REPORT OF MALAWI ANCILLARY DATA COLLECTION WORKSHOP HELD IN APRIL 2012, LILONGWE, MALAWI

DELIVERABLE NUMBER: MALAWI-IV-ADC

LAND COVER MAPPING FOR DEVELOPMENT OF GREEN HOUSE GAS INVENTORIES IN EAST AND SOUTHERN AFRICA

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ABOUT RCMRD AND SERVIR AFRICA

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Since 2008 RCMRD hosts the SERVIR Africa program jointly supported by NASA and USAID. SERVIR integrates the use of satellite imagery and other geospatial data for improved decision making in environmental monitoring, climate change adaptation and disaster risk management. In the context of the GHG project, RCMRD, through SERVIR Africa, will build capacity of the countries in developing quality and sustainable land cover and land use inventories as an input in the greenhouse gas accounting system under UNFCCC.

ACKNOWLEDGEMENT

We are grateful for the cooperation and support from the Department of Environmental Affairs in person of Mr Ben Yassin, UNF for facilitating and organizing the workshop, the country team on GHG, and the departments of Land Resources, Surveys, Animal Health and Livestock Development, Forestry and the Forestry Research Institute of Malawi for providing the required ancillary data.

Also, weacknowledge the participation and contribution of the following departments in the workshop:

1. Department of Environmental Affairs
2. Land Resources & Soil Conservation Department,
3. Lilongwe City Council
4. Bunda University College
5. Department of Surveys
6. Department of Animal Health and Livestock Development
7. Ministry of Natural Resources, Energy and Environment
8. Forestry Research Institute of Malawi
9. Crop Production Department
10. National Climate Change Programme, Ministry of Finance and Development Planning

LIST OF ACRONYMS

ADC	ANCILARY DATA COLLECTION
AFOLU	AGRICULTURE, FORESTRY AND OTHER LAND USE
ALU	AGRICULTURAL LAND USE TOOL
AMESD	AFRICA MONITORING OF ENVIRONMENT FOR SUSTAINABLE DEVELOPMENT
DBH	DIAMETER AT BREAST HEIGHT
ESA	EAST AND SOUTHERN AFRICA
GHG	GREEN HOUSE GAS
GIS	GEOGRAPHIC INFORMATION SYSTEM
IPCC	INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
LC	LAND COVER
LCCS	
LULUCF	LAND USE LAND USE CHANGE FORESTRY
NASA	NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
NDVI	NORMALIZED DIFFERENCE VEGETATION INDEX
RCMRD	REGIONAL CANTER FOR MAPPING OF RESOURCES FOR DEVELOPMENT
REDD	REDUCING EMISSIONS FROM DEFORESTATION AND FOREST DEGRADATION
TAB	TECHNICAL ADVISORY BOARD
UNFCCC	UNITED NATIONS FRAMEWORK FOR CLIMATE CHANGE CONVENTION
USAID	UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

DISCLAIMER

This document was produced in the framework of the Project 'Land Cover Mapping for GHG Inventory Development in East and Southern Africa (ESA) Region financed by USAID through RCMRD and NASA-SERVIR Africa. The Malawi Country chapter of this project is coordinated through the UNFCCC appointed national team that is led by the department of Environmental Affairs in the Ministry of Environment and Climate Change

The presentation of material in this document and the geographical designations employed do not imply the expression of any opinion whatsoever on the part of any of the agencies involved, concerning the legal status of any country, territory, or area, or concerning the delimitation of its frontiers or boundaries.

EXECUTIVE SUMMARY

This report is deliverable number MALAWI-IV-ADC of activity 2 of the project: Land Cover mapping for the development of GHG inventories for the East and southern Africa. The workshop on ancillary data collection was held from April 24 — 27, 2012, at the Wankulu Palace Hotel, Lilongwe. It was supported by USAID, RCMRD/SERVIR Africa, NASA, and the Ministry of Mines, Natural Resources and Environmental Affairs. The participants were drawn from Malawi government departments, Bunda College and the Lilongwe City Council. The purpose of the workshop was to explain the aims of the GHG program develop the classification scheme and description of the land cover and land use categories. Also, it was envisaged that through this workshop the country team on GHG would share past and current efforts in land cover mapping, provide available ancillary data and come up with recommendations to ensure that an adequate data- and knowledge base is created that will allow efficient development of a reliable, consistent and complete products.

The workshop resulted in increased understanding of the GHG project with key stakeholders of the national GHG team and agreement on definition of main IPCC land cover classes, and the definition of the subdivision of these into classes for the land cover mapping.

It became clear that Malawi Government is keen to support the project to full implementation. The workshop concluded that the Malawi Government ministries currently lack the technical and staff capacity to independently engage in land cover and land use mapping for GHG. Existing inventories and data have been produced by consultants and are not stored in a central database. Though some maps are available, accompanying metadata and technical reports are not.

The participants of the workshop formulated the following recommendations:

Recommendation 3 In addtion to the land cover categories defined by the IPCC guidelines, the project is advsed to consider producing national maps, sub categorizing the land cover land use in the forest and grassland categories to show level of management ie natural forest, plantation forest, unmanaged grassland and managed grassland, in addition to its baseline map of main land cover categories.

Recommendation 2: That RCMRD draft a proposal for on the job training in land cover and land use mapping for the Malawi GHG team.The team itself will arrange required funding for its stay in Nairobi during the training.

Recommendation 1: That the Malawi GHG inventory development team to be closely involved in defining the country specific description of land cover land use categories for the national maps.

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1.0 INTRODUCTION

1.1 Background Information

A GHG inventory includes the estimation of carbon stock, emissions and removal of greenhouse gas resulting from Land Use, Land-Use Change and Forestry (LULUCF) activities. It requires spatial information on the extent of major land cover and land use categories and their variation over time. Ancillary data collection is one of the major activities in this mapping effort.

Ancillary data is needed to guide and verify the classification of digital satellite imagery into classified land cover and land use maps .and can include annual agricultural census, periodic land use surveys, existing forest maps and remote sensing data. The availability of this data is a critical starting point for laying a baseline for GHG Inventories.

1.2 Ancillary Data Collection

The collection, reworking and capturing of quality information, forms one of the major activities of the GHG project. The data collection starts with a workshop on the assessment of the past and ongoing efforts on land cover mapping a country. This workshop introduces the mapping component of the GHG inventory and explains and develops the standards, guidelines and methodologies for land cover mapping, adapting these to national preferences and practices. . The National GHG inventory team is charged with identifying key stakeholders and with making ancillary data available to the project. Ancillary data includes reports, ground reference locations, high spatial resolution imagery and existing land use land cover maps.

The specific tasks include:

i) Gather existing and or historical land use maps and previously collected ground reference data
ii) Identify the classification scheme to be used within each country
iii) Rework and document the metadata of the existing land use land cover and related products
iv) Ensure that enough relevant data is made available for classification of satellite imagery to the required classes/categories
v) Document national description of land use land cover categories in reference to IPCC guidelines and subcategories
vi) Identify data gaps with regard to land cover categories

1.2.1 Workshop Objectives

The workshop objectives included the following;

- To gather existing land cover and land use maps and other reference data

- To explain and define the classification scheme to be used within Malawi
- To document national descriptions of land use land cover categories and sub categories
- To assess capacity and training needs with respect to land cover mapping for GHG Inventory

1.2.2 Expected Results:

The expected results include;

- a list of ancillary data collected
- set of metadata
- classification scheme and Legend, description of classes or land cover categories and discrimination criteria

1.2.2 Quality check

After collection, the data is checked for accuracy, consistency and completeness as shown in the workflow diagram (see annex?). This will done before data is adopted for use in the classification. The main tasks include; receive data, perform initial quality assessment and request for clarification from the data providers if required, verify, rework and validate the data and carry out overlays on Google Earth to check for consistency. The data will then reviewed by the Technical Advisory Board (TAB).

