



National Forestry Resources Monitoring and Assessment of Tanzania  
(NAFORMA)

# LULC MAPPING

## Methodology and Challenges

REGIONAL COURSE ON REDD+ MRV, NFI AND MONITORING, 11-15<sup>th</sup> JULY 2011, SUA,  
MOROGORO



**Boniface Mbilinyi**

## RATIONALE

- 1) Prepare national maps of forests and other land uses
- 2) Strengthen the technical capacities of FBD
- 3) Contribute to the national database on forestry and other land uses
  - mapping methodology and satellite remote sensing imagery
- 4) Existing land cover maps (Hunting and Africover) are outdated

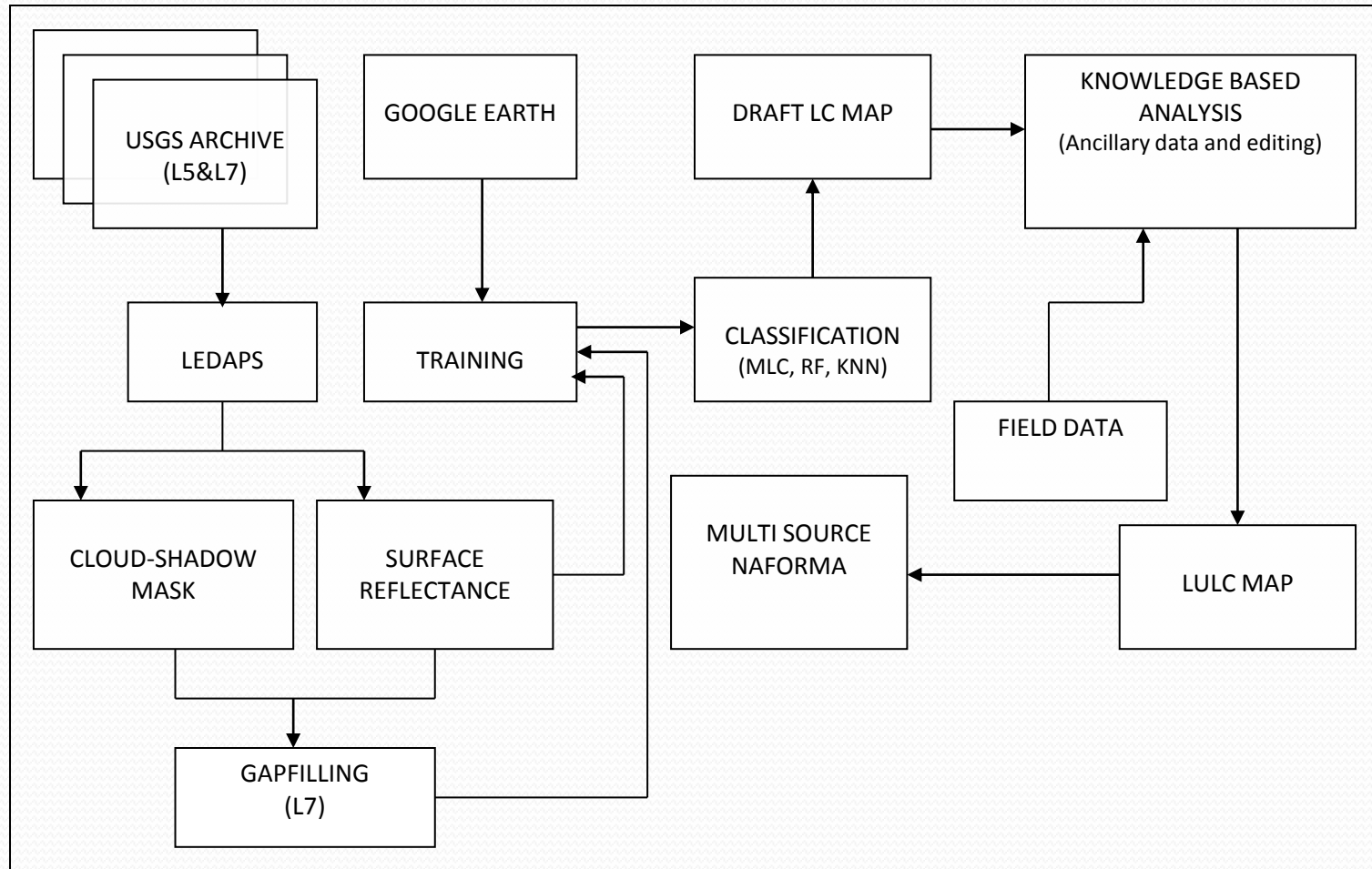
# METHODOLOGY

- Project implementation is based on a close cooperation with FAO/FIN technical staff and other relevant organization/persons
- Capacity building of FBD is key
- Iterative process
  - Several tools and methods have been tried
  - Some has proven usable and some not

