Satellite Monitoring for Forest Management: Tool description and applications

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SMFM

Satellite Monitoring for Forest Management

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School of GeoSciences

Contents

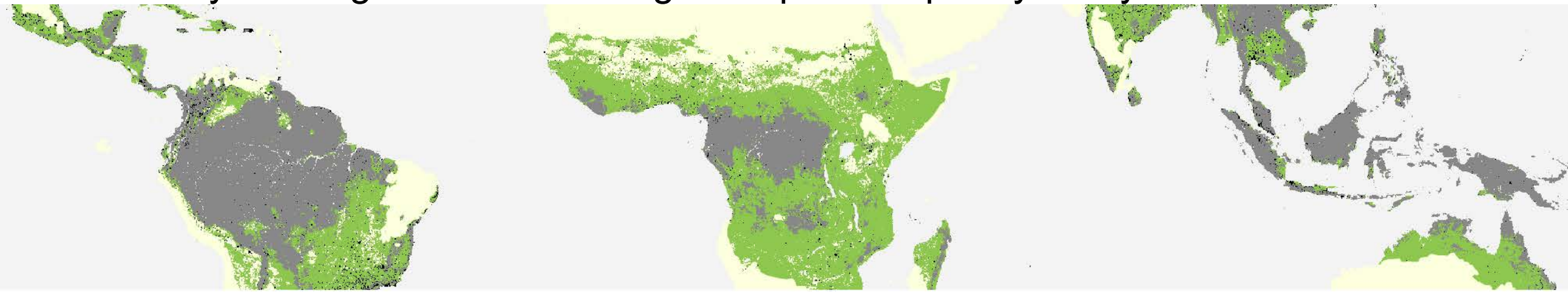
- The difficulty of dry forests
- The Satellite Monitoring for Forest Management (SMFM) project
- SMFM tool 1: Flood mapping with Sentinel-1 in Central Mozambique
- SMFM tool 2: Charcoal production near Maputo with ALOS PALSAR

The difficulty of dry forests

- Dry forests and savannas are globally extensive: ½ the tropics, 23 M km^2; ¾ of the people (Ryan et al 2016)

- Rates of conversion are probably very rapid (McNicol et al. 2018), with high demand for their goods and services.

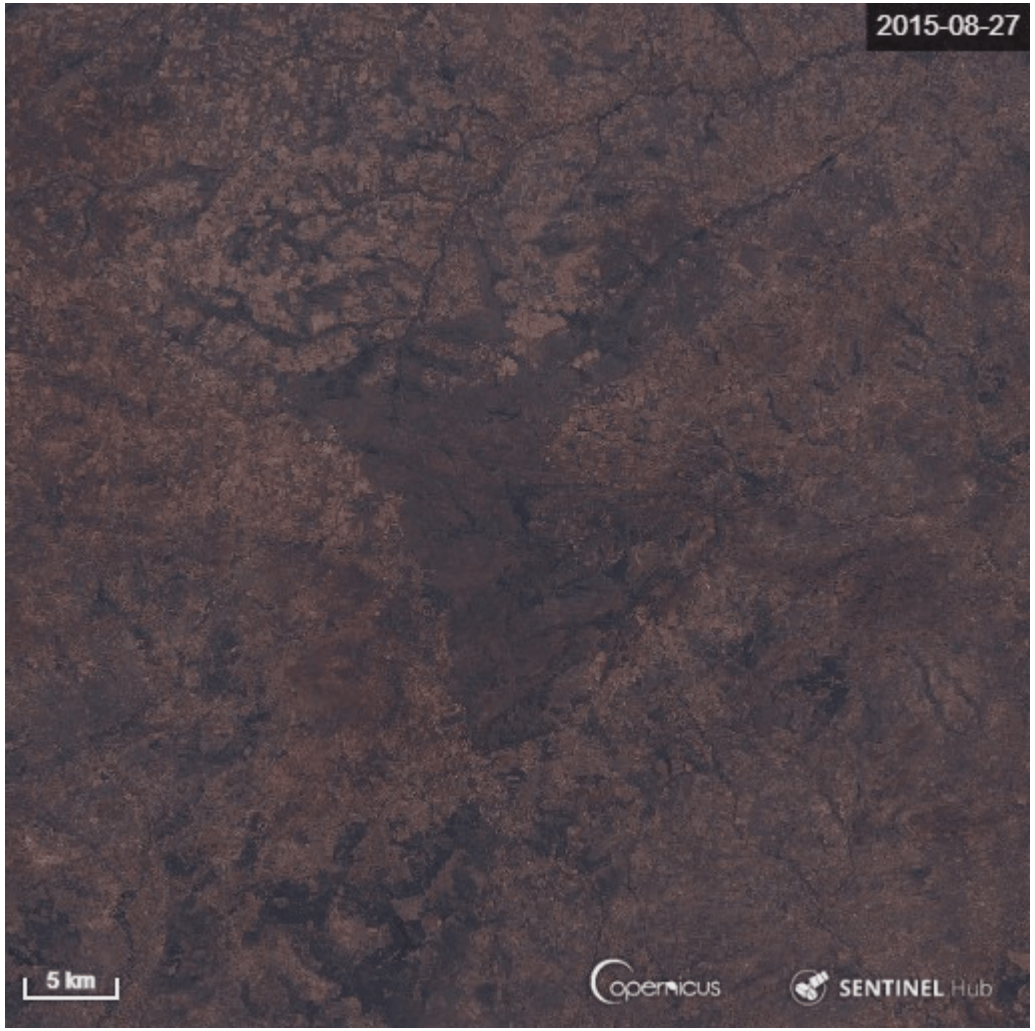
- Many existing forest monitoring tools perform poorly in dry forests



McNicol, Iain M., Casey M. Ryan, and Edward TA Mitchard. "Carbon losses from deforestation and widespread degradation offset by extensive growth in African woodlands." *Nature communications* 9.1 (2018): 3045.