2.0 WORKSHOP PROCEEDINGS DAY 1

The inaugural session began with the introduction of the participants, resource persons and the invited guests. Benon Yassin, national coordinator for the GHG Inventory Development project from Environmental Affairs Department Malawi, introduced the workshop program and welcomed the participants. Rasack Nayamuth, the regional project coordinator for UNFCCC introduced the overall GHG Inventory development project while Fredrick Mokua presented on the plans and status of the Land Cover mapping efforts.

2.1 Presentations

- Status and Plan for the GHG Land Cover Mapping Project
- Thematic Needs and Land cover Mapping Challenges: Ancillary Data Availability
- Initiatives and or Status Land Cover Mapping in Malawi: Min./depts.' of Agriculture, Forestry, Lands and surveys, Natural Resources, Environment, other institutions represented in the workshop
- IPCC Definitions of Land Cover Categories for GHG Inventories

2.2 Available Data at Departmental Level

The workshop participants indicated that the following datasets are available at their respective departments as shown below.

2.2.1 Land resources Department

a) Crop suitability/
b) Land units
c) Agro-ecological Zones
d) Soil maps
e) Land use 1992
f) Climate change programme have some land use land cover data in progress
g) world bank land cover maps
h) validation points used in simulation models for LC 2000, 2010, 2030
i) AMESD Forest fires, 2000 to 2010 NDVIs
j) GMFS crop estimates through a collaborative effort with the Ministry Agriculture's Planning Department *(Activity in progress)*

2.2.2 Surveys Department

a) Topographic database
b) 1:250,000 and 1:50,000

c) Administrative boundaries
d) Road Network
e) Rivers
f) Wetlands and water-bodies
g) Aerial photos 1940 (1:40,000)- 1995 (1:250,000) 10 years interval in analog format
h) Census data
i) Satellite imagery – spot panchromatic; 2000-2001
j) Protected areas and urban/settlements

2.2.3 Forestry Department

a) Land cover maps 1991/1973
b) Carbon maps – Height and diameters –Reference data
c) REDD inventories for specific areas
d) Forest inventories and reserves maps 2010 (timber plantations) and 2011(forest reserves)
e) Land cover 2011 maps

2.2.4 Ministry of Agriculture (Livestock and Crop Departments)

a) Agro-ecological Zones
b) Livestock data – census
c) Crop production data
d) Irrigated crop areas-Irrigation Departments

2.3 Status and Plan for the GHG Land Cover Mapping Project

Fred Mokua explained the background of the GHG project, its objectives, and methodology and anticipated results. Please refer to annex #?? for details.

2.4 Thematic Needs and Land Cover Mapping Challenges: Ancillary Data Availability

The participants were introduced to land cover mapping processes and the guiding principles for production of suitable maps for the GHG Inventory maps. The participants were advised to consider the following main factors, namely; Purpose, consistency and prior classification scheming that determine the usefulness of the maps generated. Detailed description of the discussions on thematic needs and land cover mapping challenges are shown in the Appendix 1?

2.5 Presentations from National GHG Team

The participants gave presentations on various land cover mapping initiatives and their status. Also, during this session the departments of Land Resources, Agriculture (Crop and Livestocks), Surveys, Forestry and Environmental Affairs gave an indication of the kinds of relevant information available at their data repositories. The following were the findings from the various departments:

2.5.1 Land Resources Department

It was mentioned that this department has conducted a number of activities involving or related to land use land cover mapping over the years. Some of the activities include Crop suitability mapping, GMFS crop production estimates done in collaboration with the department of Planning in the Ministry of Agriculture (this ongoing effort). In addition the department has data on soils, Agro-ecological Zones, AMESD forest fires and NDVIs for the years 2000 to 2010. The department also has land use land cover data for 1992 and validation points used in simulation models for Land Cover maps for 2000, 2010, and 2030. Through a climate change program-me some land use land cover mapping is in progress.

2.5.2 Surveys Department

The representative from the department of surveys confirmed that there is a topographic database containing data at scales of 1:250,000 and 1:50,000 and administrative boundaries, road network, rivers, wetlands and water-bodies, aerial photos 1940 (at a scale of 1:40,000) - 1995(at a scale of 1:250,000) in 10 years interval in analog format. The department also indicated that they have census data, satellite imagery – spot panchromatic; 2000-2001 and data on protected areas.

2.5.3 Forestry Department

The department also has a section for forestry research that was represented in the meeting. It was indicated that the department has land cover maps 1991 and 1973, reference data used for carbon mapping; this data shows BHD (Breast Height Diameter and tree heights. The department as well archives data on recent REDD forest inventories for specific areas, Forest inventories and reserve maps for 2010 (timber plantations) and 2011(forest reserves).

2.5.4 Ministry of Agriculture Departments of Livestock and Crop

The departments indicated that most of the data they have is also available in the Land Resources department. The data include agro-ecological zones; livestock data based on census/agricultural statistics, crop production data and irrigated crop areas.

3.0 WORKSHOP PROCEEDINGS DAY 2:

3.1 IPCC Definitions

The following land-use categories for greenhouse gas inventory reporting as provided by the IPCC guidelines were discussed during the workshop:

i) Forest Land

This category includes all land with woody vegetation consistent with thresholds used to define Forest Land in the national greenhouse gas inventory. It also includes systems with a vegetation structure that currently fall below, but in situ could potentially reach the threshold values used by a country to define the Forest Land category.

ii) Cropland

This category includes cropped land, including rice fields, and agro-forestry systems where the vegetation structure falls below the thresholds used for the Forest Land category.

iii) Grassland

This category includes rangelands and pasture land that are not considered Cropland. It also includes systems with woody vegetation and other non-grass vegetation such as herbs and brushes that fall below the threshold values used in the Forest Land category. The category also includes all grassland from wild lands to recreational areas as well as agricultural and silvi-pastural systems, consistent with national definitions.

iv) Wetlands

This category includes areas of peat extraction and land that is covered or saturated by water for all or part of the year (e.g., peat-lands) and that does not fall into the Forest Land, Cropland, Grassland or Settlements categories. It includes reservoirs as a managed sub-division and natural rivers and lakes as unmanaged sub-divisions.

v) Settlements

This category includes all developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories. This should be consistent with national definitions.

vi) Other Land

This category includes bare soil, rock, ice, and all land areas that do not fall into any of the other five categories. It allows the total of identified land areas to match the national area, where data are available. If data are available, countries are encouraged to classify unmanaged lands by the above land-use categories (e.g., into Unmanaged Forest Land, Unmanaged Grassland, and Unmanaged Wetlands). This will improve transparency and enhance the ability to track land-use conversions from specific types of unmanaged lands into the categories above.

3.2 National Descriptions

The following description of land use categories were developed during the workshop. The participants indicated that the national specific (formal) categories descriptions do not exist. However, the team reiterated that there are plans to have formal descriptions.