# LEGEND for LULC

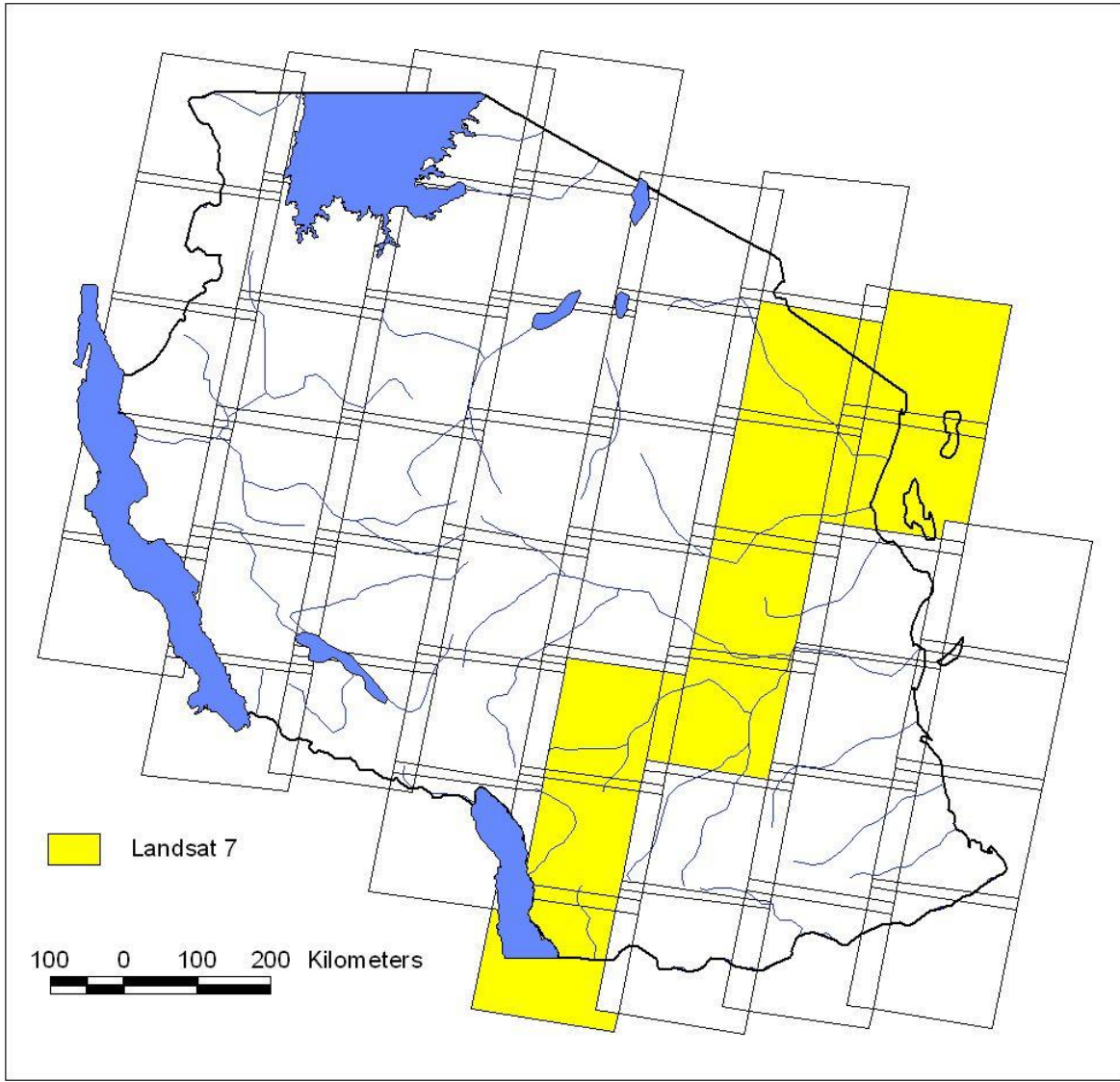
No.	Level 1 Class	Level 2 Class	Text Code	Numerical Code
1	FOREST	Humid Montane	Fhm	101
		Lowland	Fl	102
		Mangrove	Fm	103
			Fp	104
2	WOODLAND	Closed	Wc	201
		Open	Wo	202
		With scattered cultivation	Wsc	203
3	BUSHLAND	Thicket	Bt	301
		Dense	Bd	302
		Open	Bo	306
		With scattered cultivation	Bsc	303
4	GRASSLAND	Grassland	Gw	401
		With scattered cultivation	Gb	402
			Go	404
			Gsc	403
5	CULTIVATED LAND	Wooded crops	Caf	501
		Grain and other crops	Cwc	502
			Chc	503
			Cgc	504
6	OPEN LAND	Bare soil	Bsl	601
		Coastal bare land	Cbl	602
		Bare rock	Ro	603
		Ice cap/snow	Ice	604
7	WATER FEATURES	Ocean	Wo	701
		Inland water	Wi	702
		Wetlands	Wl	703
8	OTHER AREAS	Built up areas		800

# METHODOLOGY FLOW



## Image Acquisition

- Landsat 5 (39 scenes) & Landsat 7 (9 scenes)
- Freely downloaded from Usgs website (Bulk downloading)
- A maximum of 10% cc, unless not available
- Most from dry season
- Not older than 2009



## Image Pre-processing – LEDAPS & GAPFILLING

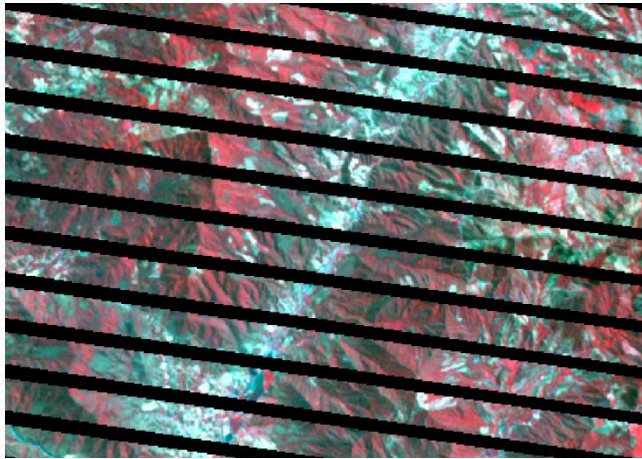
- Performed in Linux (Ubuntu) using own toolbox of scripts and stand-alone programs, leaning heavily on Gdal (Geospatial Data Abstraction Library) – FAO/FIN technical support
- One server running Windows + Linux (Ubuntu) via a Virtual machine
- Another server with pure Linux (Ubuntu) environment, to be taken into use ASAP
- **10** Desktops accessing the server



