



## **Report of the Miombo GOFC Coordination Meeting**

Maputo, Mozambique

20 – 22 July, 2000

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**GOFC-GOLD Report No. 9**

Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD) is a coordinated international effort to ensure a continuous program of space-based and in situ forest and other land cover observations to better understand global change, to support international assessments and environmental treaties and to contribute to natural resources management.

GOFC-GOLD encourages countries to increase their ability to measure and track forest and land cover dynamics by promoting and supporting participation on implementation teams and in regional networks. Through these forums, data users and providers share information to improve understanding of user requirements and product quality.

GOFC-GOLD is a Panel of the Global Terrestrial Observing System (GTOS), sponsored by FAO, UNESCO, WMO, ICSU and UNEP. The GOFC-GOLD Secretariat is hosted by Canada and supported by the Canadian Space Agency and Natural Resources Canada. Other contributing agencies include NASA, ESA, START and JRC. Further information can be obtained at <http://www.fao.org/gtos/gofc-gold>



## Report of the Miombo GOFC Coordination Meeting Maputo, Jul 20-22<sup>nd</sup>, 2000

*(This is a report of a GOFC meeting for Southern Africa/Miombo Region that was held in Maputo during July 20-22<sup>nd</sup>, 2000. The report shows how each item of the agenda was dealt with, then gives a summary of group discussions, followed by an outline of a proposed journal special issue that is in progress, and a list of GIS data that were prepared to support GOFC activities and related modeling in southern Africa).*

### **Summary:**

Miombo Network members see great value in the Global Observation of Forest Cover Project with its goal of promoting increased use of remotely sensed data for operational forest monitoring. In particular the network sees the benefit of 1) remote sensing data acquired through the Miombo Network and distributed widely among existing projects 2) improved information on data availability 3) improved information on and access to data from new or experimental sensing systems 4) derived satellite products, for example on land cover and fires for the region being validated by regional scientists in an applications context. National mapping activities in Malawi, Mozambique, Zimbabwe and Tanzania are taking full advantage of latest Landsat 7 provided through the network to update areas of special interest in their countries and for special projects (land degradation study in Tanzania, flood mapping in Mozambique, biomass studies and conservation area monitoring in Zimbabwe. Regional institutions that are active in the Network activities include SADC - Regional Remote Sensing Unit, Forestry and Biodiversity Coordination Units, ICRAF, FAO and WWF.

Forestry and Mapping specialists in the region acknowledge the increasing utility of remote sensing, and they look forward to experimenting with data from new instruments such as Ikonos and MODIS. Utility of Radarsat data was easily demonstrated in the recent floods of Mozambique, however, cost of data remains a major obstacle to wider application. It was suggested that a request be sent to space agencies (via GOFC) for sample data sets from the region to facilitate testing and capacity building in processing and using these new data types.

Acquisition of satellite data in response to the flood emergency was noted as especially problematic. The national mapping agency in Mozambique was unable to secure imagery for the flooded areas up until the time of the meeting (several months after). This was mainly due to funding agencies insisting on different priorities from national interests.

A special issue of the journal 'Forest Ecology and Management' is planned to publish papers from the Miombo Network, that will form the basis for a Miombo GOFc activity, including working group summaries from the regional GOFc workshop. Review and synthetic papers will bolster themes that were not fully discussed during the short workshop such as state-of-the-art in using remote sensing in biomass estimation.

A data CD-ROM following the design of the first Miombo LUCC CD-ROM, is planned and will contain georeferenced data for the miombo region and some more detailed for special countries, to be used for landscape characterization and carbon modeling, and later, in integrated modeling. Most of the datasets are ready, and comprise approximately 3 Gigabytes of Arcinfo GIS data layers.

A Miombo GOFc brochure and web site is planned, and will form the main archive and distributor of miombo satellite data holdings. This home page will expand and extend the existing Miombo Home Page at <http://miombo.gecp.virginia.edu>. to include the GOFc activities. Information specific to Mozambique (including an emerging Integrated Analysis and Modeling activity) can be found at <http://mozambique.gecp.virginia.edu>.

