www.bsrsi.msu.edu/trfic/MIOMBO/. Work is in progress to upload rest of Miombo Landsat data holdings.

- *Preliminary design of carbon models and links to land use*

A carbon model has been designed and was presented at the July 2000 workshop. A manuscript is in review for inclusion in the special issue. A regional map for 1990 showing forest/non-forest coverage has been produced (derived from individual national maps) (see Figure 1). This map will be used in the carbon mapping and many other applications including the Millennium Assessment projects and national planning.

**Timeline (milestones), Accomplishments**

Workshop at beginning of project as planned, journal special issue in progress (not initially proposed). Regional forest/non-forest map produced, web-based data distributed accomplished through collaboration with MSU/TRFIC ESIP. Field work on track.

**Gaps/Problems and Possible Solutions**

- Reduced budget resulted in efforts being restricted to one country (Mozambique) versus a more regional approach, making it more difficult to engage the whole regional group of the Network. Need coordinated field work across countries in production of land cover products. Related proposals in progress to fund this field work through the Millennium Assessment project for Southern Africa.
- Not possible to implement an online data distribution system as initially proposed. Collaborating with MSU/TRFIC to do this, although most regional partners are still unconnected to the Internet for full access to online data. Temporary solution would be to cut CDs and distribute to regional collaborators.

## 3. PROGRESS, SIGNIFICANT RESULTS AND NEXT STEPS

This study is making very good progress. An early regional workshop clearly established data needs, methods and regional partnerships for the GOFC network in Southern Africa. Emphasis in year one has been on acquiring and distribution of Landsat data in media and formats that are useable in Africa. The availability of the Landsat 1990 mosaic from Earthsat has greatly enhanced our database. The mosaic data are being used to provide a 1990 baseline for further mapping.

* New findings -
* New potential
- A Miombo land use change model (MELT) has been constructed and provides the integration of rural and urban economic forces prevalent in this region (formal and informal sectors). The model has the necessary spatial resolution to be useful in impacts studies of land use change on hydrology, carbon and land use planning. It is forming the basis for an integrated assessment model (for climate change) in Southern Africa. Early simulation experiments indicate a threshold in landscape fragmentation after which land use changes become monotonic. In general, the nature of land use change decisions make land use trajectories unstable – that is, equilibrium conditions are difficult if not impossible to achieve. These initial results will be discussed in the Miombo GOFC special issue later this year, and at the IGBP Open Science Meeting in Amsterdam in Jul 2001.

* New products
- Regional Map of Forest/non-Forest for 4 countries of the Miombo Region (see Figure attached as a jpeg – higher resolution image available).
- Southern African country-wide mosaics based on 1990 Landsat data from Earthsat available (processed from individual UTM panels provided by Earthsat). The country mosaics provide overlaying capabilities with other baseline information.

**Next Steps**
- Finalize journal special issue
- Continue field observations to develop carbon densities relationships under different land uses
- Complete Mozambique mapping using Landsat 7 data when national coverage available later this year.
- Present land use modeling results at the IGBP Open Science Meeting in Amsterdam in July 2001 as part of a Miombo Network cluster of posters (at least 8 posters planned).
- Upload all Landsat data in the Miombo collection to the MSU TRFIC online data service. This will greatly enhance availability of data to the science community.
- Participate in Millennium Assessment projects in Southern Africa.

## CONCLUSIONS

Regional forest/non-forest map available.

Publications from this year 1 including related papers presented at the first Miombo GOFC workshop in July 2000 are in review and will be published in *Forest Ecology and Management* (Elsevier) later this year.

The data acquired through this project and the previous Miombo LCLUC project, have been very useful in regional applications. These data will be very useful in the new Millennium Assessment regional project being developed for Southern Africa. Other international projects in Africa are also taking serious note and developing close collaborations e.g. FAO projects in Mozambique, World Wildlife Fund (WWF) and UNEP in Nairobi – there is interest to link the Miombo work to their Land and Water initiatives in the region.

Will need another 15 Landsat 7 images to complete coverage for Mozambique.