3.2.1 Forest Land

Considerations

i) Area; A land-use category that includes areas at least 36 m wide and 0.4 ha in size (yet to be confirmed) with at least 10 percent cover (or equivalent stocking) by live trees of any size, including land that formerly had such tree cover and that will be naturally or artificially regenerated.
ii) Forest land includes transition zones, such as areas between forest and non-forest lands that have at least 10 percent cover (or equivalent stocking) with live trees and forest areas adjacent to urban and built-up lands.
iii) Roadside, streamside, and shelterbelt strips of trees must have a crown width of at about 36m and continuous length of at about 120 m to qualify as forest land.
iv) Unimproved roads and trails, streams, and clearings in forest areas are classified as forest if they are less than about 36 m wide or 0.4 ha in size; otherwise they are excluded from Forest Land and classified as Settlements.
v) Tree-covered areas in agricultural production settings, such as fruit orchards, or tree-covered areas in urban settings, such as city parks, are not considered forest land (Smith et al. 2009).
vi) Village forests that meet the minimum criteria forest shall be considered as forests

3.2.2 Forest Sub-categories

a) Dense Forest (70% and above)
b) Moderately Dense Forest (40-70%)
c) Open Forest (10-40%)

There was a general interest from the participants that a further (Level 3) subcategories be considered which include;

a) Natural Forest
b) Plantation Forest
c) *Miombo Woodland Forest*

Further, UNFCCC is interested in using the land use land cover maps for biomass mapping. It was suggested that some focus be given towards achieving species-wise discrimination of categories and subcategories

3.2.3 Cropland

Considerations

i. A land-use category that includes areas used for the production of adapted crops for harvest; this category includes both cultivated and non-cultivated lands.

ii. Cultivated crops include row crops or close-grown crops and also hay or pasture in rotation with cultivated crops.

iii. Non-cultivated cropland includes continuous hay, perennial crops (e.g., orchards) and horticultural cropland.

iv. Cropland also includes land with alley cropping and windbreaks, as well as lands in temporary fallow or enrolled in conservation reserve programs (i). Roads through Cropland, including interstate highways, state highways, other paved roads, gravel roads, dirt roads, and railroads are excluded from Cropland area estimates and are, instead, classified as Settlements.

3.2.4 Cropland Sub-categories

a) Annual Cropland
b) Perennial Cropland
c) Mixed Cropland

3.2.5 Grassland

Considerations

i) A land-use category on which the plant cover is composed principally of grasses, grass-like plants, forbs, or shrubs suitable for grazing and browsing, and includes both pastures and native rangelands. This includes areas where practices such as clearing, burning, chaining, and/or chemicals are applied to maintain the grass vegetation.
ii) Savannas, waterlogged areas,, low woody plant communities and shrubs, such as mesquite, mountain shrub, etc are also classified as Grassland if they do not meet the criteria for Forest Land.
iii) Grassland includes land managed with agro forestry practices such as silvi-pasture and windbreaks, assuming the stand or woodlot does not meet the criteria for Forest Land.

iv) Roads more than 5m wide through Grassland, including highways, other paved roads, gravel roads, dirt roads, and railroads are excluded from Grassland area estimates and are, instead, classified as Settlements.

3.2.6 Grassland Sub-categories

a) Closed Shrub-land
b) Open Shrub-land
c) Closed Grassland
d) Open Grassland

3.2.7 Wetlands

Considerations

i) A land-use category that includes land covered or saturated by water for all or part of the year.
ii) Managed Wetlands are those where the water level is artificially changed, or were created by human activity.
iii) Certain areas that fall under the managed Wetlands definition are covered in other areas of the IPCC guidance and/or the inventory, including Cropland (e.g., rice cultivation), Grassland, and Forest Land (including drained or un-drained forested wetlands).

3.2.8 Wetland Sub-categories

a) Water bodies
b) Vegetated wetlands

3.2.9 Settlements

Considerations

i) A land-use category representing developed areas consisting of units of 0.25 acres (0.1 ha) or more that includes residential, industrial, commercial, and institutional land; construction sites; public administrative sites; railroad yards; cemeteries; airports; golf courses; sanitary landfills; sewage treatment plants; water control structures and spillways; parks within urban and built-up areas; and highways, railroads, and other transportation facilities.
ii) Also included are tracts of less than 10 acres (4.05 ha) that may meet the definitions for Forest Land, Cropland, Grassland, or Other Land but are completely surrounded by urban or built-up land, and so are included in the settlement category.

iii) Rural transportation corridors located within other land uses (e.g., Forest Land, Cropland) are also included in Settlements.

3.2.10 Other lands

Considerations

i) A land-use category that includes bare soil, rock, ice, and all land areas that do not fall into any of the other five land-use categories.

ii) It allows the total of identified land areas to match the managed national area.

4.0 DAY 3 AND 4: ANCILLARY DATA COLLECTION

The following datasets were collected from the various departments;

4.1 Land resources Department

a) Crop suitability
b) Abiotic/Biotic Communities
c) Agro-ecological Zones
d) Soil maps
e) Land use land cover - 1991 and 1973
f) Administrative boundaries
g) Validation points used in simulation models for producing extrapolated LC 2000, 2010, 2030 from the 1991 LC
h) Irrigation schemes
i) Forest reserves
j) Protected areas
k) Wetlands
l) Crop and livestock production maps

4.2 Surveys Department

a) Topographic database (already submitted to RCMRD earlier for data Archiving / back-up)
    1) 1:250000 and 1:50000
    2) Administrative boundaries
b) Road Network
c) Rivers
d) Wetlands and water-bodies
e) Population Census data -
f) Protected areas and urban/settlements

4.3 Forestry Department

a) Land cover maps 1991/1973
b) Carbon maps – Height and diameters –Reference data
c) REDD inventories for specific areas
d) Forest inventories and reserves maps 2010 (timber plantations) and 2011(forest reserves)

4.4 Agriculture (livestock and crop Departments)

a) Livestock data – census
b) Crop production data

5.0 CONCLUSIONS AND RECOMMENDATIONS

Ground Referencing Plan

The ground referencing activity for Malawi will be carried out soon after classification (tentatively scheduled for early June 2012). A plan for the activity will be sent to the Malawi-GHG team lead as early as possible. Selected Malawi-GHG team members will participate in guiding the RCMRD Staff through the country during the Ground Referencing activity.

Malawi National Legend and Category Descriptions

The Malawi GHG team will initiate a review of the land cover legend and national description of various categories and communicate appropriately.

Suggestions

There are a number of land cover mapping initiatives currently ongoing in Malawi. Major projects are the FAO land cover mapping project using LCCS and the REDD programme financed by JICA. The workshop participants identified the need to have the various land cover mapping projects linked up to share lessons, critical data sets; especially ground reference information and harmonize interventions. Further, the GHG team requested to have some of its members participate in an on the job training at RCMRD during the classification process.

APPENDIX I WORKSHOP PROGRAMME AND PARTICIPANTS

WORKSHOP PROGRAMME

Land Cover Mapping for Greenhouse Gas Inventories
Malawi Workshop
Date: 24-26 April, 2012
Venue; Wankulu Palace Hotel, Lilongwe
Moderator: Ben Yassin

Day 1:		
08:00 – 08:30	*Registration*	
Session-1	Introduction and Review of Land Cover Mapping	
08:30 – 09:30	*Opening*	*Master. Ceremony Benon Yassin*
	Overall GHG Inventory Development Programme	*Rasack*
	Role of RCMRD in the Region	*Mtaroni Vincent*
	Opening Speech: Guest of Honour	*Guest of Honour*
09:30 – 09:50	*Tea/Coffee break*	
Session - 2	Review of Land Cover mapping practices and methodologies in the Malawi	
9:50 - 10:30	*Adoption of Programme* • *Introduction, objectives and workshop programme*	*Fredrick Mokua*
	Land Cover Mapping for GHG Inventories • *Status and Plan for the GHG Land Cover Mapping Project* • *Thematic Needs and Land cover Mapping Challenges: Ancillary Data Availability*	*Fredrick Mokua*
10:30– 1:00	*8 Land Cover Mapping in Malawi* • *Initiatives and or Status Land Cover Mapping in Malawi: Min./depts.' of Agriculture, Forestry, Lands and surveys, Natural Resources, Environment, ALL Institutions represented in the workshop*	Land Use Land Cover Mapping Experts, National GHG Team.
1:00 – 2:00	*Lunch break*	
Session - 3	Description Land Cover Categories	
2:10 – 2:40	*IPCC Definitions of Land Cover Categories for GHG Inventories*	*Fred Mokua*
2:40 – 3:40	*9 National Description of Forest Category and Sub-categories and Mapping (Geo-locating the sub-categories)*	*Group Discussion Forum*
3:40 – 4:00	*Tea/Coffee Break*	
4:10 – 4:30	*Available Ancillary Data on Forestry for 1998-2012*	*Plenary session*
	Summary of the Day	
	Wrap up of Day 1	