## **Introduction**

A meeting of the Tropical Component of the Global Observation of Forest Cover (GOFc) Program in Washington DC in March of 1999, laid out an agenda of activities desired for the Miombo Region of Southern Africa. These included an early meeting to highlight the broad range of remote sensing instruments and data products available or soon to be available, as well as to plan regional distribution and use of satellite data being archived by the Miombo Network and others, and to strengthen a regional network of GOFc partners. Such a meeting was held during July 20-22, 2000 in Maputo, Mozambique, organized by the University of Virginia in collaboration with CENACARTA in Maputo (mapping unit of the Surveyor General) and TANRIC (Tanzania Natural Resources Institute).

The overall goal of a Miombo Network activity under GOFc is to plan the operational use of remote sensing data in natural resource management and monitoring of land cover change for global change and biodiversity applications, by national institutions and NGOs operating in the Miombo Region. It is planned that a pilot activity during the first three years (currently being funded by the NASA LCLUC program) will develop methods and models for a case study using Mozambique, in collaboration with existing projects.

Specific objectives of the meeting were to:

1. Review satellite data instruments and classification methods, with emphasis on high-resolution sensors in relation to data needs for the Miombo Region.
2. Review status of forest inventories in the Miombo countries, with emphasis on methods and results that are available.
3. Design integration of remote sensing data products with forest and other models for use in addressing Miombo science issues.

4. Design a Miombo GOFD Data and Information Management strategy.
5. Discuss plans for using GOFD to help transfer methods from research to the operational mode in Southern Africa.
6. Discuss Emerging Science Topics and application of models and data that would be generated from GOFD.

While some of these objectives were not fully exhausted at the meeting, plans were put in place to address all these issues through contributed papers to a journal special issue that is planned as an output of this workshop (see later).

It should be noted that a subgroup of the Miombo Network has developed around the GOFD Theme of Fire Detection and Monitoring. This Miombo Fire group met at Matopos, Zimbabwe in 1999 and in Mongu, Zambia in 2000 and is currently focusing on fire product validation in conjunction with the CEOS CVWG on Land Product Validation. The topic of GOFD-Fire was not addressed at this meeting.

Main results of the meeting under each objective include:

***Review of satellite data instruments and classification methods, with emphasis on high-resolution sensors.***

Discussions covered harmonization of legends between GOFD and regional mapping efforts, with emphasis on recommending a common approach for future processing of Landsat 7 imagery for the Miombo region. Utility of Landsat 7 data was highlighted especially given the growing acquisition by the Landsat 7 Acquisition Strategy and access to data through the Miombo Network. Other data types are less available due to high costs, and it was recommended that sample data of high-cost data (for areas of interest) be requested to help expose capabilities and development of methods. These sample data need to be for sites where there is interest and existing field data in the region, rather than generic samples data from outside the region.

Other potentially useful data sets include RADARSAT, IKONOS and MODIS. MODIS data is beginning to come online, and it was recommended that the Miombo Network work closely with Safari 2000 to put together a regional MODIS 250 m dataset that can be used for land cover change mapping.

***Review status of forest inventories in the Miombo countries, with emphasis on methods and results that are available.***

Various documents that have summarized forest inventory and regional mapping plans for the region were highlighted and will be reviewed in detail and summarized in a paper for the special issue. Where data are accessible, it will be desirable to start collating these into a database for the Miombo Region, including forest compartment maps in digital formats. Some data for Malawi has already been assembled. It will be desirable to archive other field datasets that have been collected systematically at forest sites in the region. These data will form the *in-situ* data that will be useful for calibrating models for forest management and carbon assessments. This would be a contribution from regional partners to the broader GOFD program.

***Design integration of remote sensing data products with forestry and other models.***

This component of the meeting will be fully explored through a review of the state-of-the-art methods for linking GIS and remote sensing data to forest growth and yield prediction systems, and related landscape analyses for other natural resource management. This will form a contribution to the special issue, and will include other applications such as monitoring of hot spots of land-use change.

***Design a Miombo GOF C Gateway.***

A data management system for archive, access and display, and distribution of data under a Miombo GOF C activity and metadata about satellite data in general, was discussed. A protocol for sharing data between GOF C partners in the region and globally was discussed, and it was recommended that the Miombo Network take advantage of NASA ESIPS for data archival and distribution. Plans were made for building databases of field measurements that will contribute to the regional effort. It is expected that partners will have full access to raw satellite data (for non-commercial applications, and they will sign agreements to that effect), and that they will make value-added products accessible to other GOF C partners (after appropriate publication of results and acknowledgement of authors of value-added products). Meta-data, preview images etc., will be put on a Miombo GOF C project web page and occasionally released on CD-ROM. The Miombo GOF C web site will also serve as a gateway for satellite data and GOF C products for the Miombo Region.