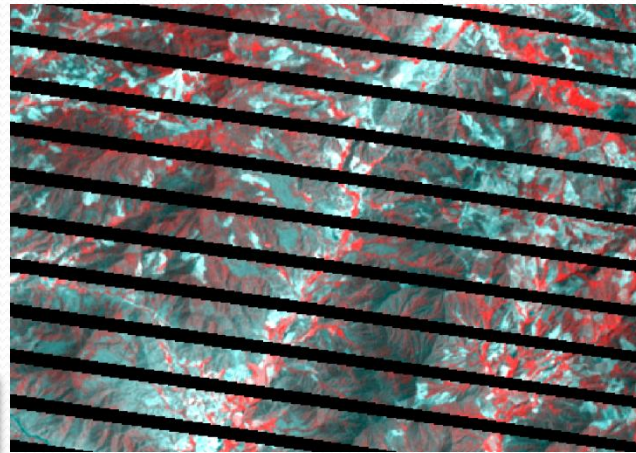
## LEDAPS

- The Landsat Ecosystem Disturbance Adaptive Processing System (LEDAPS)
- Images are calibrated, converted to top-of-atmosphere (TOA) reflectance, and then atmospherically corrected to surface reflectance using atmospheric correction algorithms and uncertainty analyses
- Outputs also Cloud and shadow mask

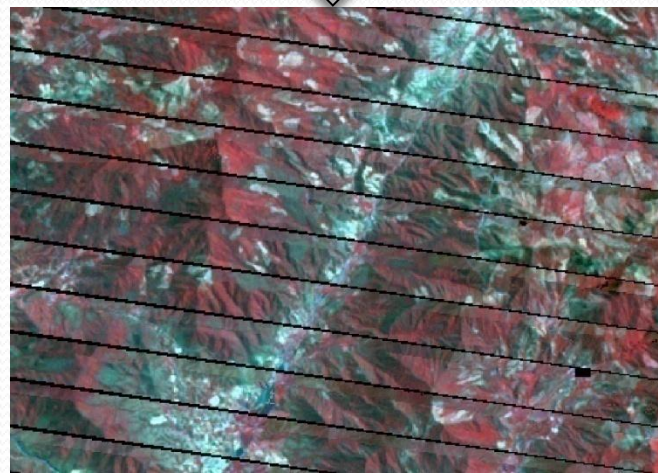
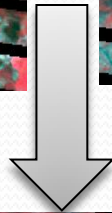
# GAPFILLING