Day 2:		
08:00 – 08:30	*Registration*	
08:30 – 9:30	*Recap from Previous Day and Formation of Groups*	
08:30 – 12:00	*National Description of Grassland Category and Sub-categories and Mapping(Geo-locating the sub-categories)*	*Group I discussion forum*
	Available Ancillary Data on Grassland for 1998-2012	
	National Description of Cropland Category and Sub-categories and Mapping(Geo-locating the sub-categories)	*Group II discussion forum*
	Available Ancillary Data on Cropland for 1998-2012	
	National Description of Wetlands Category and Sub-categories and Mapping(Geo-locating the sub-categories)	*Group III discussion forum*
	Available Ancillary Data on wetlands for 1998-2012	
	National Description of Settlements and Other lands Category and Sub-categories and Mapping	*Group IV discussion forum*
	Available Ancillary Data on Settlements and Other lands for 1998-2012	
10:20 – 10:40	*Tea/Coffee Break*	
12:00 – 01:00	*Group I Presentation and Plenary Discussion*	*Group Lead*
1:00 – 2:00	*Lunch Break*	
2:00 – 3:00	*Group II Presentation and Plenary Discussion*	*Group Lead*
3:00 – 4:00	*Group III & IV Presentation and Plenary Discussion*	*Group Lead*
4:00 – 4:20	*Tea/Coffee Break*	
4:20 - 5:00	*Summary, Way Forward and Closing Remarks*	
Day 3		
8:00 – 1:00	Agriculture, Forestry, Ancillary data collection and packaging	Team Lead and RCMRD
2:00 - 5:00	Land and Surveys, Planning, environment, institutions	Team Lead and RCMRD
	Day 4	
8:00 - 5:00	Other organizations	

LIST OF WORKSHOP PARTICIPANTS
Land Cover Mapping For Greenhouse Gas Inventories - Malawi Workshop

Wamkulu Palace, Lilongwe, Malawi Date: 24-27 April, 2012

NAME	DESIGNATION	INSTITUTION	Tel/Mobile	Email
Benon Yassin	Chief Environmental Officer, GHG National Coordinator	Environmental Affairs, Depart., Private Bag 394, Lilongwe 3	Mob:+265 (0) 995 416 850 Phone:+265 (0) 1 773 177 Fax: +265 (0) 1773379	benyassin@gmail.com
Vincent Laurent Mtaroni	Facilitator	Regional Center for Mapping of Resources for Development (RCMRD)		lvmtaroni@rcmrd.org
Fred Ogoro Mokua	Facilitator	Regional Center for Mapping of Resources for Development (RCMRD)		ogor@rcmrd.org
Rasack Nayamuth	Regional Project Coordinator for ESA GHG Inventory Capacity Building Project	Le Bocage, Mt Ory Moka, Mauritius	Phone: +230 433 3835; Mob: +230 777 6747	r.nayamuth@yahoo.com
André Kooiman	Facilitator	SERVIR EA/RCMRD	Mob:+254 726 066 575	andre.kooiman@rcmrd.org
Mihla Phiri	Land Resources Conservation Officer	Land Resources Conservation Department, P.O. Box 30291, Lilongwe	Mob: +265 (0) 999 420 297	mihlaphiri@yahoo.com
Austin Tibu	Land Resources Conservation Officer	Land Resources Conservation Department, P.O. Box 30291, Lilongwe	Mob: +265 (0) 995 641 990	austintibu@gmail.com
Phyllis George Mkwezalamba	Sewage Engineer	Lilongwe City Council, P.O. Box 30396, Lilongwe 3	Mob:+265 (0) 999 800 262 Phone: +265) (0) 1 928 024	mkwezalamba@gmail.com
Junice Undi	Lecturer	Bunda College P.O. Box 219, Lilongwe	Mob:+265 (0) 888 723 563	junicedzonzi@yahoo.com
Geoffrey Mzembe	Senior Photogrammetrist	Surveys Department, P/Bag B525, Lilongwe 3	Mob: +265 (0) 991 799 380 +265 (0) 888 435 486	jeffmzembe@yahoo.com
Leah Gomani	Principal Cartographer	Surveys Department, P/Bag B525,	Mob: +265 (0) 999 581 014	leahgomani@yahoo.com

		Lilongwe 3		
Wilson Nandolo	Animal Development officer	Department of Animal Health and Livestock Development, P.O. Box 2096, Lilongwe	Mob:+265 (0) 888 157 000 Phone.: +265 (0) 1 208 358 Fax: +265 (0) 1 751 349	wilsonandolo@gmail.com
Ms. Stella Gama	Assistant Director of Forestry	Ministry of Natural Resources, Energy and Environment, P.O. Box 30048, Lilongwe 3	Cell:+265 (0) 999 441 766	stellagama@ifmslp.org
Michael Freeman Chirwa	Forestry Officer	Forestry Research Institute of Malawi, P.O. Box 270, Zomba	Cell:+265 (0) 999 345 928	chirwamike@yahoo.com
Boyd Mwafulirwa	Crops Officer	Crop Production Department, P/Bag 30145, Lilongwe 3	Tel: +265 (0) 211 953 886	boydmwafulirwa@ymail.com
Muti Kachilu	Project Manger	National Climate Change Programme, Ministry of Finance and Development Planning	Cell:+265 (0) 999 357 110 Cell:+265 (0) 881 518 041	mutiekachulu@gmail.com
Joel Munthali	Chief Draughtman	Land Resources Conservation Department, P.O. Box 30291, Lilongwe	Cell: +265 (0) 888 379 686	jgmunthali@yahoo.com

Plate 1 I Malawi Ancillary Data Collection Workshop Participants

APPENDIX II: WORKSHOP PRESENTATIONS

Methodology and work flow

The chart shown below indicates the work flow and methodology to be applied in land cover mapping for Malawi