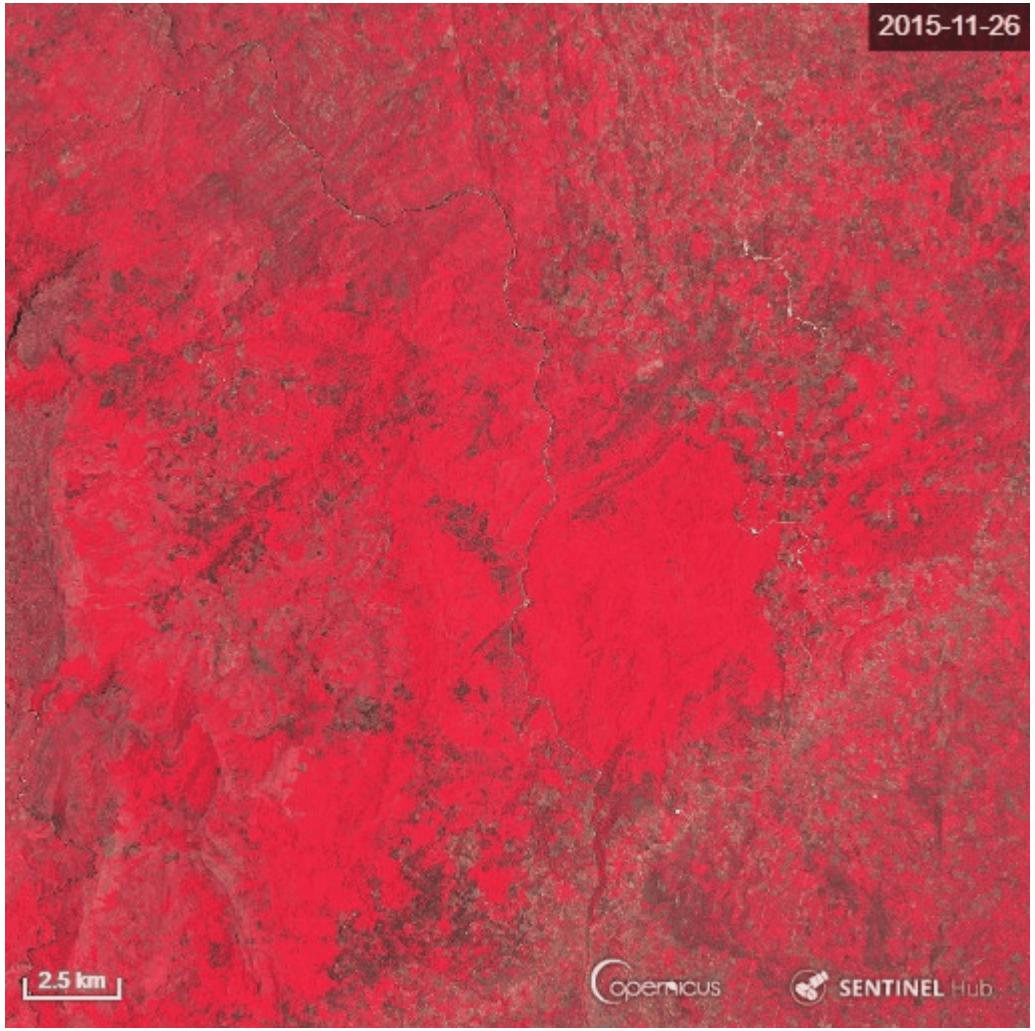
The difficulty of dry forests

Phenology



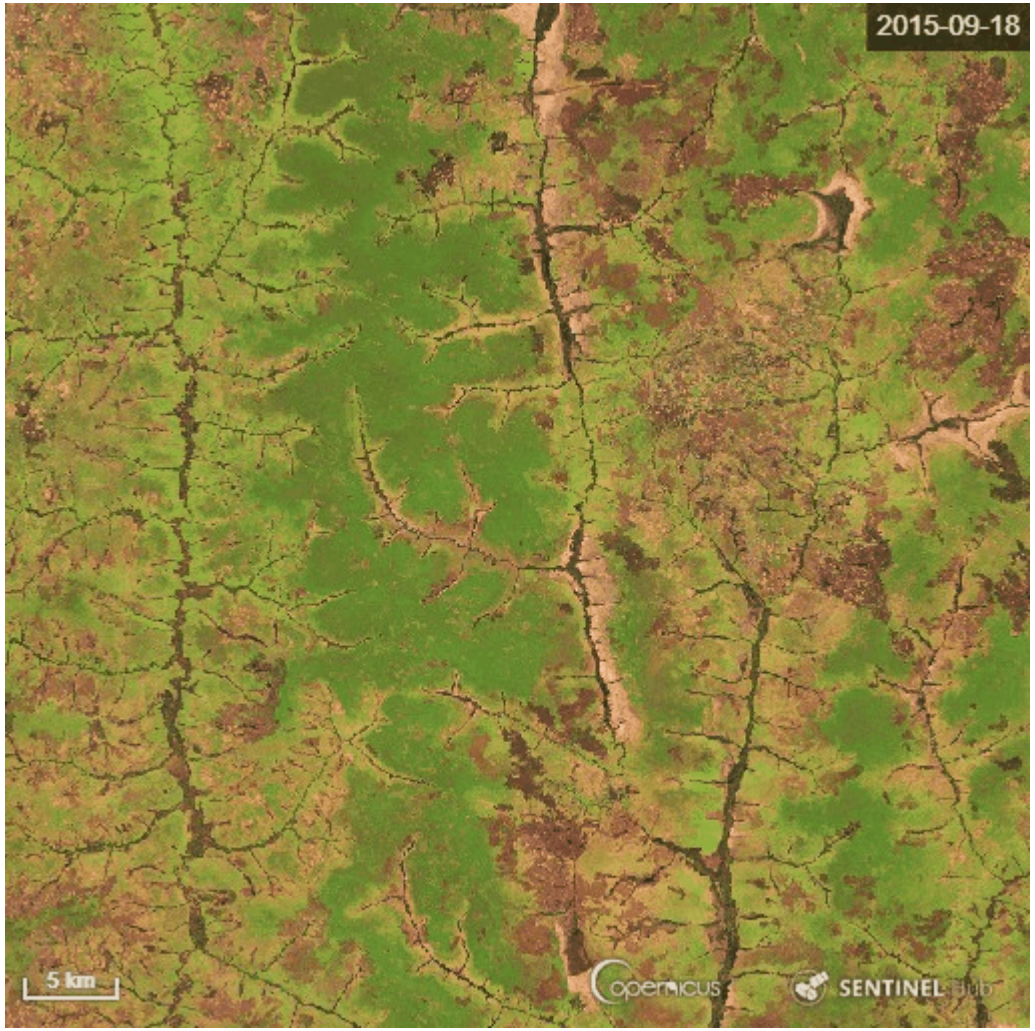
The difficulty of dry forests

Heterogeneity



The difficulty of dry forests

Fire



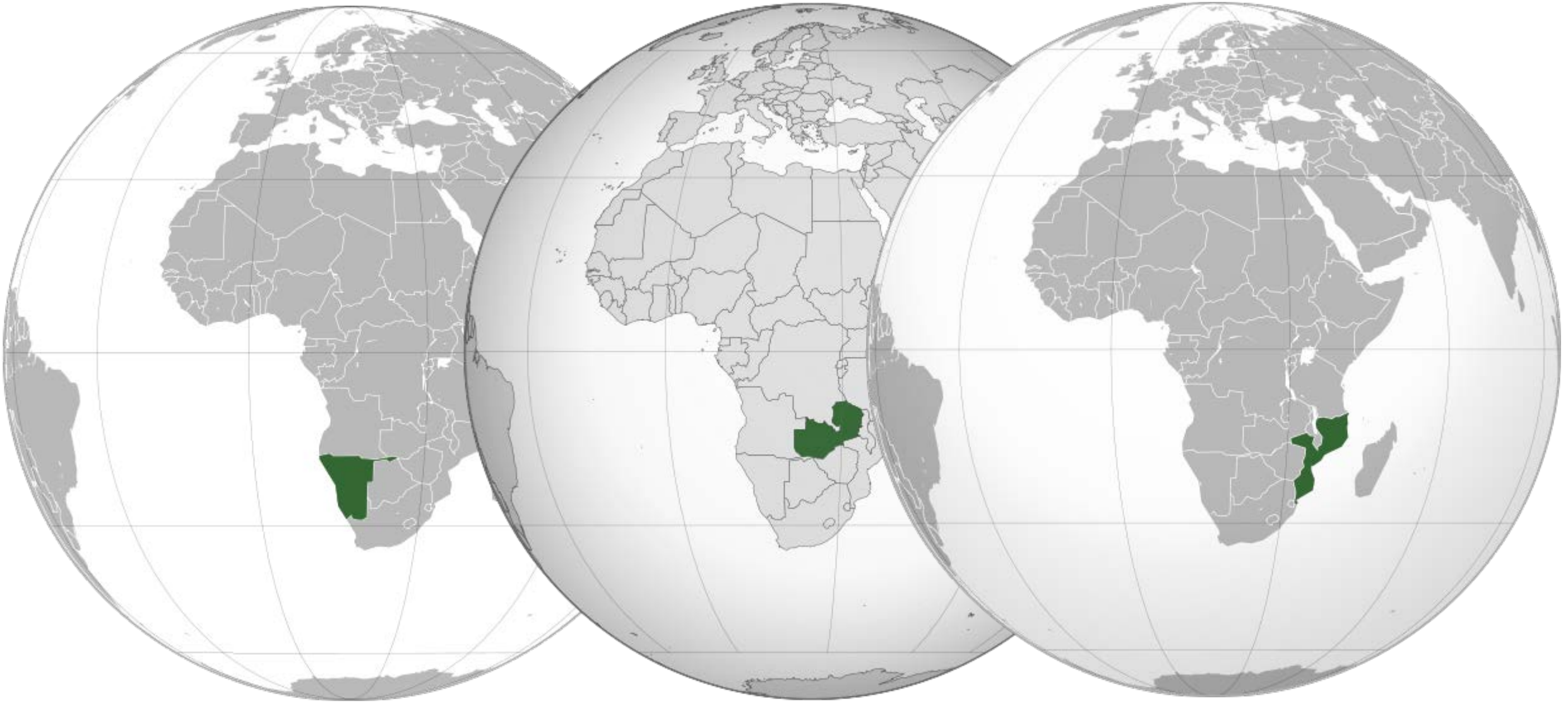
The SMFM Project

- Recent advances in **satellite Earth Observation (EO) data provision** provide **free access to satellite data**
    - Higher resolution
    - Higher frequency
    - Optical and Radar

- However **improved EO methods are required** to take advantage of these new data in dry forests

- Many countries looking to improve EO monitoring capabilities
    - **SFM**
    - **REDD+**