Anchor image

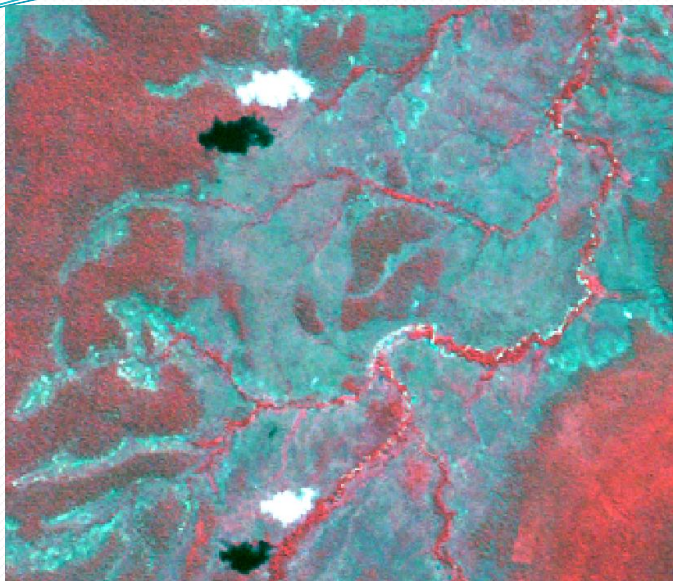


Filler image

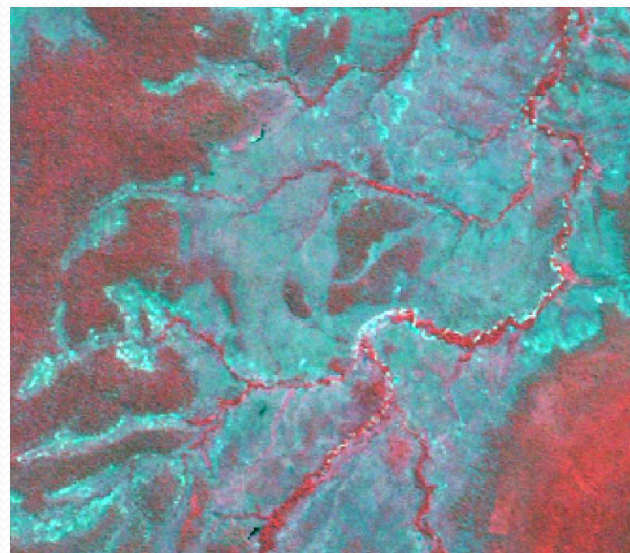


Filled image

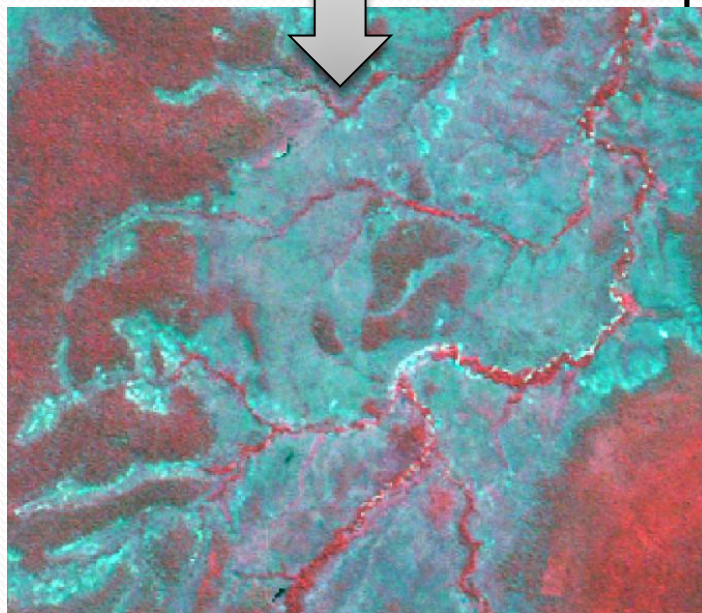
# CLOUDS-SHADOW FILLING



Anchor image



Filler image



Filled image

# Training and Classification

## Training

- What is it
  - identify examples of the Information classes , i.e. LULC types of interest in the image. These are called "*training sites*"
  - image is then classified by examining the reflectance for each pixel and making a decision about which of the signatures it resembles most



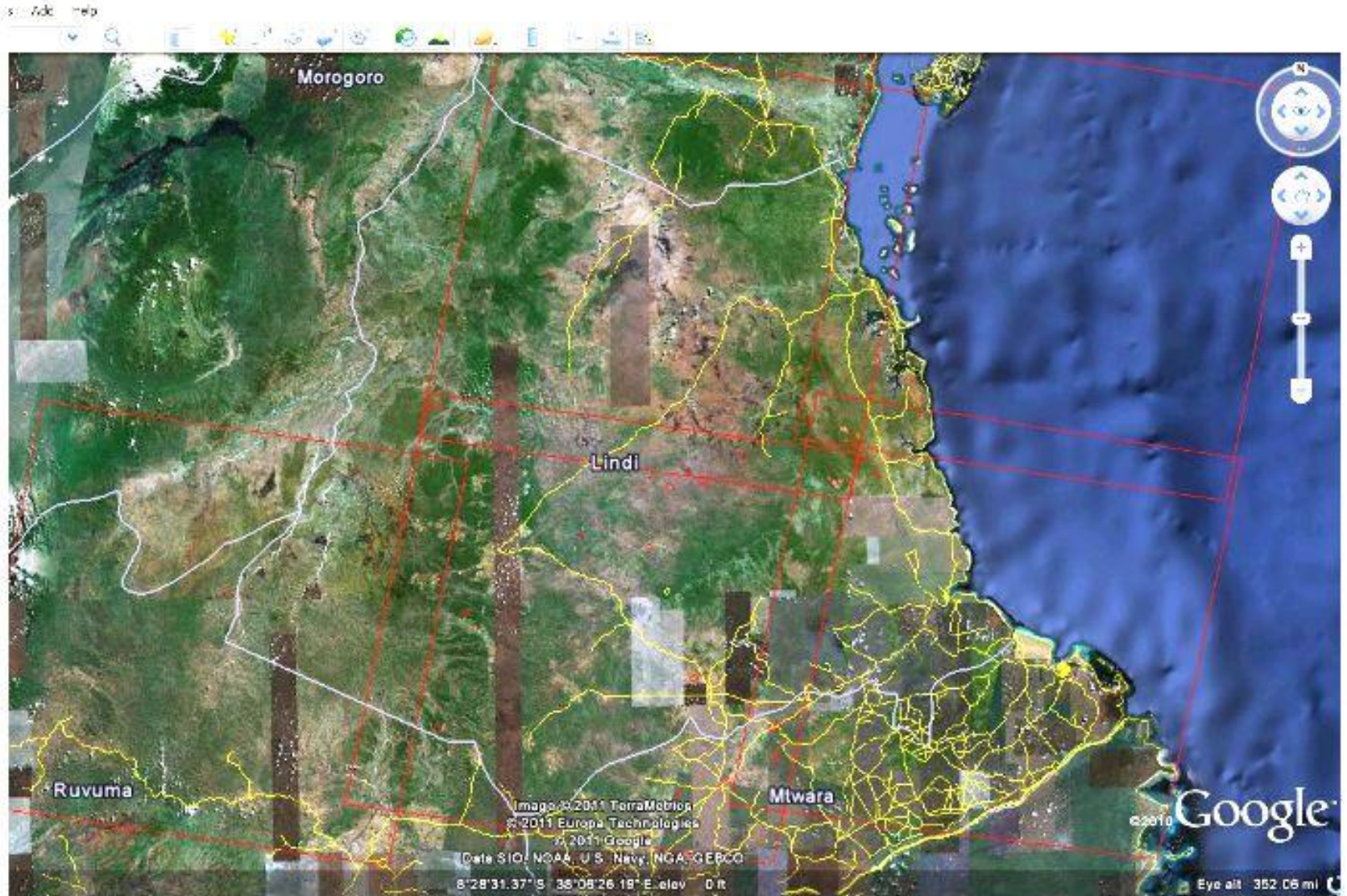
- Why use GE

- Freely available high resolution images
- Easier to identify different LULC classes even for a non-RS expert