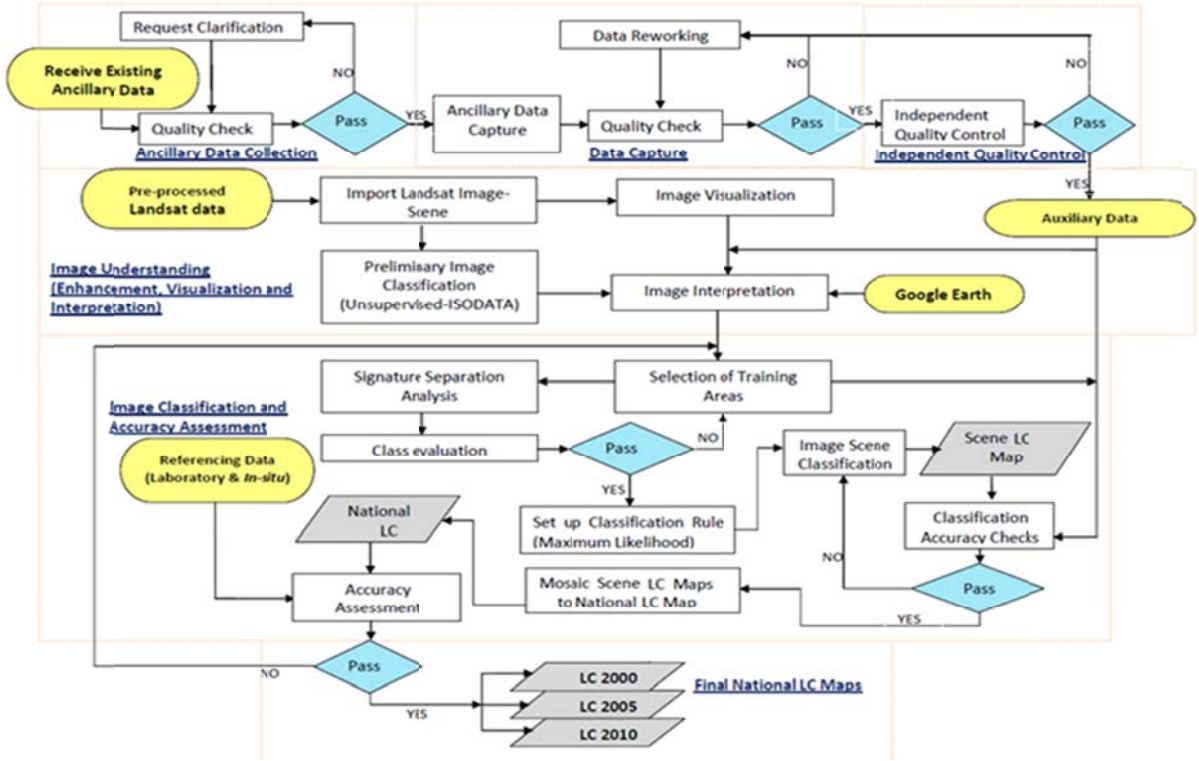

Figure 1 Land cover mapping workflow

It was noted that Landsat data for three time steps; 2000, 2005 and 2010 is available for the project. The figures below show a sample of the datasets and Path/Row of Landsat covering Malawi.

Annex 1

The Green House Gas land cover mapping project was kicked-off during a workshop in Mauritius from..-.. June 2011, with the basic aim to address the need for capacity building on the production of maps that specify land use, land use change, data for GHG Inventories. L land cover maps consistent with the IPCC categories include (1) forestland, (2) cropland, (3) grassland, (4) wetlands, (5) settlements and (6) other lands. These classes will be obtained by classifying satellite imagery, using statistical algorithms to produce consistent wall-to-wall land cover maps of three time slices, 2000, 2005 and 2010, for each of six countries: Malawi, Rwanda, Zambia, Namibia, Botswana and Tanzania.

This project will enable the countries to produce and store for subsequent use all auxiliary data, satellite imagery and the produced land cover maps. Thereby the countries themselves will be able to undertake GHG inventories in fulfilment of the requirements of their carbon accounting system.

The project will generate national land cover maps in three slices of similar resolution in GIS compatible formats. The maps will be of such format that they can be used as input in the Agricultural Land Use (ALU) Tool applications. The methodology will be fully replicable so it can be used in future monitoring efforts.

The general objective of this project is to undertake a GHG inventory for each of six countries in the ESA region, Malawi, Rwanda, Zambia, Namibia, Botswana, and Tanzania through the training and development of land cover maps for the Agriculture and Land Use, Land-Use Change and Forestry (LULUCF) sectors. The specific objectives include the following;

i) To Collect ancillary reference data for validating land cover maps

ii) To produce land cover maps from Landsat satellite images using remote sensing techniques.

iii) To conduct training for key stakeholders in land cover mapping for GHG Inventory

2.3.1 Methodology and work flow

The chart shown in the appendix II indicates the work flow and methodology

2.3.2 Project Deliverables

The following are the main project deliverables;

i) Database of captured spatial data and produced land cover maps.

ii) Land cover classification in three time slices (2000, 2005 and 2010) in a look-up table for the classification ID number specified to the description of the land cover type in a country

specific/level classification scheme, which allows the maps to be “rolled up” to regionally consistent maps.

iii) The map products will adopt at least schema I and or II as shown below.

a) Schema I: Six IPCC Classes and three dates is the bare minimum—tier 1, everything gets rolled up (bare minimum)

b) Schema II: national sub classification categories agreed upon with countries; 12 to 15 classes, and keeping them consistent with IPCC guidelines (required)

c) Schema III: country based/country specific—that rolls up/cross walks to Schema I/ Schema II (desired)

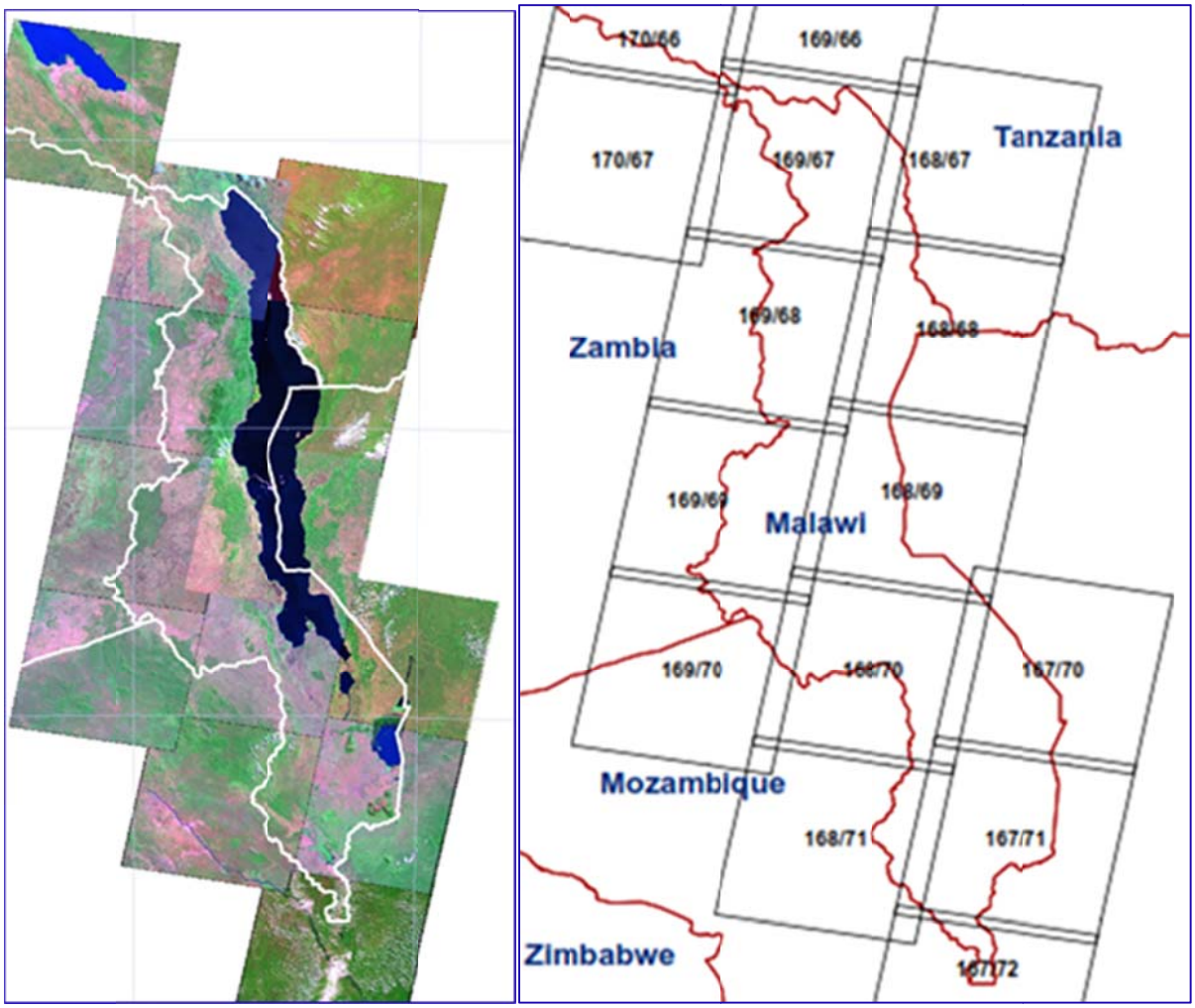

Figure 2 Sample of the Available Landsat Data

The participants were also taken through the implementation plan for Malawi to raised awareness of what the project entails and emphasis on the project expectations. The implementation plan is as shown below.