The SMFM Project



The SMFM Project

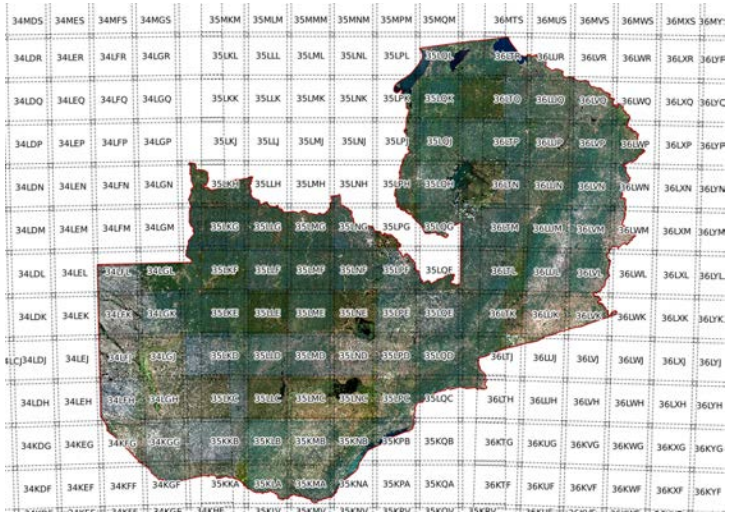
Capacity building workshop, Lusaka

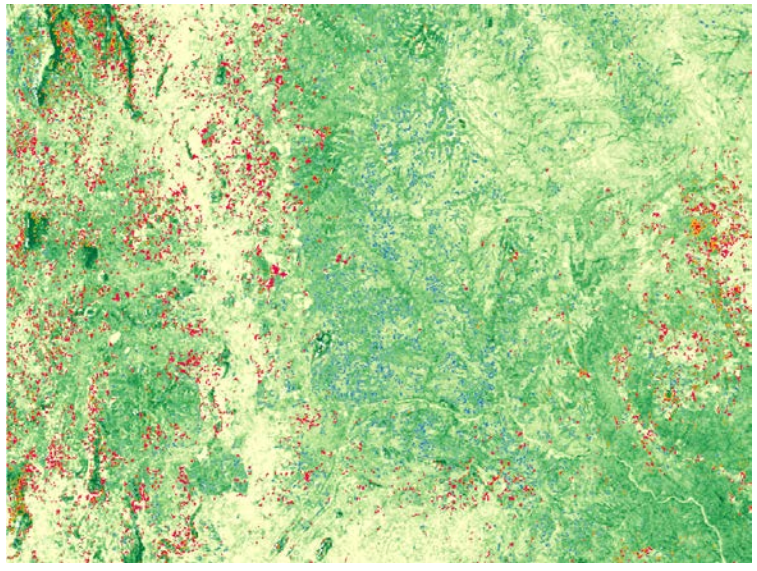
Regional meeting, Nairobi

Fieldwork, Central Mozambique

The SMFM tools

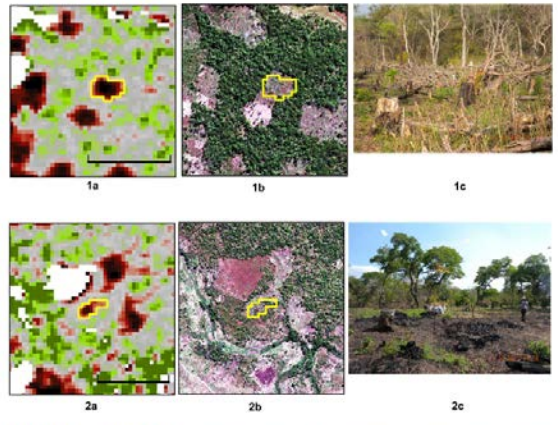
Activity 1: Mosaicking + cloud masking



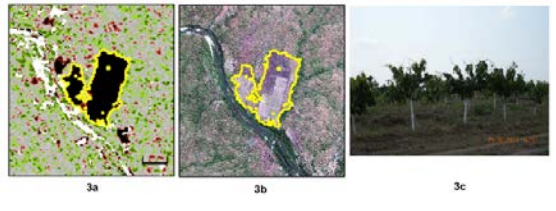


Activity 2: Biomass + change mapping

Activity 3: Dense time series for change mapping



Activity 4: Change type mapping

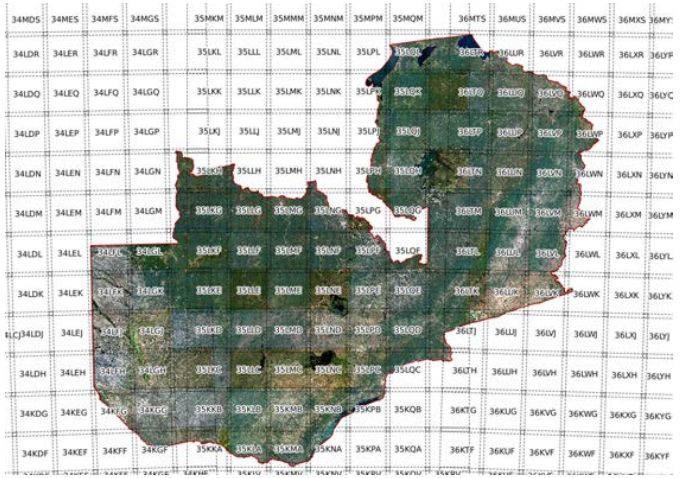


Tool 1a/1b: Mosaicking and cloud masking

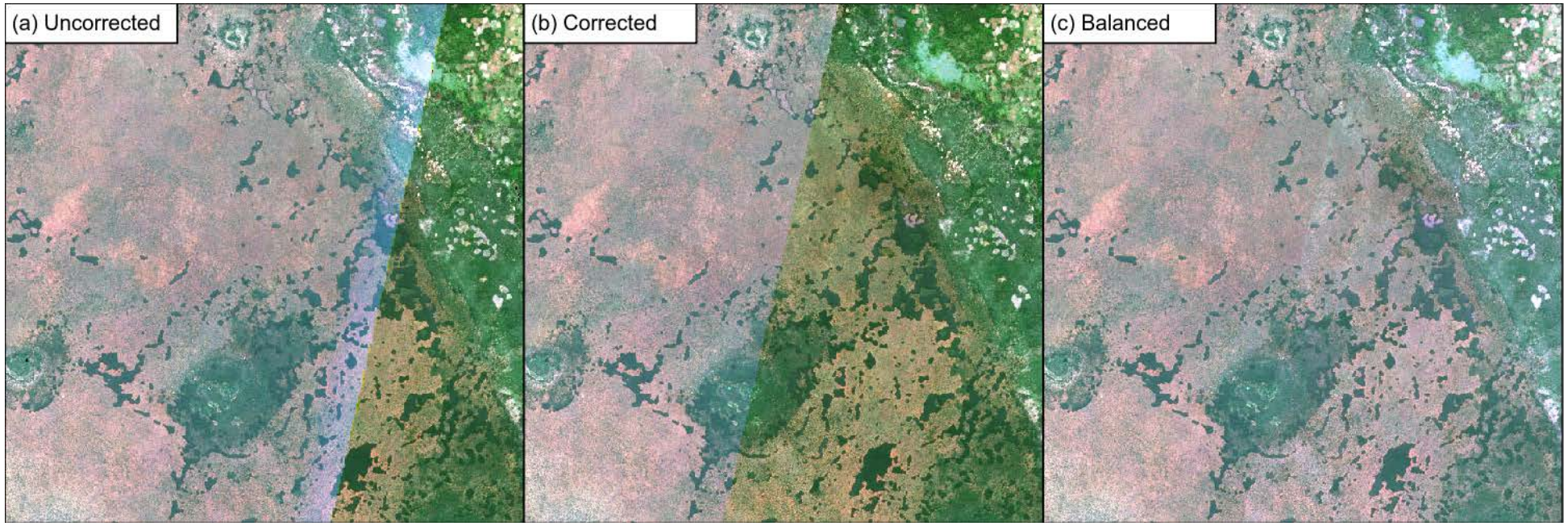
Rationale:

- Access to cloud-free images for land cover classification is difficult in most tropical dry forest countries.
- Sentinel-1 and Sentinel-2 offer free data with high resolution and strong data continuity guarantees.
- There are high barriers to making use of this data