***Discuss Plans for Transfer to Operational Mode of GOF C.***

Plans for migrating to operational use of remote sensing in forest inventory and forest cover mapping and monitoring were discussed. Training in remote sensing data processing and modeling was suggested as necessary before operationalizing Miombo GOF C. Sample data from difference sensors and distribution of appropriate digital image processing software will assist in this effort. Involvement of regional institutions involved in national mapping and international projects will ensure continuity of GOF C goals for the Miombo Region.

***Emerging Science Topics relevant in Modeling and Use of the Data that would be generated from GOF C.***

An important science application for products from a Miombo GOF C activity include questions of carbon, and the dynamics of carbon above and belowground in response to human land use. Interest in using dry woodlands for carbon sequestration projects under implementation of the Kyoto Protocol, require information about the extent and rates of change of the Miombo woodlands. Field studies of carbon buildup under different land use systems and management activities will be necessary to make full use of satellite derived maps of forest cover. Another issue is the application of observed land cover data in impacts models such as hydrological and food security models used in assessments. These topics will be expanded in papers of the special issue.

## ***Workshop Outputs***

A series of papers are being prepared for publication in a special issue of the international journal *Forest Ecology and Management*. A workshop summary paper will form a work plan for Miombo GOFM activities. A CD-ROM is planned to contain data and materials useful for implementing the Miombo GOFM project, *and will include models for carbon and land use change*. Data sets that will form part of this CD were used during a GIS/Spatial Modeling workshop that was conducted immediately prior to the Miombo GOFM Workshop, under START sponsorship.

### **Summary of Workshop Discussions:**

#### *Main Forestry-related Applications of Remotely Sensed Data in the Miombo Region*

- Mapping Land Cover – mostly using visual interpretation methods of hard copy prints. Data mostly acquired through South Africa receiving station at full cost for Landsat data. Typically 3 bands purchased and delivered in hard copy. Other data used most often include SPOT and some Radarsat.
- Some limited application in deriving Forest Cover (areal extent for forest inventory), although done nationally for Zimbabwe to assist in biomass assessment.
- Major Constraints:
  - High cost of data from international receiving station in South Africa
  - Lack of awareness of broad range of data types available
  - Need for advanced and continued training
  - Technical capacity to deal with new software and new sensors
  - Duplication of data acquisition and product development especially between national agencies and international groups.
  - Lack of standardization of methods
  - Slow in adapting new methods for forest inventory
  - Poor data acquisition – windows, temporal and spatial – databases sparse
  - Software constraints: cost – especially for newer appropriate packages
  - Alternative software for operational forest mapping ...simpler, cheaper, just adequate: e.g. Idrisi and MapInfo, are available. However, they still need training, and still require working knowledge of other platforms for data exchange.
  - Difficult to maintain/upgrade software beyond when funded projects expire.
  - Lack of critical mass of foresters etc that can use RS data and incorporate in their forest inventory work.
- There is a large user base for remotely sensed data, and so there is potential for high gains in networking a lot better and sharing data more openly.
- Facility for customized Training for specific projects and activities through the SADC Regional Remote Sensing Unit in Harare – countries need to specify needs and center will help. Other training facilities include those through START/Miombo Network workshops and others. Better awareness of needs and facilities required.
- The problem of cross-institutional linkages was highlighted.
- Data fusion across spatial scales and between different sensors remains difficult.

### *Summary of Carbon Discussions*

- It is well accepted that Kyoto presents many opportunities for funding carbon sequestration projects including soil improvement, afforestation etc., and that too few of these exist for Africa despite several years of carbon projects (through Activities Implemented Jointly -AIJ, International Emissions Trading - IET, Clean Development Mechanisms - CDM).
- Several excellent candidate project sites exist in the miombo region, including several plantations such as the Vipya Forest in Malawi, community-managed forests/woodlands such as Mecuburi in Nampula, Mozambique, Chimaliro in Kasungu, Malawi, etc.
- What is needed is a strong sensitization of the decision makers and scientists in the region about the carbon possibilities.