MALAWI PROJECT IMPLEMENTATION PLAN

COUNTRY NAME	MALAWI
ACTIVITY 2	**Collection of ancillary data**

Product/ Result 2: List of ancillary data collected, and Classification scheme/Legend, Description of classes/Categories and criteria, Identified difficult mapping areas, Package of ancillary data collected and a set of metadata

Tasks	2012								Lead Person, organization or applicant partner
	APRIL				MAY				
i) Gather existing and or historical land use maps and previously collected ground reference data	1[1]	2	3	4	1	2	3	4	• RCMRD-SERVIR • National Team on GHG • UNFCCC
ii) Identify the classification scheme to be used within each country									
iii) Rework and document the metadata of the existing land use land cover products									
iv) Ensure that enough relevant ancillary datasets are available for classification of Landsat Imagery to the required classes/categories									

ACTIVITY 3	**Check quality of the ancillary data**

Product/ Result 3: List of ancillary data captured/selected for land cover classification

Tasks	2012								Lead Person, organization or applicant partner
	APRIL				MAY				
i) Receive auxiliary data, perform initial quality assessment and request for	1	2	3	4	1	2	3	4	• RCMRD-SERVIR

[1] *Month divided into four parts (approximate weeks)*

clarification from the participant country. ii) Verification, reworking and validation of the auxiliary data iii) Subject the data to independent quality assessment iv) Identify data gaps with regard to land cover categories									• National Team on GHG •
Technical Advisory Board will convene to: (a) review the ancillary data collected; (b) review land use categories for each country; (c) review and advise plans to check data quality under Activity 2, (d) review the assessment of data quality[2].									
ACTIVITY 5[3]	Landsat TM and ETM+ Image Understanding (enhancement, visualization and Interpretation)								
Product/ Result 5: Unsupervised classification maps; extracted built up areas and barren lands (for internal use only)									
Tasks	2012								Lead Person, organization or applicant partner
	APRIL				MAY				
i) Carry out image statistics to determine suitability of maximum likelihood classifiers ii) Carry out image enhancement to improve visual interpretation iii) Carry out preliminary unsupervised classification iv) Extract built up areas and barren lands	1	2	3	4	1	2	3	4	• RCMRD-SERVIR
ACTIVITY 6	Image classification								
Product/ Result 6: National land cover maps with 12-15 classes, Image classification manual, Training/regions of interest/spectral signatures, separability analysis results									

[2] *Technical Advisory Board to act as independent data quality reviewer*

[3] ***Activity 4: Database development will be designed for all countries at one instance***

Tasks	2012								Lead Person, organization or applicant partner
	APRIL				MAY				
	1	2	3	4	1	2	3	4	
i) Develop image classification manual ii) Create regions of interest/spectral signatures for identified land use land cover categories iii) Perform image classification using maximum likelihood at scene level iv) Mosaic classified scenes to produce wall to wall national land use land cover maps									• RCMRD-SERVIR
Technical Advisory Board will convene to (a) discuss and review database standards and database, (b) discuss and review Image classification, (c) advice on design of ground reference campaign(s).									
ACTIVITY 7	Ground Reference Data Collection								
Product/ Result 7: Ground Reference Data collected.									
Tasks	2012								Lead Person, organization or applicant partner
	APRIL				MAY				
	1	2	3	4	1	2	3	4	• RCMRD-SERVIR • National Team on GHG • UNFCCC
i) Identify representative sampling zones/plots ii) Develop a sampling design and collect ground reference data iii) Implement simple QA/QC procedures on ground reference data									
ACTIVITY 8	Accuracy assessment								

Product/ Result 8: Classification accuracy report									
Tasks	2012								Lead Person, organization or applicant partner
	APRIL				MAY				
	1	2	3	4	1	2	3	4	
i) create error matrix for accuracy assessment using random generated points at scene level and at national level ii) Assess accuracy using both ground reference data points and points interpreted from high spatial resolution aerial or satellite imagery									• RCMRD-SERVIR
Technical Advisory Board will convene to advice accuracy assessment and review results[4]									
ACTIVITY 9	Preparation of final land cover maps								
Product/ Result 9: A package of land cover maps compiled per country									
Tasks	2012								Lead Person, organization or applicant partner
	JUNE				JULY				
	1	2	3	4	1	2	3	4	
i) Generate land cover in the required raster format (ERDAS Imagine.img) ii) Prepare single file per country with three attributes; 2000,2005, and 2010 land cover maps iii) Prepare three files (one for each time slice) of land cover map per country. iv) Prepare maps to a uniform reference system (latitude/longitude with WGS84 and country specific UTM zones) so that the data from the neighboring countries can be merged for GHG inventory without data gaps due to projection differences									• RCMRD-SERVIR

[4] *Technical Advisory Board will convene in the first week of June.*

Technical Advisory Board will convene to review maps and ensure they are ready for input into ALU tool.									
ACTIVITY 10	Capacity building								
Product/ Result 10: *12 Country Representative trained as trainers and training report, 20-40 stakeholders familiarized with use of final products per country and six workshop report, Follow up training of 60 (10 per country) officers in LULC mapping and procedures, and six training reports*									
Tasks	2013								Lead Person, organization or applicant partner
	JULY				AUGUST				
	1	2	3	4	1	2	3	4	
i) Training of country representatives in LULCF (6X2) at RCMRD ii) Training of officers involved in LUCF mapping in each country(6X10) iii) Workshop for dissemination of results by users and stakeholders per country									• RCMRD-SERVIR • National Team on GHG • UNFCCC
Technical Advisory Board to send one or more representatives to the technical training workshops to participate in trainings.									

ANNEX II: PRESENTATION ON THEMATIC NEEDS AND LAND COVER MAPPING CHALLENGES:

Despite the necessity for a standard classification system, none of the current classifications has been internationally accepted (Danserau, 1961; Fosberg, 1961; Eiten, 1968; UNESCO, 1973). Often, the land cover classes are inappropriate for particular purposes (e.g., statistical or rural development needs). The scale is usually related to a specific purpose and the information is mostly inappropriate for other usage not initially planned for. The classification system design may result in a undesirable mixture of potential and actual land cover. The reasons why none of the current classifications could serve as a reference system GHG are manifold, which may include;

Purpose

A proportion of the existing classifications are either Vegetation classifications (Danserau, 1961; Anderson et al.,), or broad land cover classifications, or systems related to the description of a specific feature (e.g., agricultural areas). Thus, they are limited in their capacity to define the whole range of possible land cover classes required for GHG Inventories

Consistency

In most current classifications, the criteria used to derive classes are not systematically applied. Often, the use of different ranges of values for categories depends on the importance given by the user to a particular feature (e.g., in many systems the cover ranges are designed to distinguish tree-dominated areas, whereas only one single cover range is used to define shrub- or grass-dominated areas). The required temporal resolutions of the produced land cover maps is not consistent with the requirements for GHG Inventory development.