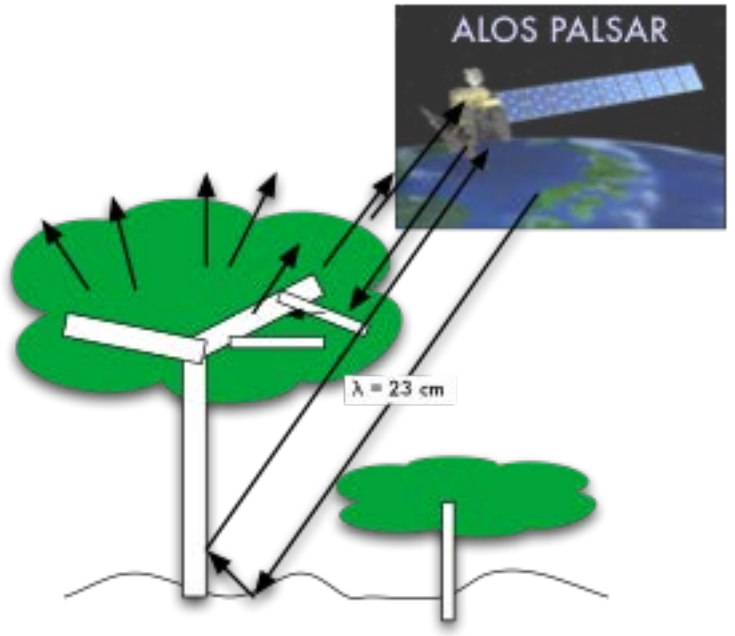
Tool 1: Mosaicking + cloud masking



Tool 1a/1b: Mosaicking and cloud masking

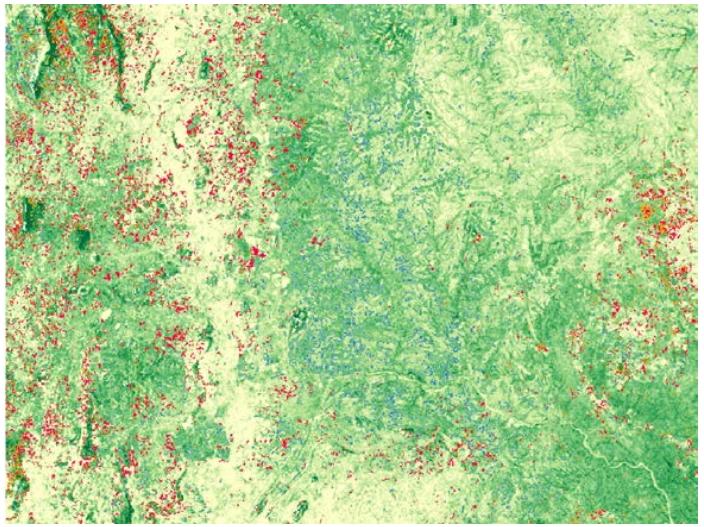


Tool 2: Biomass and change mapping



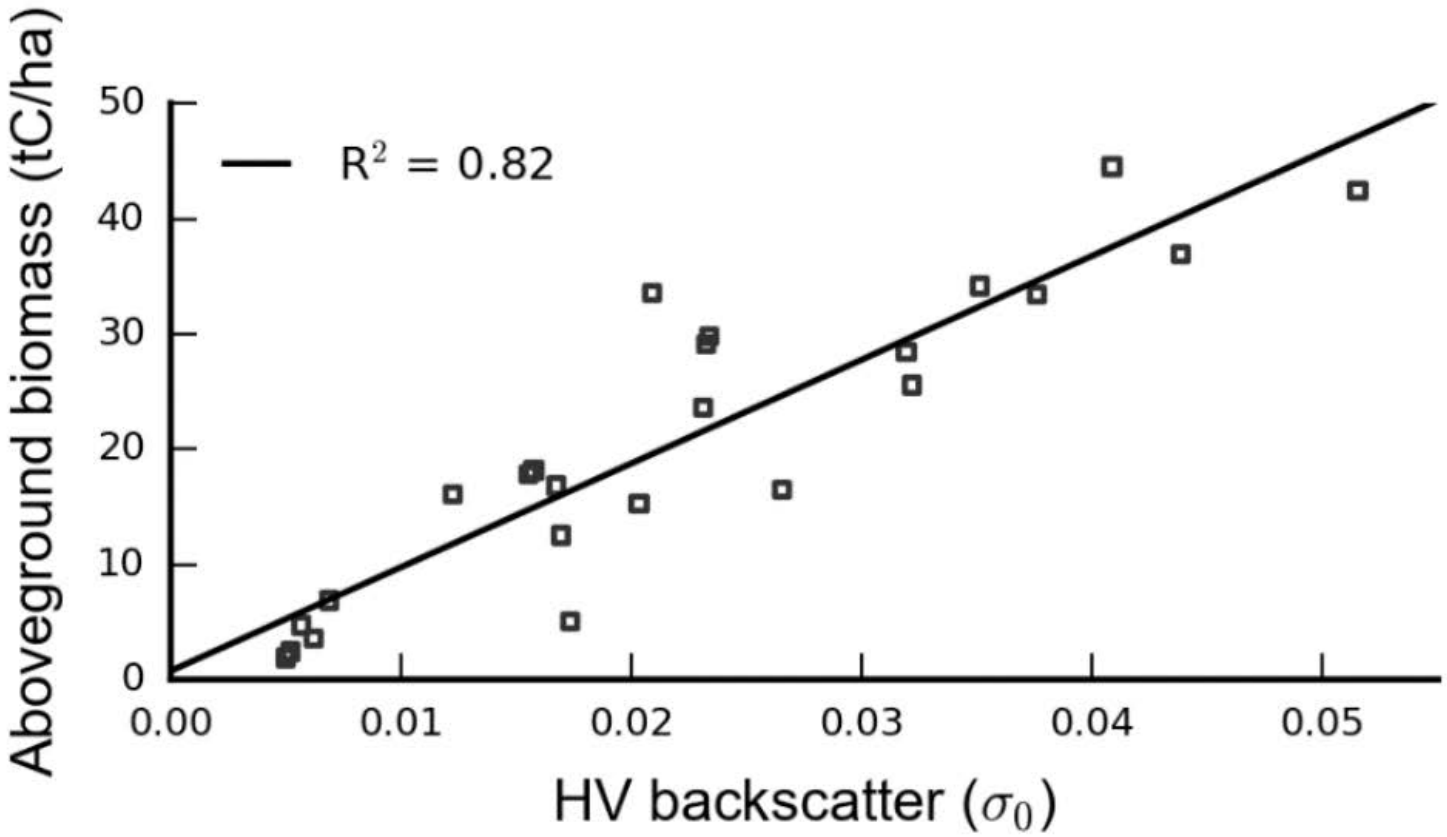
Rationale:

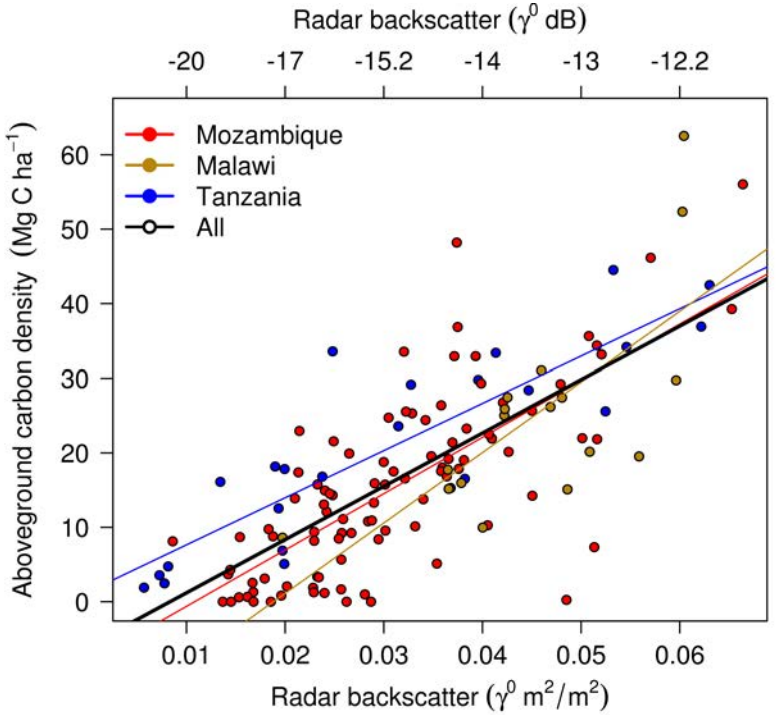
- L-band radar is a proven technology for quantifying biomass in moderate density woodlands (Mitchard et al 2009; Ryan et al 2012, 2014; McNicol 2018)
- Free data are available through ALOS PALSAR mosaics, with low processing and storage overheads.
- Future free L-band data will be available from NISAR (NASA/India).
- Biomass change is indicative of forest change.