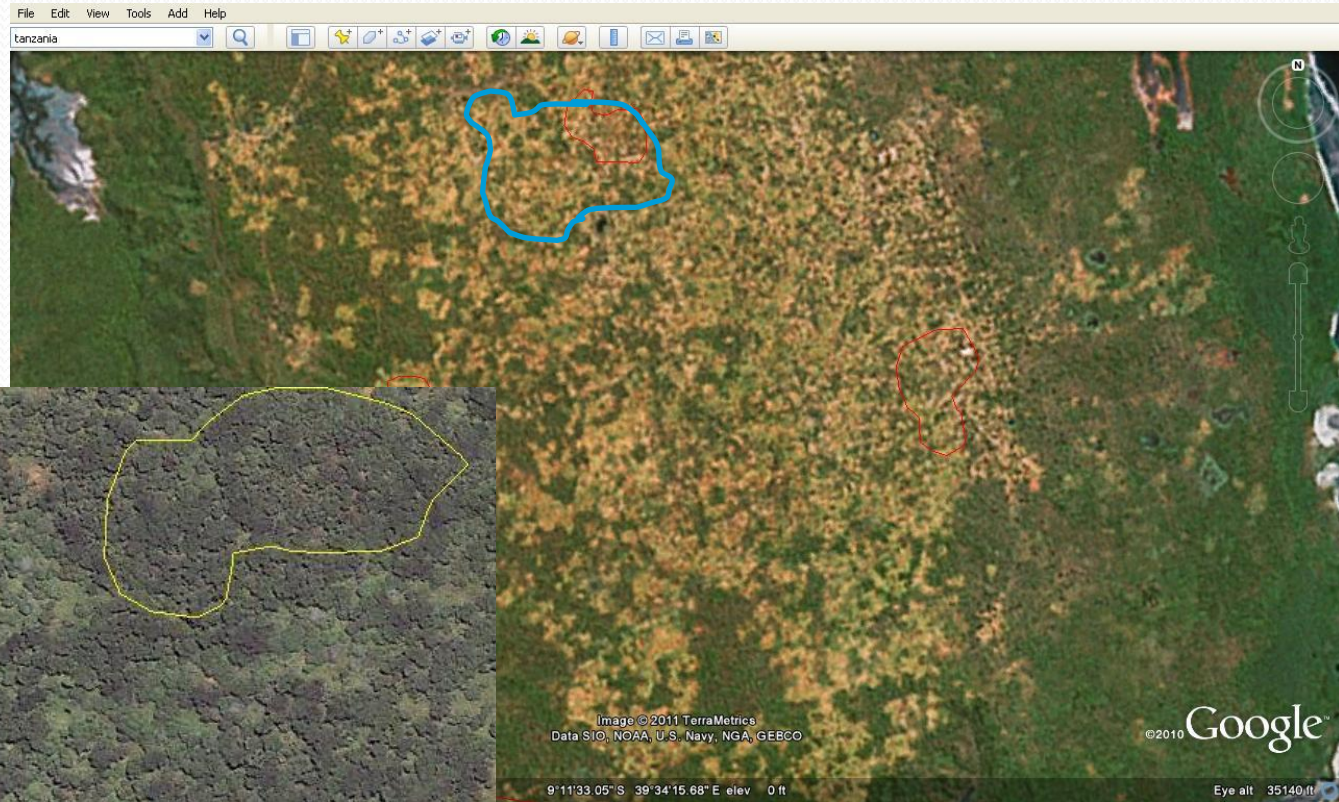
But,

- Observe the dates of images
- Internet connectivity
- Recheck data consistency with respective image and make sure that the data does not fall into image clouds/shadows