Prior Classification Systems/Schemes

Initial classification systems or schemes are always targeted at achieving a given state of satisfaction in representing areas. This can be to either to achieve high levels of flexibility or standardization. As the number of desired classes or categories is increased the level of achieving on standardization is increasingly compromised while flexibility of applications of products is increased significantly. However, to achieve optimum satisfaction an adequate number of detailed classes is a critical; this also depends on the purpose of the desired products. In this project there is a desire to improve on flexibility and still retain the required level of standardization and if possible achieve Scheme II of project deliverables. The standard classes in this project include; Forestland, Cropland, Grassland, Wetland, Settlement and otherlands.

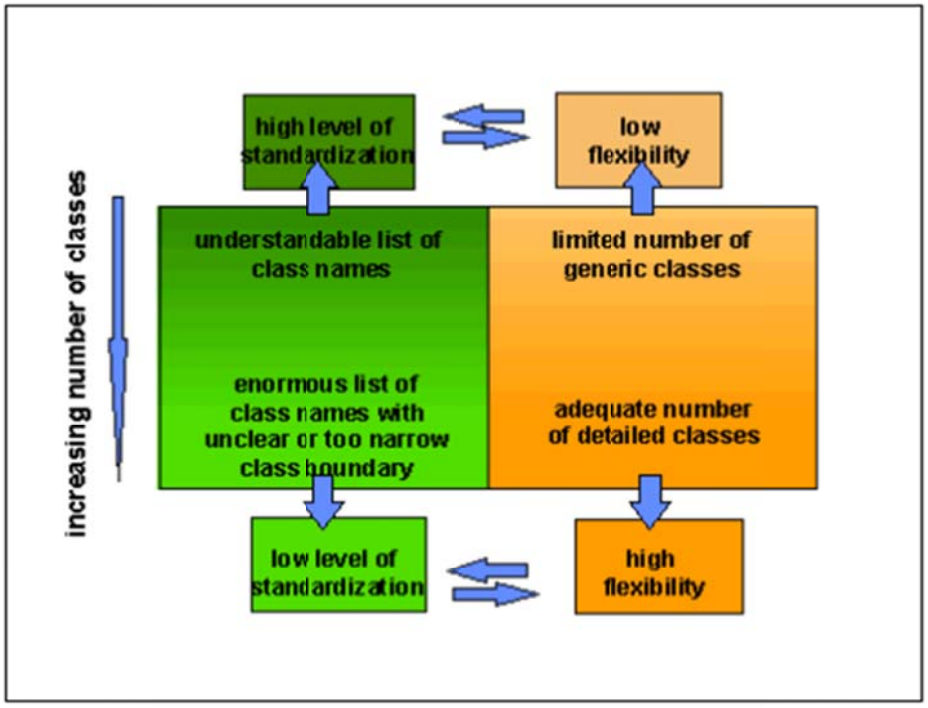

Figure 3 Effect of Increasing Number of Classes/Categories in Land Cover mapping (FAO)

Challenges and Suitable Approaches in Land Cover Mapping

There is not as much compatibility between classification systems, or between classification and legend, as may be desired. There are numerous inconsistencies in definition of classes, class boundaries and in the use of threshold values, etc. However, useful the current classifications may be, these factors limit the possibility of the use of such classification results for GHG inventories.

To create a standardized, hierarchical, consistent, a priori classification system containing systematic and strict class boundary (unambiguous and clear) definitions is required. This implies the basic requirement of having to build flexibility into the classification system. The use of diagnostic criteria and their hierarchical arrangement to form a class should be a function of the *mapability.* Mapability is enhanced by the use of a set of independent diagnostic attributes, so-called classifiers

As a general rule before starting to use the classifiers, the user has to take into account some basic rules governing the concepts of classification of (Semi-) Natural Vegetation, namely: the definition of ***Life Form***; and or the definition of ***dominance***. Based on life form a condition of height may be applied to separate Trees from Shrubs i.e. woody plants higher than 5m or 2m are classified as Trees depending on country preferences. In contrast, woody plants lower than 5m or 2m are classified as Shrubs. Concerning the concept of dominance, two criteria need to be considered. One, the main or uppermost canopy layer; means that the dominant layer goes from

Tree canopy to Shrub to Herbaceous. This general rule is subject to a sub-condition of Cover: it is only valid if the dominant Life Form has a Cover either Closed or Open. If the Life Form is Sparse, the dominance goes to another Life Form that has a Closed or Open cover

The other rule governing the concept of classification especially for Wetlands and Croplands mainly as a second level classifier is *Seasonality*. This classifier can be considered as the type of persistence of the water at or near the surface. There are three subdivisions:

i) (Semi-)Permanent (more than four months a year or more than a specific season);
ii) Temporary or Seasonal (less than four but more than two months a year or during a specific season); and
iii) Waterlogged

Cropland can be subdivided into Annual crops, Perennial crops and Mixed based on seasonality

The following examples adopted from FAO classifications were shared in the workshop session.