Tool 2: Biomass + change mapping

Tool 2: Biomass and change mapping





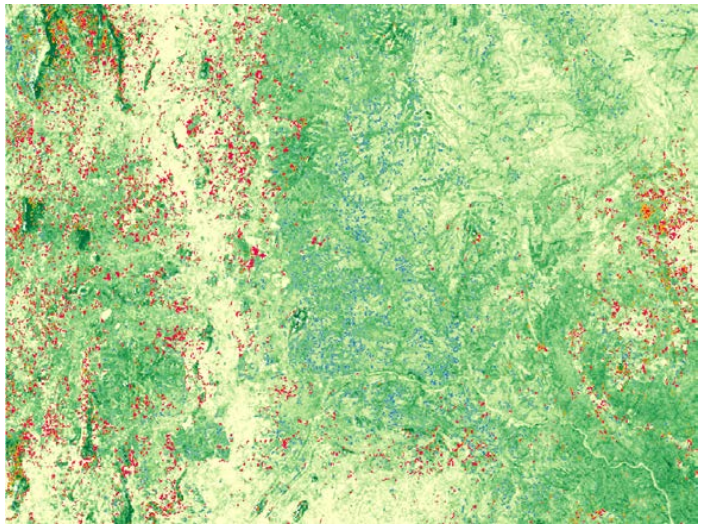
Data from Kilwa, Tanzania (McNicol, Ryan et al 2014).
1 ha permanent plots. All stems > 5 cm DBH

Ryan et al 2012; 2014

Tool 2: Biomass and change mapping

The BIOmass Tool for ALOS (biota):

- Downloads and manages ALOS mosaic data (free)
- Performs data pre-processing (calibration, filtering)
- Forest cover and biomass mapping
- Change detection
- Global visualisation now available:
- **https://tinyurl.com/miombo-change**



Tool 2: Biomass + change mapping

Application: Charcoal production for Maputo

Charcoal

- In most of Africa, ~90% of urban households cook with charcoal
- ~4% of GDP associated with trading of woodfuels
- Demand is focused around urban centres, with production in an expanding wave

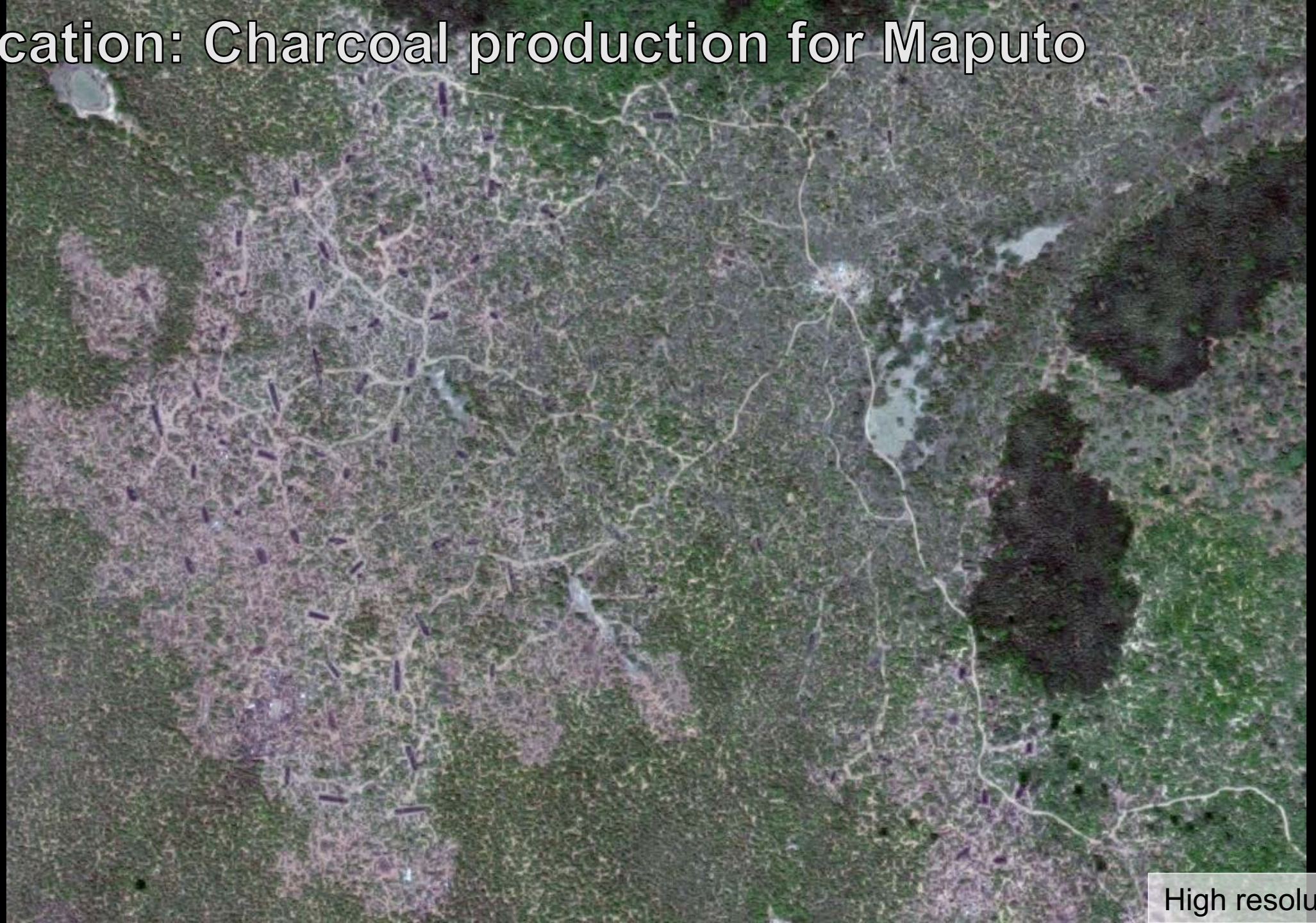
Why?

- High energy density, especially compared to wood
- Better for indoor use
- Hot, even burn
- Tasty!