### *Data Needs and Capacity Building from GOFCC through Miombo Network*

- The community is very interested in acquiring remotely sensed data through the GOFCC initiative, as well as training in analyzing new data and participation in development of data standards. Operational use of the most appropriate remotely sensed data requires expertise in many data types and in keeping up-to-date with software. GOFCC can assist in making this transition to new data types and software through targeted training workshops and distribution of data samples.
- Data over Regional Sites are needed to implement demonstration projects.
- Existing data through the Miombo Network will be used to update national products and to create baseline for monitoring
- There are special needs for biomass assessment that build upon existing auxiliary data, and yet take advantage of advances in forest inventory methods. It was recommended that synthesis papers be prepared for the special issue to shed light on this topic as it relates to the region.
- There is much historical data for hot spots e.g. resettlement areas, that should enrich monitoring efforts.
- Intermediate centers (in region/countries) are needed to help pre-process data into useable formats/media e.g. help transition into new formats/software e.g. HDF, production of hardcopies
- Need flexibility of product type and resolution to suit needs e.g. very high resolution data (Ikonos) for very detailed analysis.
- Develop test bench sites across sensors/products – build on existing sites used to test new data in-country: encourage free samples to test in these areas from data providers. The field data need to be archived properly and made available to the wider GOFCC community for method and product testing.

### **Specific Data Needs from GOFCC through Miombo Network**

- Continuity and expansion of permanent sample plots – need long-term strategy and use for data. Need higher res/GPS
- Improved baseline/cadastral maps – updates. Need to link with appropriate institutions when developed improved products so they are institutionalized.



- Need to revisit methods to merge traditional forest inventory with methods coupled to RS
- High priority RS data are Landsat 7, MODIS, Spot Vegetation (1km): regional extent, for 1999-2001 window
- Higher resolution Ikonos, Aster, etc are desired for benchmark sites for testing
- Data rescue – CCT at ERSI (Zimbabwe) – tapes damaged, need to explore where data were originally acquired and makes sure that these historical data are kept in an archive.
- The following are Regional Test Sites where the above data should be acquired:

Site	Size/#scenes	What
- Mozambique: Nampula/Niasa	~3 by 4 matrix	multitemporal ETM (2-3/yr), at least one Ikonos. Modis, monitoring of rapid LUC (need to specify dates to acquire), Aug/Sept/Oct, March/May
- Tanzania: Kasulu (W Tanzania, new Tobacco, refugee affected areas), Tabora:		encroachment of FR, monitoring/”miombo watch”
- Zimbabwe: Mzola/Gwaai area/Fuller (Vic Falls area),		encroachment, resettlement areas,
- Malawi: Chimaliro/Viphya; Lower Shire (land degradation)		
- Zambia: need to outreach to partners in Miombo Network:		
- Angola: Need to link better, try going through SADC Forestry		
- DRC – through CARPE		
-		
-		Data needed for disaster area monitoring e.g. flooding and droughts in different countries: before, during and after. Timely delivery of data during disaster can assist in recovery efforts.
-		Regional MODIS at 250 m (link with Safari)- request sample data for Network evaluation

- Suggest a Regional Nodal Network to Implement Activities – see below.

### *Regional Nodal Network to Implement Activities*

#### Mozambique:

- Cenacarta: preprocessing/printing, training (Portuguese)
- INIA (Methods development for Soils, Land use)
- DNFFB/CEF/UMC – Inventory and Monitoring (forests), biomass assessment

#### Zimbabwe:

- VegRIS: preprocessing, training, forest inventory, interpretation
- ERSI: historical data for Zim FC only,
- WWF Zim: user
- SADC RRSU: technical backstopping, training

#### Tanzania:

- TANRIC: preprocessing, distribution ...(COFUR)
- Division of Forestry/National Forest Research Institute
- WWF Tanzania

- National Parks

Malawi:

- FRIM/Forest Dept: user
- Land Husbandry: user, links to agric
- Univ of Malawi/Bunda

Regional:

- SADC Forestry: coordination with member states
- USAID Regional Center in Botswana
- FAO Sub-Regional Office in Harare and other FAO project offices in Region
- ICRAF - Zimbabwe