# Extract training dataset from GE

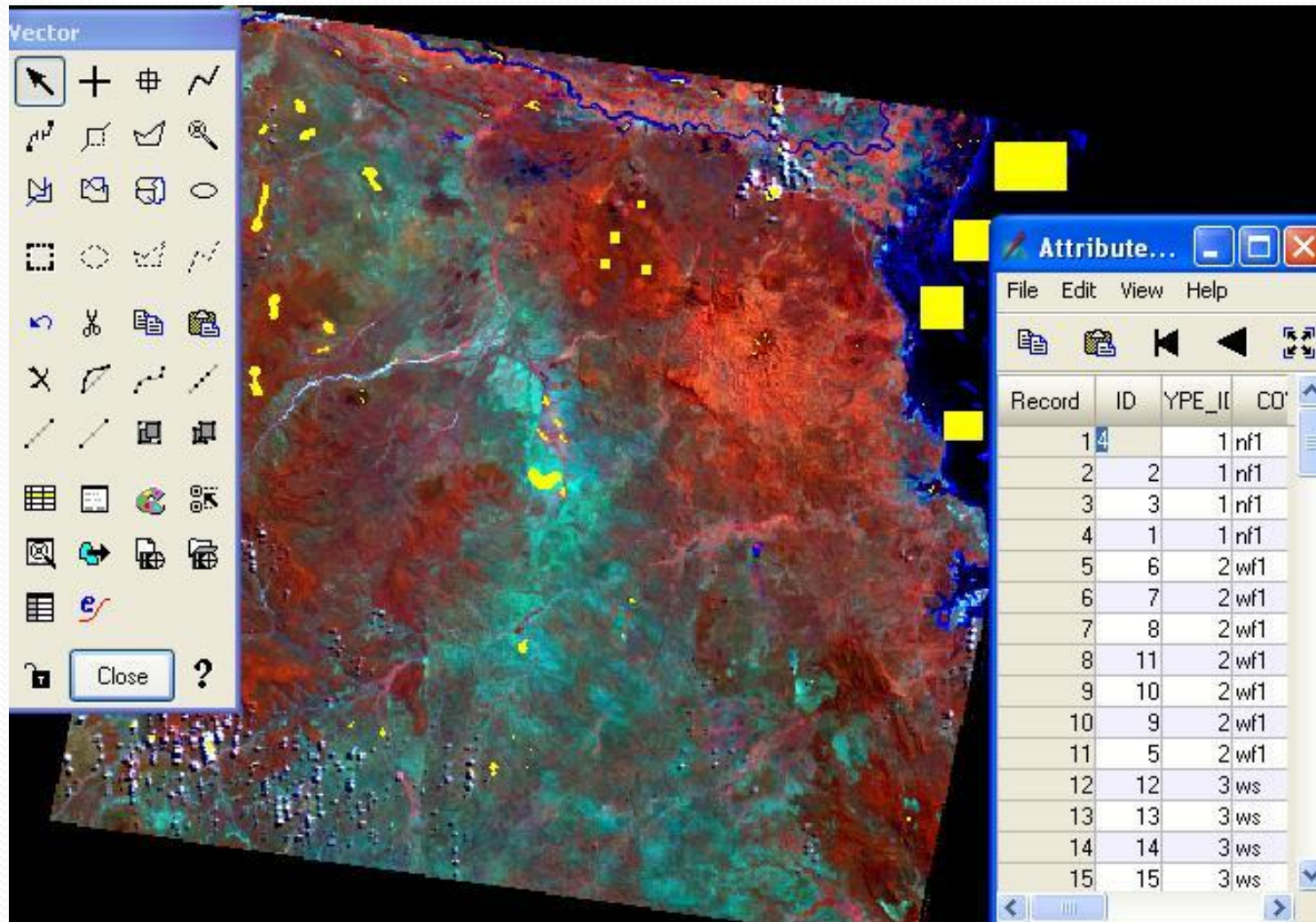


# Extraction of training dataset with GE



# Training dataset from GE rechecked and add more data

- Erdas imagine, ArcGIS, ArcView



The screenshot displays a GIS application interface. On the left is a 'Vector' toolbar with various drawing and editing tools. The central area shows a satellite image with several yellow rectangular markers overlaid on it. On the right, an 'Attribute...' window is open, showing a table with 15 records. The table has columns for 'Record', 'ID', 'YPE\_IL', and 'CO'.

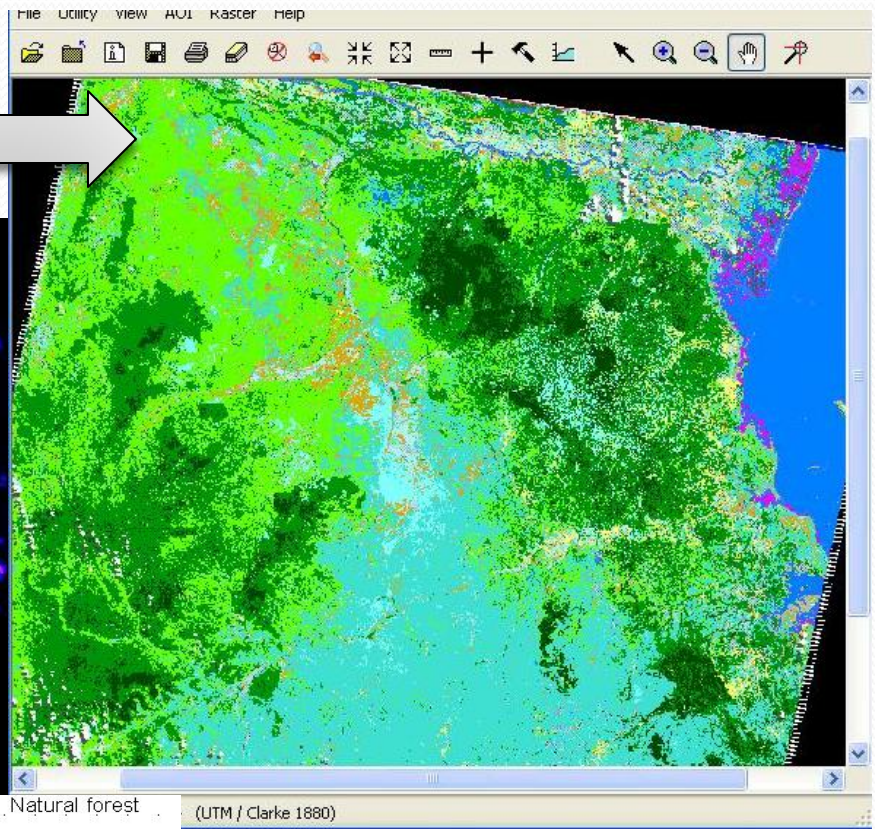
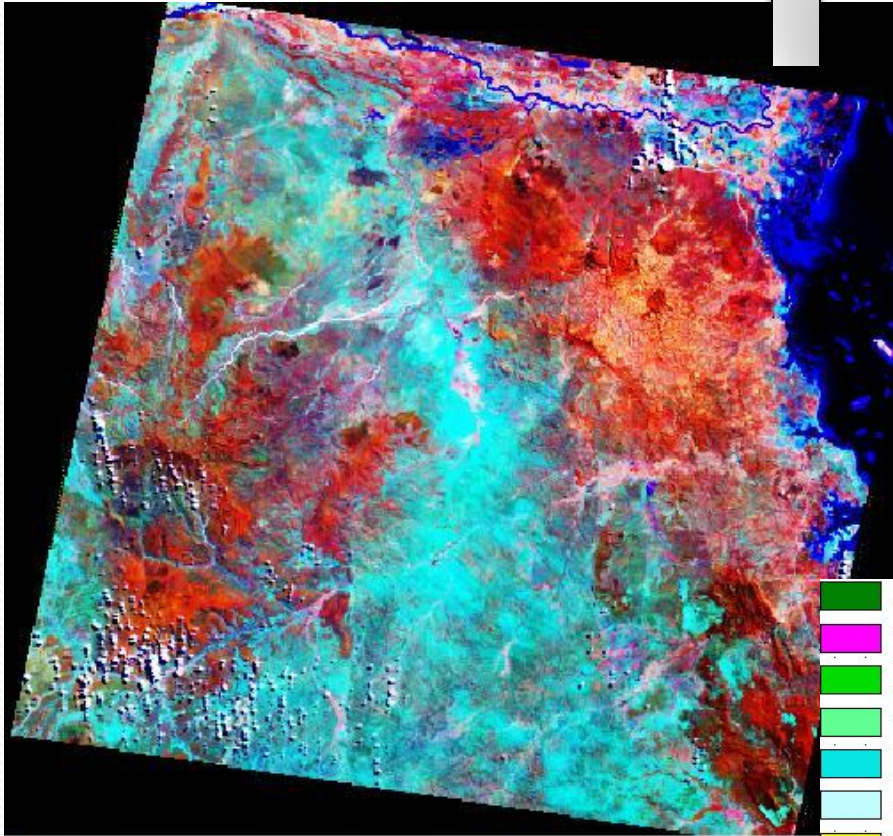
Record	ID	YPE_IL	CO'
1	4	1	nf1
2	2	1	nf1
3	3	1	nf1
4	1	1	nf1
5	6	2	wf1
6	7	2	wf1
7	8	2	wf1
8	11	2	wf1
9	10	2	wf1
10	9	2	wf1
11	5	2	wf1
12	12	3	ws
13	13	3	ws
14	14	3	ws
15	15	3	ws