Application: Charcoal production for Maputo

High resolution optical

Application: Charcoal production for Maputo

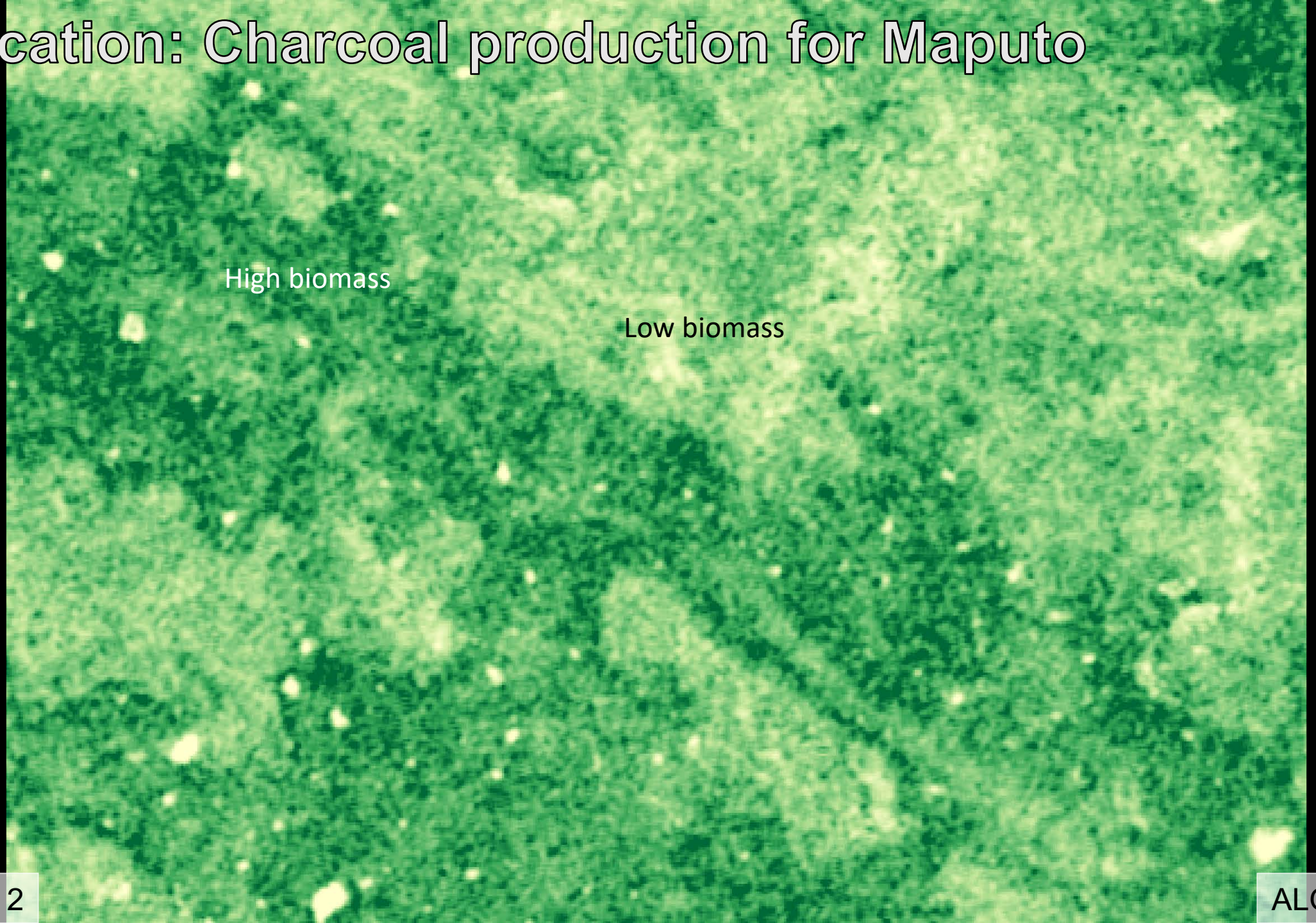


High resolution optical

Application: Charcoal production for Maputo

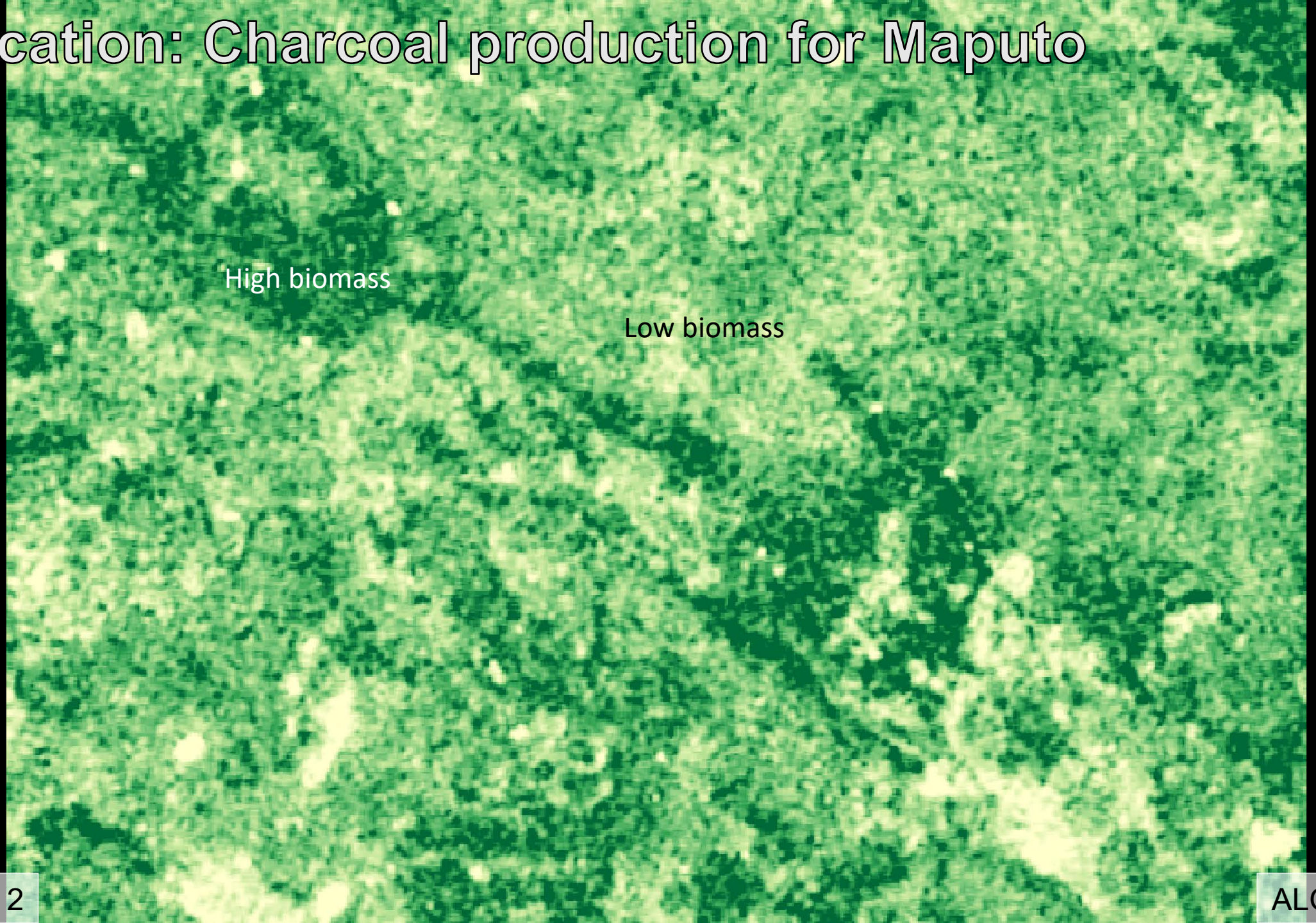
High resolution optical

Application: Charcoal production for Maputo



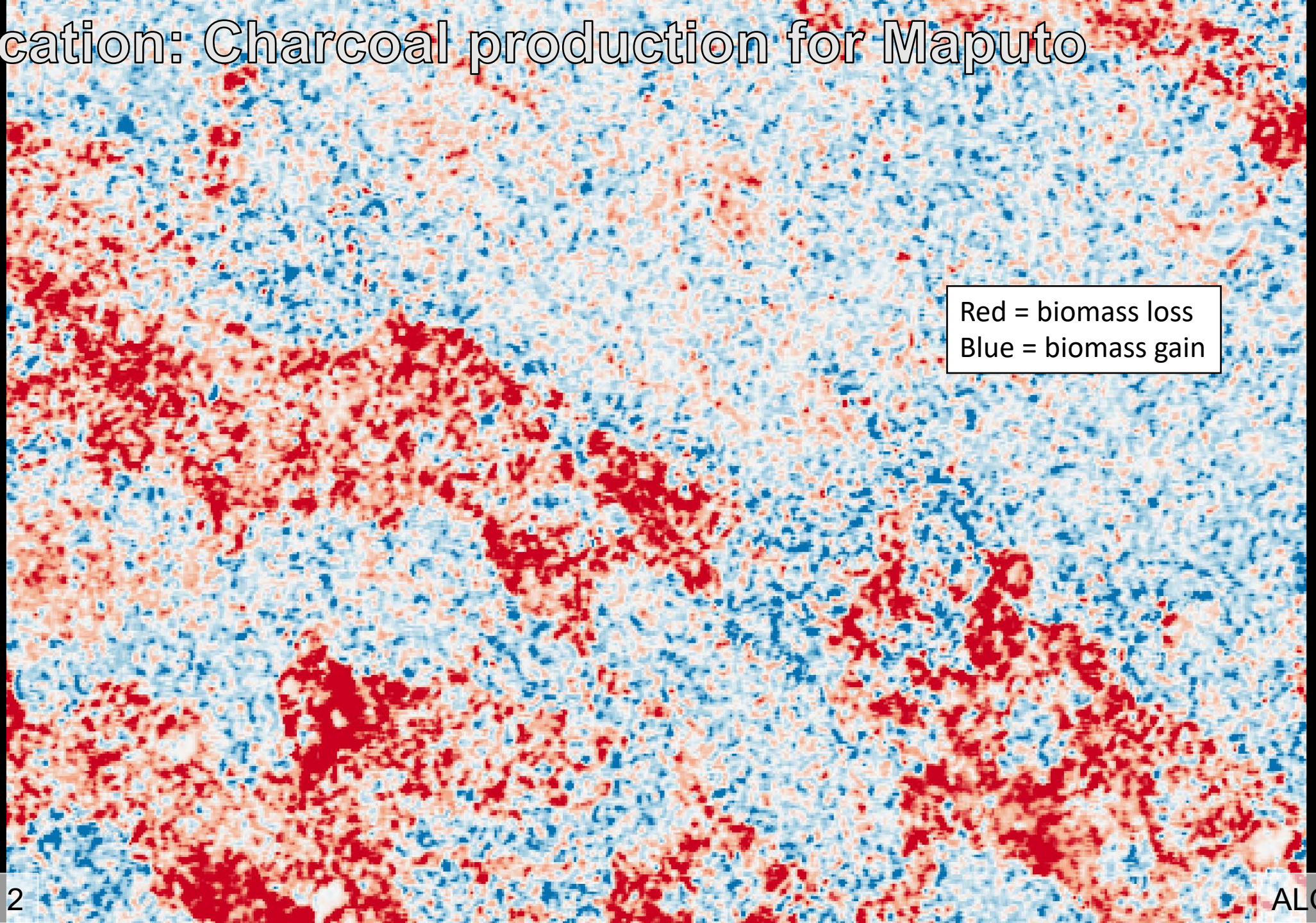
ALOS-1, 2007

Application: Charcoal production for Maputo



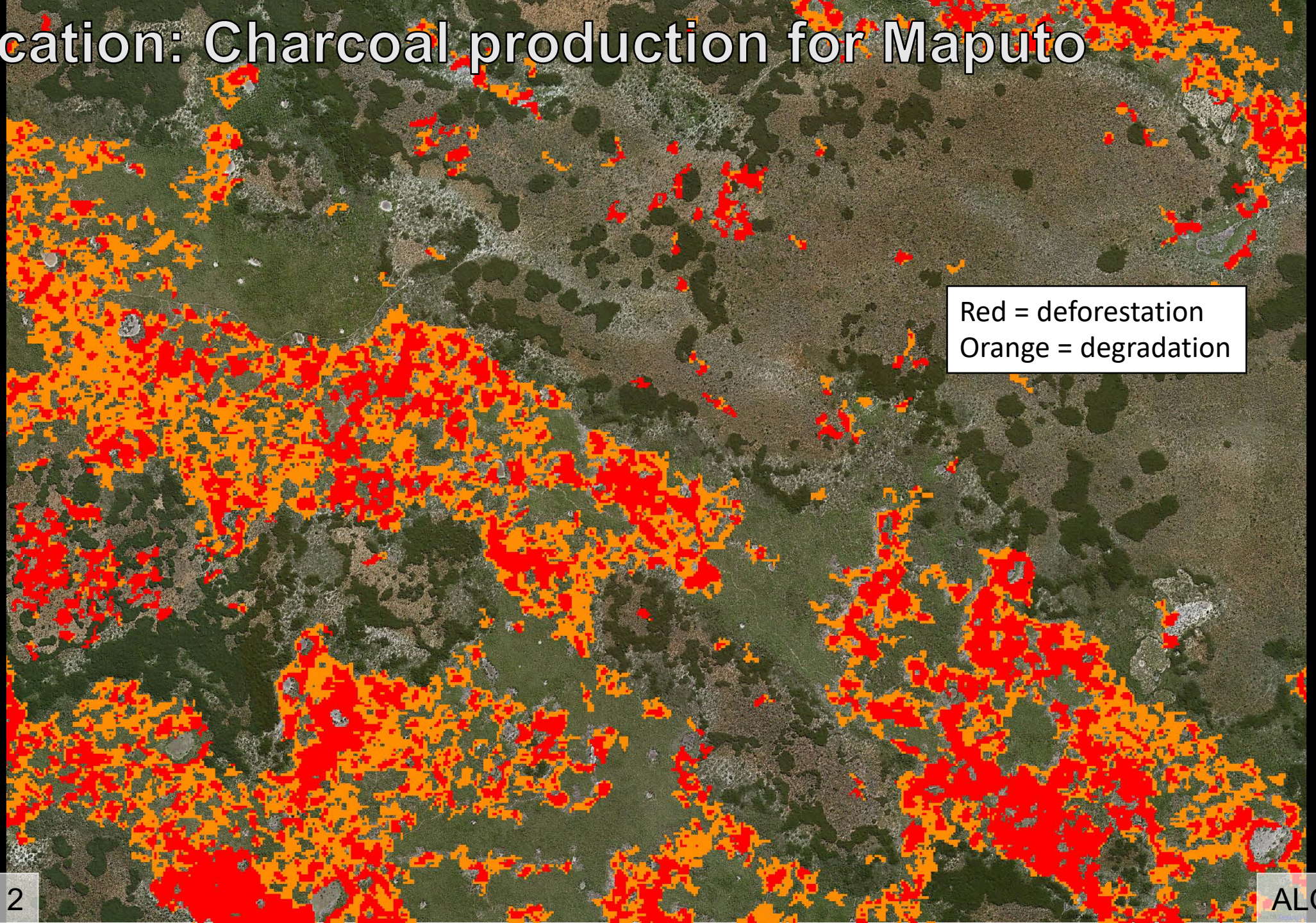
ALOS-2, 2016

Application: Charcoal production for Maputo



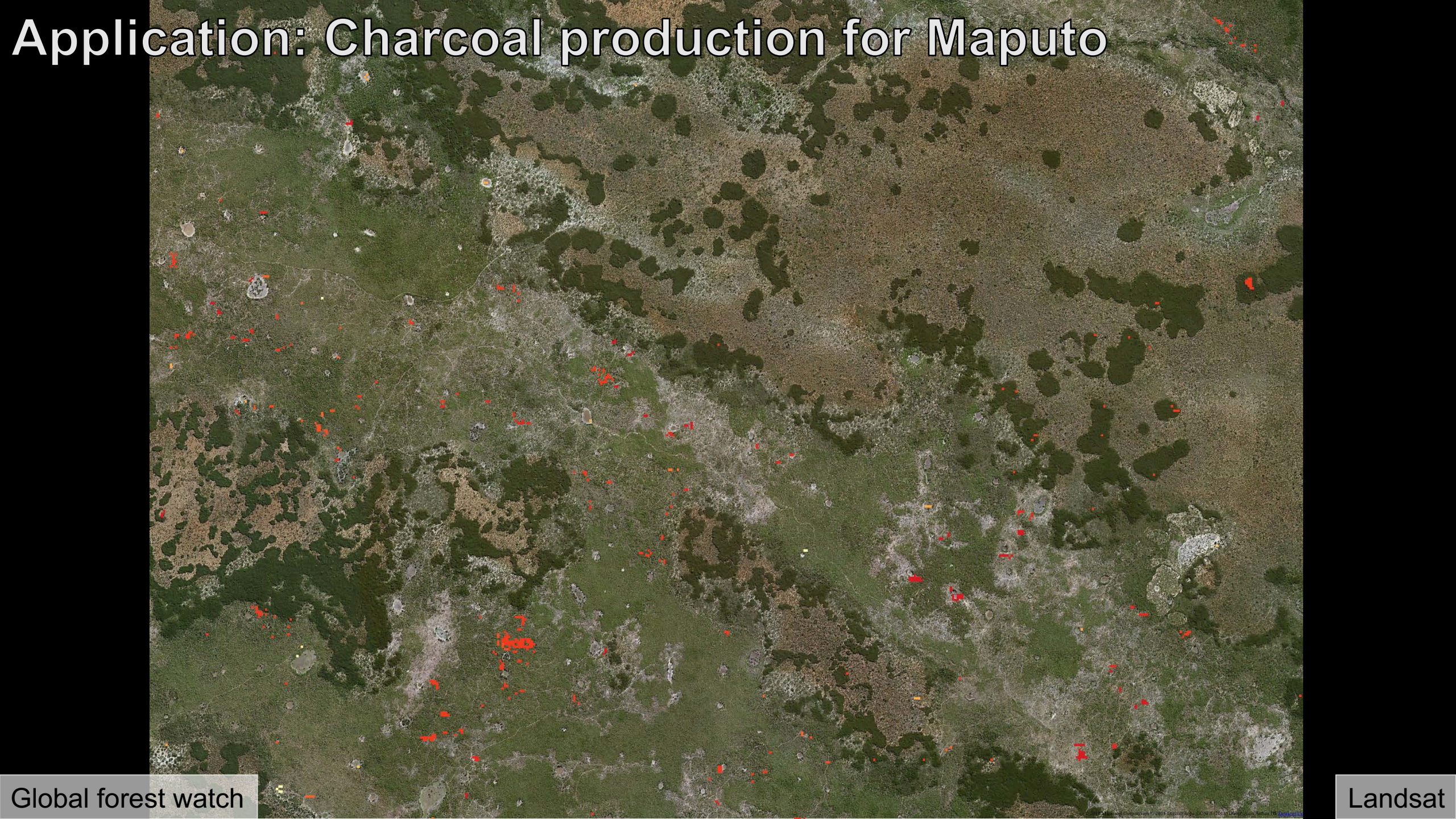
ALOS-2, 2016

Application: Charcoal production for Maputo



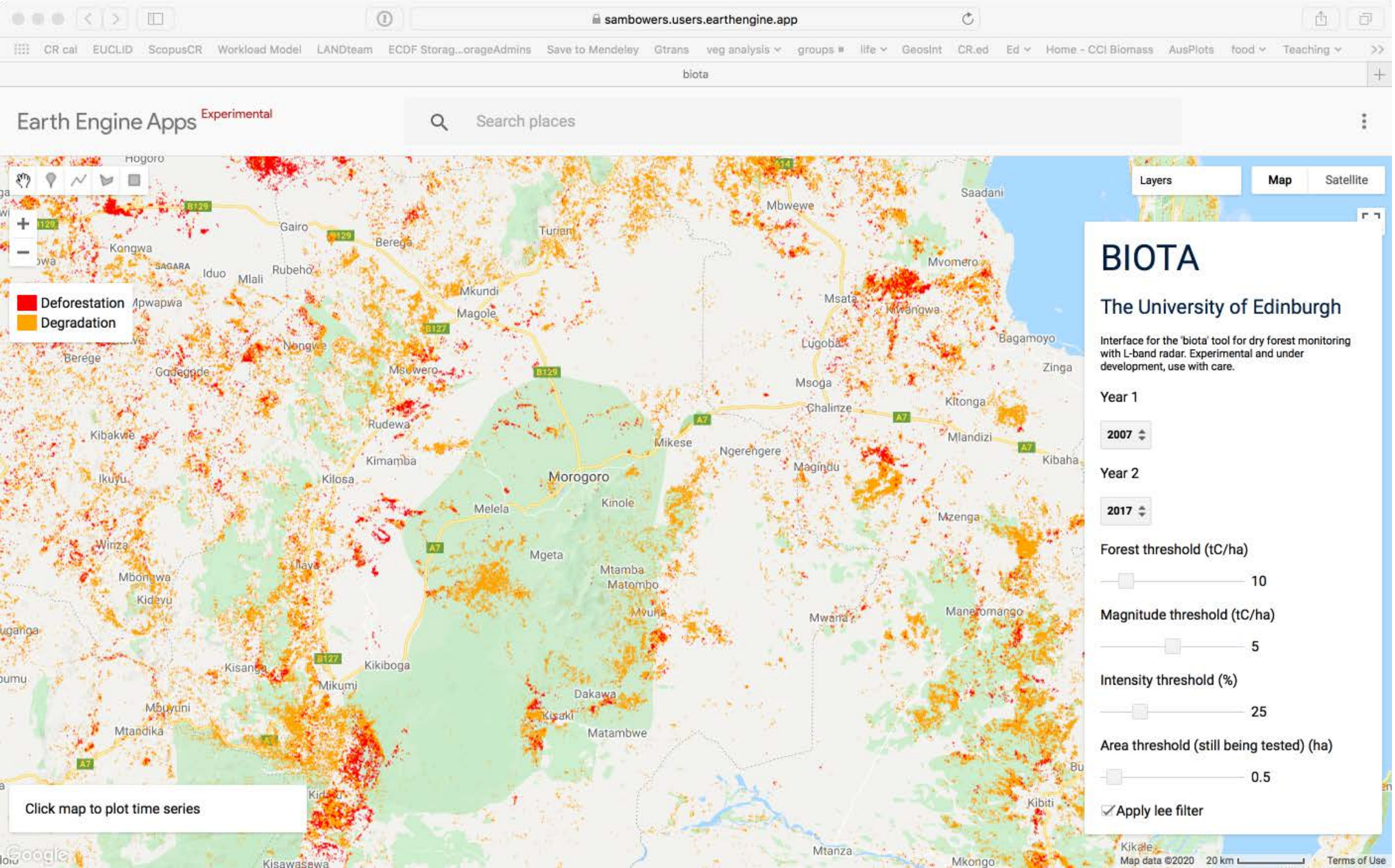
ALOS-2, 2016

Application: Charcoal production for Maputo



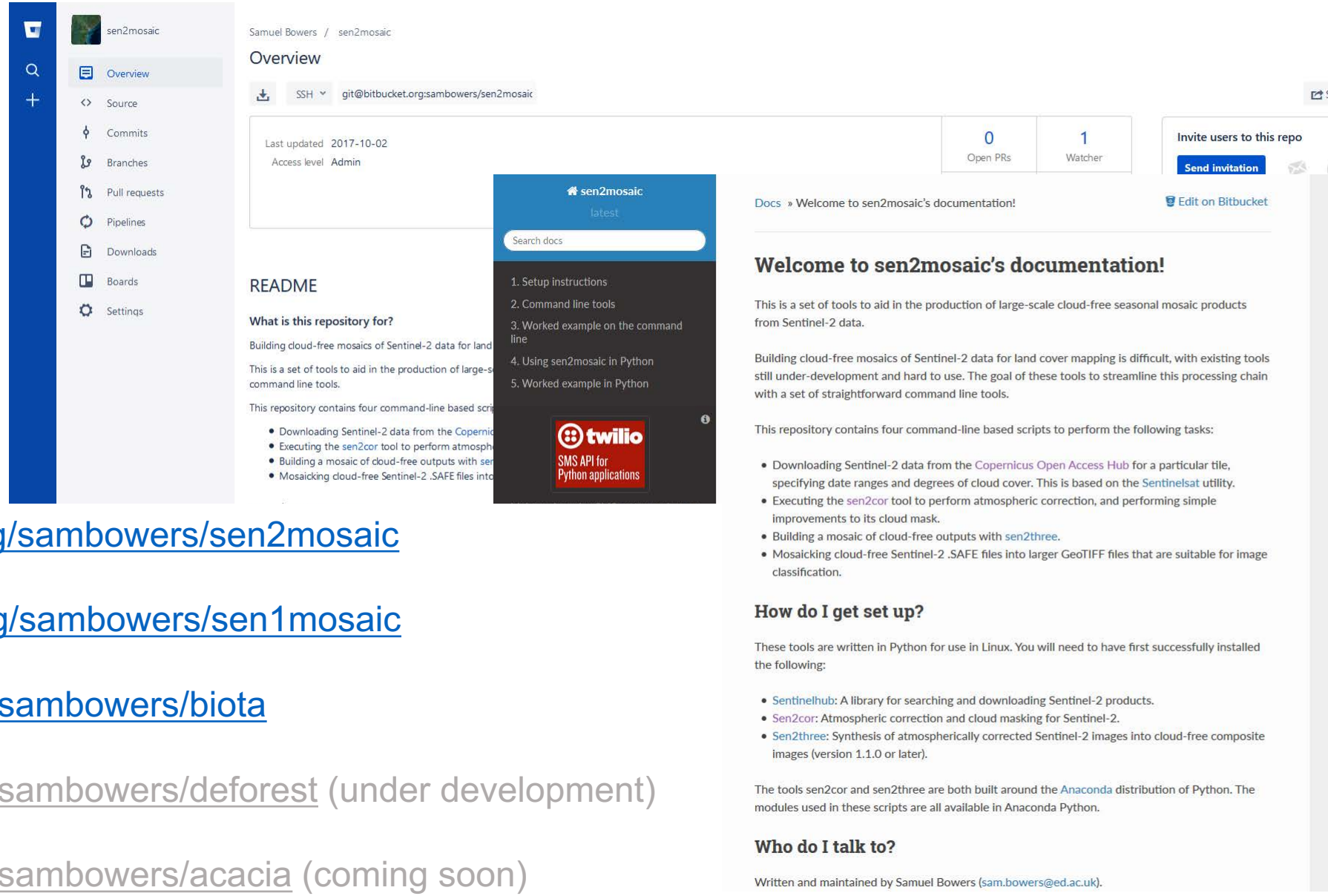
Global forest watch