**Workplan (to be expanded)**

Projects/Use of RS/GOFC Operational Planning

- Lake Victoria Erosion Hazard Mapping Study (~1 year, image processing in progress), 14 ETM scenes
- Characterization of Miombo Distribution – use data bundle to develop modeled characterization of region using climate, soils and other information.
- Zimbabwe Biomass Assessment - \$ needed to implement national biomass study linking field and RS data – need method development (For Inv using RS). AP in use for monitoring, Some prelim results possible early 2001. Need Ikonos, ETM (band 8).
- Zimbabwe PSP in conjunction with NORAD in Kalahari Sands (miombo), need high res, need Ikonos, 100 ha plots based on RS data
- Quick looks for resettlements – national mosaics to show contrasts and new changes.
- Mozambique – flooded area mapping, LRB, Inkomati, Save, Buzi, Messalo, and Upper Zambezi using Radarsat, ETM+, field work
- Monitoring new resettlement areas in Mozambique, conservation areas/wwf/iucn?, etc
- Updated Forest Inventory in Zambezia/Inhambane – DNFFB/Cenacarta
- Nampula/Mecuburi CBNRM mapping/monitoring/luc
- Malawi: updated national LC map – possible next 2 years, Forest dept/others; Biomass and Forest Growth and Yield by linking PSPs with GPS and ETM; Viphya forest inventory/mapping case study
- Explore ETM, Aster, Ikonos for soil/land degradation/land cover for Kasungu Miombo/safari site, also northern Moza and Zambia sites
- Case Studies: Flood mapping in the different countries – Zim, Moza, Malawi. Need bundle of TS of weather and other high-temporal datasets such as noaa/meteosat; need story line of progression of weather system and ensuing floods
- Monitoring of Hot Spots over baseline, national update planned ~2002
- Regional case study sites over region – biomass, land cover change, hot spots, site characterization

Special Issues:

## GOFC CD Contents/Case Studies/Tutorials

- need template
- 6-12 months draft
- Multiple audiences: policy, rs user community, forest inventory, etc

## Next Miombo Network Meeting(s):

- Tanzania or Moza / Nampula for a follow up GOFC related meeting
- Regional IAM – Characterization/Ecoregional analysis of miombo region
- SADC Biodiversity meeting in Tanzania – mid 2001
- Julia: web updates of events

## Network Management

- Need to establish regular communications with existing regional (SADC FSTCU, RRSU, Biodiversity, WWF, IUCN, CIFOR, ICRAF, FAO) and national institutions and groups – mailing lists etc.
- Develop MOU between MN and SADC FSTCU, FSTCU and RRSU
- Steering/Advisory Group: Manuel, Pius, Dominick, Leo, Paulos, Patrick, Paul, Chris
- National Points of Contact:
  - Zim – Dominick/Julia
  - Malawi – Denis/Steve
  - Moza – Mario Rui Marques/Adao
  - Tanz – Pius/Simon
  - Zambia – TBD
  - Angola – TBD
  - DRC – link with CARPE and Central Africa GOFC

## ‘GOFC Reps’:

Dr Enos Shumba – GOFC Steering Technical Board (Central and Southern Africa)

Patrick Mushove – Pan African START Committee (Nairobi Africa HQ, Washington DC HQ)  
([www.start.org](http://www.start.org)), [start@agu.org](mailto:start@agu.org)

## **Appendix I. Table of Contents for Special Issue**

**September 18, 2000 Update**

*Forest Ecology and Management* Special Issue Proposal

### **THE GLOBAL OBSERVATION OF FOREST COVER (GOFC) PROGRAM IN THE MIOMBO REGION OF SOUTHERN AFRICA**

**Guest Editors: Pius Yanda** (University of Dar es Salaam, Tanzania), **Paul V. Desanker** (University of Virginia), and **Christopher O. Justice** (University of Virginia)

#### ***Goal of Issue:***

*Give definitive statement about the state-of-the-art in use of Landsat data (and others) in forestry and mapping in the Miombo Region, and develop a strategy for operational implementation of GOFC in Southern Africa in concert with global and national efforts. Papers will include contributions from individuals and working groups at the meeting.*

#### ***Timetable***

July 20-22, 2000: NASA/Miombo GOFC Workshop in Maputo, Mozambique (draft papers presented). Manuscripts due 1-3 months later.