# Image classification

Options:

- Rf in R
- K-NN, to be tested ASAP



- Natural forest
- Mangrove forest
- Closed woodland
- Open woodland
- Bushland
- Grassland
- Agriculture

# Knowledge Based Analysis - Editing of LC

## Reasons:

- To improve the classification results
- To extract sub-classes (level two)
- To mosaic classification from different scenes

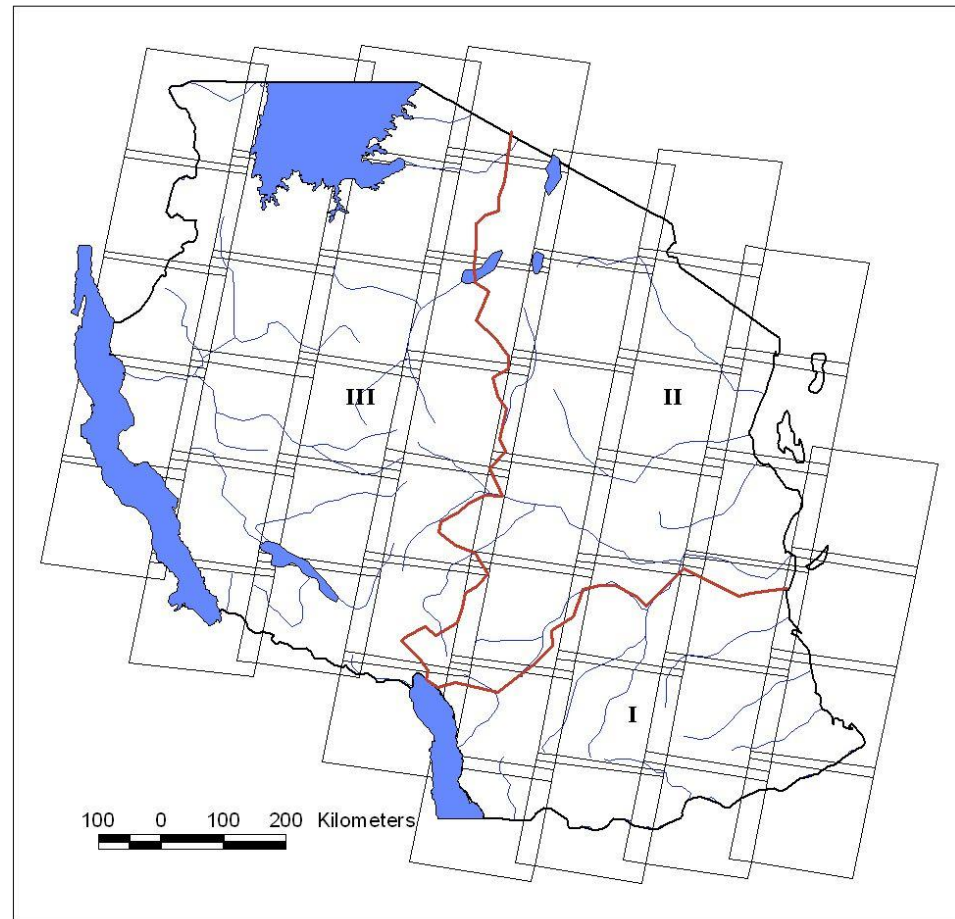
## How:

- Use of ancillary data, e.g. maps on protected areas, hunting map and field observations (including forest inventory data)
- Use of rules/algorithms, e.g. if agriculture  $\geq 20 \leq 50$  in a mixture with woodland, then assign the class “woodland with scattered cultivation”
- Use of INPE tool