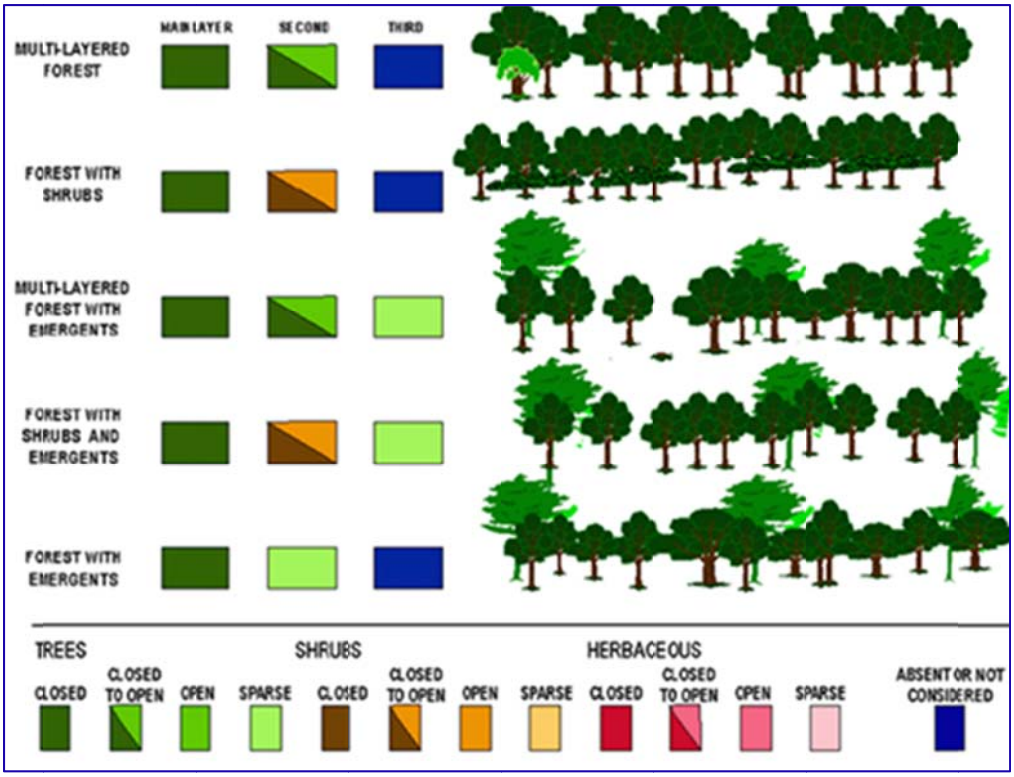

Figure 4 Forest domain; structural subclasses

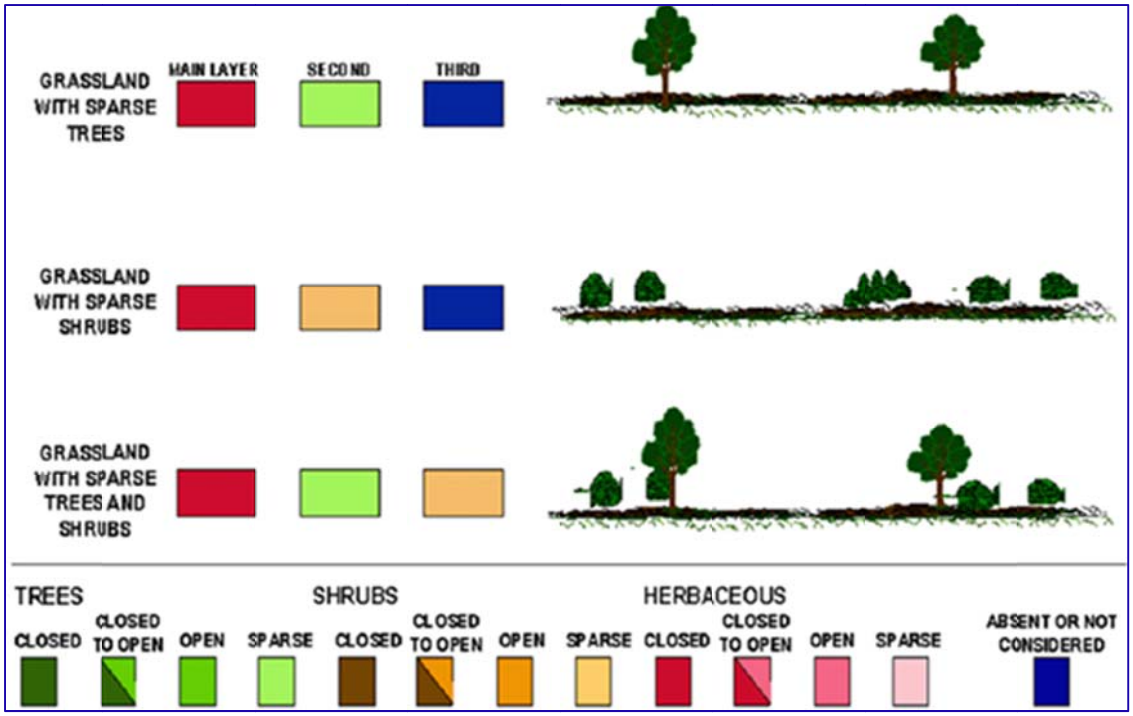

Figure 5 Grassland domain; structural subclasses

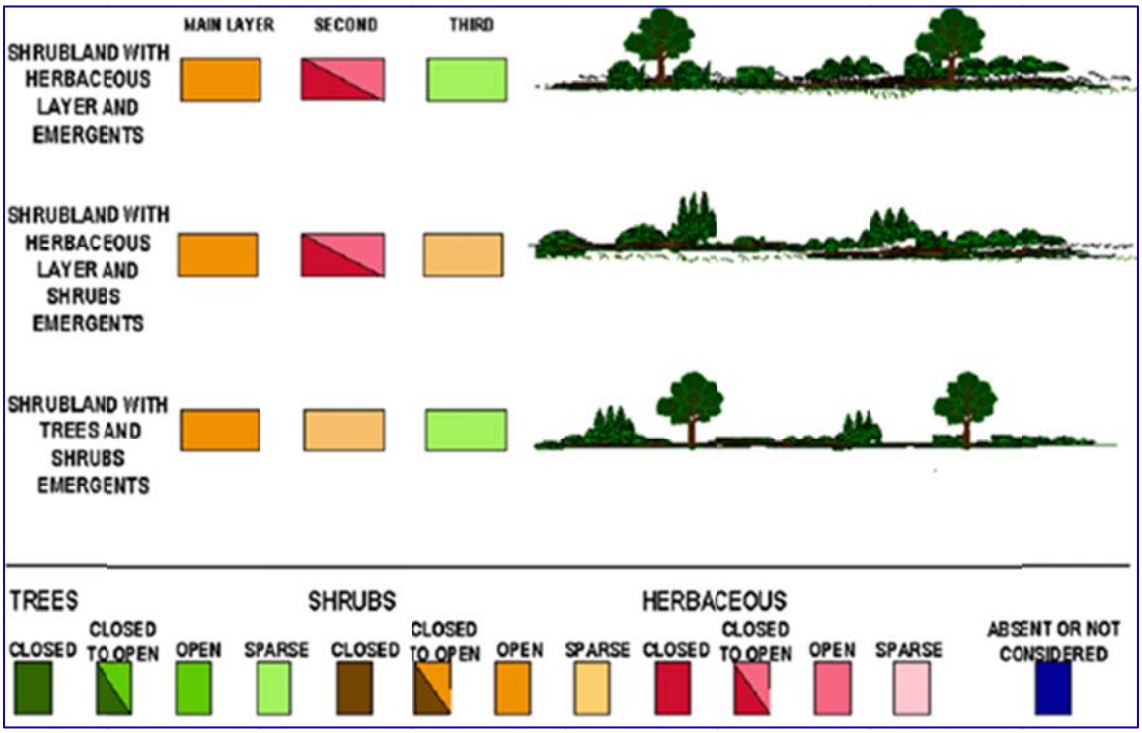

Figure 6: Shrub-land domain; structural subclasses

Presentations from National GHG Team

The participants presented on various initiatives and or statuses of land cover mapping in Malawi.

The participants drawn from the departments of Land Resources, Agriculture (Crop and

Livestocks), Surveys, Forestry and Environmental Affairs further gave an indication of the kinds of relevant information available at their data repositories. The following were the findings from the various departments;

Land Resources Department

It was mentioned that this department has conducted a number of activities involving or related to land use land cover mapping over the years. To name but a few of the activities include Crop suitability mapping, GMFS crop production estimates done in collaboration with the department of Planning in the Ministry of Agriculture (this ongoing effort). In addition the department has data on soils, Agro-ecological Zones, AMESD forest fires and NDVIs for the years 2000 to 2010. The department also has land use land cover data for 1992 and validation points used in simulation models for Land Cover maps for 2000, 2010, and 2030. Through a climate change program-me some land use land cover mapping is in progress.

Surveys Department

The representative from the department of surveys confirmed that there is a topographic database containing data at scales of 1:250000 and 1:50000 and administrative boundaries, road network, rivers, wetlands and water-bodies, aerial photos 1940 (at a scale of 1:40,000) - 1995(at a scale of 1:250,000) in 10 years interval in analog format. The department also indicated that they have census data, satellite imagery – spot panchromatic; 2000-2001 and data on protected areas.

Forestry Department

The department also has a section for forestry research that was represented in the meeting. It was indicated that the department has land cover maps 1991 and 1973, reference data used for carbon mapping; this data shows BHD (Breast Height Diameter and tree heights. The department as well archives data on recent REDD forest inventories for specific areas, Forest inventories and reserve maps for 2010 (timber plantations) and 2011(forest reserves)

Ministry of Agriculture's Departments of Livestock and Crop

The departments indicated that most of the data they have is also available in the Land Resources department. This data include agro-ecological zones, livestock data based on census/agricultural statistics, crop production data and irrigated crop areas.