August – December, 2000: Reviews and Revisions

#### ***Tentative Table of Contents***

1. **Introduction to GOFC and the Miombo Pilot Study**, Paul Desanker, Chris Justice, Dominick Kwesha, Pius Yanda, Manuel Ferrao, Leo Zulu
2. **Exploratory Analysis of Landsat Data in the Miombo**, Paul V. Desanker and Leo Zulu, and others [take a transect across region and analyze TM data including ETM+]
3. **The Miombo Regional Land Cover Map: First Results and Suggestions for a Land Cover Change Monitoring Activity** Paul V. Desanker, Malanding S. Jaiteh, Dominick Kwesha, Manuel Ferrao, Pius Yanda, Quanfa Zhang and Leo Zulu
4. A hybrid Approach to Classification of Landsat TM Data for Miombo Land Cover Mapping  
**Malanding Jaiteh, Paul V. Desanker, Jiquan Chen**
5. Spatial and Temporal Characteristics of Landscape Change in Miombo Test Sites  
**Malanding Jaiteh, Paul V. Desanker, Jiquan Chen**
6. **Ecological and Economic Zoning of Forest Resources in Nampula Province, Mozambique** Patrick Mushove

7. **A Review of Biomass Assessment Methods with Emphasis on Role of Remote Sensing** **Paul V. Desanker et al.**
8. **Modeling Forest Carbon in the Miombo Region: Approaches and Initial Results** Paul V. Desanker et al.
9. **Design of a Land Use Change Model for Southern Africa** **Paul V. Desanker and Ian Davies**
10. **Exploring the Potential of Sub-pixel Classification of One Kilometer AVHRR HRPT Data for Forest Monitoring in Malawi**, Leo Zulu
11. **Carbon in the Soil: Emerging Issues for Southern Africa**, Sarah Walker, Paul Desanker
12. **Data Typology for GCC and LUC Study for the Miombo Region and Development of a Sampling Scheme**, Paul Desanker and Leo Zulu
13. **The Zimbabwe National Biomass Assessment Study – Development of Improved Allometric Equations**, Dominick Kwesha and Julia Mambo
14. **Forest Modeling and Carbon Dynamics in the Miombo Region using the HYBRID-GISS GCM Linked Model**, Andrew Friend
15. **Management of Forest Reserves in Tabora Region, Western Tanzania: A Study on Biophysical and Socio-economic Factors for Encroachment**, Yanda, P.Z.; Shishira, E.K.; Mwakaje, A.G. and Majule, A.E.
16. **Threatened Pockets of Dry Miombo Woodland in the Semi-arid Central Tanzania - The Case of Mrijo Chini**, Pius Z. Yanda

#### **WORKING GROUP PRODUCTS**

17. **Mapping the Floods in the Limpopo River Basin** – Manuel Ferrao and Leo Zulu
18. **State of Mapping and Forest Inventories in the Miombo Countries: Working group Report: Dominick and Pius, etc**
19. **Data Rescue: Legacy Forest Biomass and Inventory Data from the Miombo Region: Working group Report: Steve, Julia, Esperanca, Simon Mwansasu, Zambia?**
20. **Regional Strategy for Mapping Forest Cover and Change in Miombo: Working group Report: Leo, Dominick, Paul, Pius, Manuel,**
21. **Information Management Strategy for the Miombo GOFCC Projects: Working group Report, Paul, Sarah, Julia, etc**