# Zones

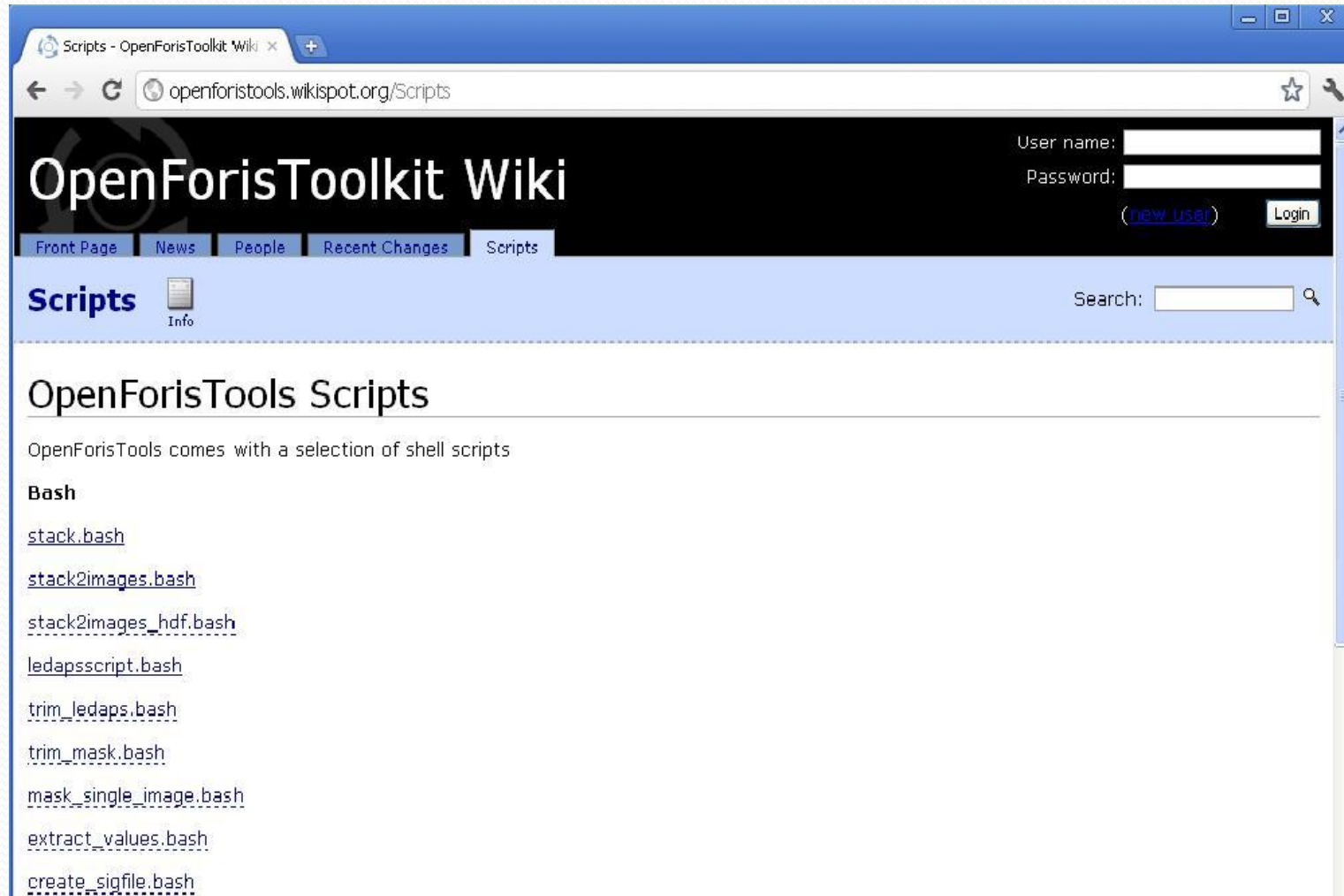
- Zone I is meant specifically for enhancing the capacity of FBD staff – involves the entire team
- the team will then be split into two groups, each working on one of the remaining two zones



# DOCUMENTATION & DESSEMINATION OF THE PROCESS AND PRODUCTS

- wiki-page (<http://openforistools.wikispot.org>)
- Reports
- Maps
- Workshops

# Initial version of the Wikipage



The screenshot shows a web browser window displaying the 'Scripts' page of the 'OpenForisToolkit Wiki'. The browser's address bar shows the URL 'openforistools.wikispot.org/Scripts'. The page header features the title 'OpenForisToolkit Wiki' and a navigation menu with links for 'Front Page', 'News', 'People', 'Recent Changes', and 'Scripts'. A search bar is located in the top right corner. The main content area is titled 'OpenForisTools Scripts' and contains the following text:

OpenForisTools comes with a selection of shell scripts

**Bash**

- [stack.bash](#)
- [stack2images.bash](#)
- [stack2images\\_hdf.bash](#)
- [ledapsscript.bash](#)
- [trim\\_ledaps.bash](#)
- [trim\\_mask.bash](#)
- [mask\\_single\\_image.bash](#)
- [extract\\_values.bash](#)
- [create\\_sigfile.bash](#)

# CHALLENGES

## Technical

- Availability of images: seasonality, cloud cover, SLC-off images
- Uniformity in describing some classes in the field, e.g. is it bushed grassland or open bushland? closed woodland or forest?
- Difficulties in classifying some of the classes, e.g. agriculture
- Time constraint

# Bushed grassland or open bushland?





## **Others:**

- Duo engagement of staff
- Fieldwork – accessibility

# Accessibility problems