## Appendix IIa. List of Data for Africa GIS Data Bundle

Filename	Description
<i>afr_countries</i>	Africa country boundaries: Arc coverage, latlong, decimal degrees, source SCT.
<i>africa_admin</i>	Africa administrative boundaries – 3 levels: Arc coverage, latlong, decimal degrees, source SCT.
<i>africa30_dem</i>	Africa digital elevation model, DEM - 30 arc seconds, Arc grid, latlong, decimal degrees, source SCT.
<i>africalc1km</i>	Africa 1 km land cover: Arc grid, latlong, decimal degrees , source SCT.
<i>africa_wsheds</i>	African watersheds: ArcGrid, latlong, decimal degrees, source SCT.
<i>watershd</i>	African watersheds: Arc coverage, latlong, decimal degree, source SCT.
<i>white_vegn</i>	White’s vegetation map of Africa, 1983: Arc coverage, latlong, decimal degrees.
<i>faosoilaf</i>	Africa-wide soil data by and according to the FAO classification: Arc coverage and grid, latlong, decimal degrees, source FAO, 1991.
<i>faosoilafg</i>	Africa-wide soil data by and according to the FAO classification: Arc grid and grid, latlong, decimal degrees, source FAO, 1991.
<i>usdasoil</i>	Africa-wide soils by and according to the U.S. Department of Agriculture classification, Arc coverage, latlong, decimal degrees, source SCT.
<i>umd1km_Africa</i>	University of Maryland District (UMD) 1 KM land cover map for Africa: Arc grid, latlong, decimal degrees – <b>extent is Desanker’s standard grid.</b>
<i>usgslc1k</i>	Africa-wide 1km land cover map by the United States Geological Survey, USGS: Arc grid, latlong, decimal degrees.
<i>rivermaj</i>	African lakes and major rivers: Arc coverage and Arc grid, latlong, decimal degrees, source SCT.
<i>Rivermin</i>	African rivers: Arc coverage, latlong, decimal degrees, source SCT.
<i>soceconc</i>	Various socio-economic data attributes (demographic, agriculture stats, etc) for each African country: Arc coverage, latlong, decimal degrees, source SCT.
<i>cattdense</i>	Cattle density for African countries, Arc grid, latlong, decimal degrees, source SCT.
<i>etp</i>	Africa level mean annual evapotranspiration data: Arc grid, latlong, decimal degrees, source SCT.
<i>povpe</i>	Mean potential evapotranspiration/precipitation for each African country, source SCT.
<i>it</i>	Mean annual minimum temperature data for each African country: Arc grid, latlong, decimal degrees, source SCT.
<i>xt</i>	Mean annual maximum temperature data for each African country: Arc grid, latlong, decimal degrees, source SCT.
<i>pre</i>	Mean annual precipitation data for each African country: Arc grid, latlong, decimal degrees, source SCT.

*Pod70* Population densities for African countries, 1960: Arc grid, latlong, decimal degrees, source SCT

*Pod70* Population densities for African countries, 1970: Arc grid, latlong, decimal degrees, source SCT.

*Popd80* Population densities for African countries, 1980: Arc grid, latlong, decimal degrees, source SCT.

*Popd90* Population densities for African countries, 1990: Arc grid, latlong, decimal degrees, source SCT.

## Appendix IIb. Southern Africa Regional Level Data

Filename	Description
<i>sothern_africa</i>	SADC country boundaries: ArcView shapefile, latlong dec. deg., source SCT.
<i>sal_region_bnd</i>	SADC country boundaries: Arc grid, latlong, dec. deg., source SCT.
<i>miombo_borders</i>	Miombo country boundaries: ArcView shapefile, latlong, dec. deg., source SCT.
<i>miombo_bnd</i>	Miombo country boundaries: Arc grid, latlong, dec. deg. source SCT.
<i>miombo_mask</i>	Miombo mask image: Arc grid, latlong, dec. deg, source SCT.
<i>sadch20_sheds</i>	SADC watersheds: Arc grid, latlong, dec. deg., source SCT.
<i>Miombo_umd1km</i>	Miombo UMD 1km land cover map: Arc grid, latlong, dec. deg.
<i>wwflcmap</i>	Miombo WWF land cover map: Arc coverage, latlong, dec. deg., source Miombo Network
<i>wwflcmap_grid</i>	Miombo WWF land cover map Arc grid, latlong, dec. deg., source Miombo Network



## Appendix IIc. List of Data for a Mozambique GIS Data Bundle

Filename	Description
<i>Admin250</i>	Administrative (state, province and district) boundaries for Mozambique at 1:250,000: Arc coverage, latlong, decimal degrees, source SENACARTA.
<i>City250</i>	Mozambique provincial and district capitals at 1:250,000: Arc coverage, latlong, decimal degrees, source SENACARTA.
<i>faosiaf</i>	Africa-wide soil data by and according to the FAO classification: Arc grid, latlong, decimal degrees, source FAO, 1991.
<i>Fol250</i>	Mozambique latlong (one degree) grids, Arc coverage.
<i>Hydr250</i>	Mozambique hydrography lakes - lagoons, dams, river banks: Arc coverage, latlong, decimal degrees, source SENACARTA.
<i>Jpegs</i>	Folder containing various JPEG images for Mozambique.
<i>lcfeb00</i>	Land use/land cover map for Mozambique at 1:250,000 scale, February 2000, latlong, dec. deg., source CENACARTA.
<i>limpopo_wshed.shp</i>	Limpopo Valley watershed data, ArcView shapefiles, latlong, dec. deg., derived from SCT Africa watershed data.
<i>lpdem30</i>	DEM for the Limpopo and Indian Ocean Coast catchment areas (Limpopo valley) at 1km resolution, latlong, dec. deg., derived from Africa level DEM for SCT.
<i>lpwshed</i>	Watershed boundaries for the Limpopo and Indian Ocean Coast catchment areas: Arc coverage and grid, latlong, decimal degree, derived from SCT Africa watershed data.
<i>lpmozapk</i>	Mozambique parks and reserves within the Limpopo Valley, Arc grid, latlong, dec. deg., source CENACARTA.
<i>lposoils</i>	Limpopo Valley soil data derived from FAO Africa-wide soil data: Arc grid and grid, latlong, decimal degrees, source FAO, 1991.
<i>lppbord</i>	Limpopo Valley Catchment area border for, Arc grid, latlong, dec. deg., source SCT Africa catchments data.
<i>Lppop90</i>	Limpopo Valley population densities, 1990, Arc grid, latlong, dec. deg., derived from SCT population density data.
<i>lpumdlc</i>	University of Maryland District (UMD) 1km land cover map for Limpopo Valley: Arc grid, latlong, decimal degrees, derived from SCT data.
<i>Lpusgslc</i>	United States Geological Survey 1km land cover map for Limpopo Valley: Arc grid, latlong, decimal degrees, derived from SCT data.

<i>lprvmaj</i>	Lakes and major rivers for Limpopo Valley: Arc grid, latlong, decimal degrees, derived from SCT data.
<i>lpetp</i>	Evapotranspiration data for Limpopo Valley: Arc grid, latlong, decimal degrees, derived from SCT data.
<i>lpovpe</i>	Mean potential evapotranspiration/precipitation data for Limpopo Valley: Arc grid, latlong, decimal degrees, derived from SCT data.
<i>lpit</i>	Mean annual minimum temperature data for Limpopo Valley: Arc grid, latlong, decimal degrees, derived from SCT data.
<i>lpxt</i>	Mean annual maximum temperature data for Limpopo Valley: Arc grid, latlong, decimal degrees, derived from SCT data.
<i>lprecip</i>	Mean annual precipitation data for Limpopo Valley: Arc grid, latlong, decimal degrees, derived from SCT data.
<i>Lpwwflc</i>	Miombo WWF land cover for Limpopo Valley, Arc grid, latlong, dec. deg., derived from Miombo Network WWF land cover map.
<i>mozabord.shp</i>	Mozambique national boundary, ArcView shapefile, latlong, dec. deg., derived from CENACARTA data.
<i>provarcs.shp</i>	Mozambique provinces arc boundary, ArcView shapefile, latlong, dec. deg., derived from CENACARTA data.
<i>province.shp</i>	Mozambique provinces arc boundary, ArcView shapefile, latlong, dec. deg., derived from CENACARTA data.
<i>provarcs.shp</i>	Mozambique provinces and districts (polygons), ArcView shapefile, latlong, dec. deg., derived from CENACARTA data.
<i>Res250</i>	Mozambique reserves and national parks at 1:250,000 scale, Arc coverage, latlong, dec. deg., source CENACARTA.
<i>Trans250</i>	Mozambique roads and railway network at 1:250,000 scale, Arc coverage, latlong, dec. deg., source CENACARTA.
<i>usdasoil</i>	Africa-wide soils by and according to the U.S. Department of Agriculture classification, Arc coverage, latlong, decimal degrees, source SCT.
<i>Wshedbrd.shp</i>	Border for the Limpopo and Indian Ocean Coast catchment areas, ArcView shapefiles, latlong, dec. deg., derived from SCT Arica watershade data.