Landsat


sambowers.users.earthengine.app
CR cal EUCLID ScopusCR Workload Model LANDteam ECDF Storag...orageAdmins Save to Mendeley Gtrans veg analysis groups life GeosInt CR.ed Ed Home - CCI Biomass AusPlots food Teaching
biota
Earth Engine Apps Experimental
Search places
Layers
Map
Satellite
Deforestation
Degradation
BIOTA
The University of Edinburgh
Interface for the 'biota' tool for dry forest monitoring with L-band radar. Experimental and under development, use with care.
Year 1
2007
Year 2
2017
Forest threshold (tC/ha)
10
Magnitude threshold (tC/ha)
5
Intensity threshold (%)
25
Area threshold (still being tested) (ha)
0.5
Apply lee filter
Click map to plot time series
Morogoro
Mikese
Ngerengere
Kinole
Melela
Mgeta
Mtamba
Matombo
Mwana
Dakawa
Kisaki
Matambwe
Kikiboga
Mikumi
Kilosa
Kimamba
Rudewa
Mbwewe
Saadani
Mvomero
Msata
Kiwangwa
Lugoba
Bagamoyo
Zinga
Msoga
Chalinze
Kitonga
Mlandizi
Kibaha
Magindu
Mzenga
Maneromango
Turiani
Magole
Mkundi
Berega
Gairo
Kongwa
Iduo
Mlali
Rubeho
Nongwe
Msowero
Godegode
Berege
Kibakwe
Ikuyu
Winza
Mbongwa
Kidevu
Kisanga
Mbuyuni
Mtandika
Kisawasewa
Mtanza
Mkongo
Kibiti
Kikale
Map data ©2020
20 km
Terms of Use

The SMFM Tools

- **Open source**
- **Generic**
- **Multiple interfaces**
  - Python
  - Linux command line
  - Online platform (F-TEP)
  - Graphical User Interface



Tool 1a: https://www.bitbucket.org/sambowers/sen2mosaic

Tool 1b: https://www.bitbucket.org/sambowers/sen1mosaic

Tool 2: https://www.bitbucket.org/sambowers/biota

Tool 3: https://www.bitbucket.org/sambowers/deforest (under development)

Tool 4: https://www.bitbucket.org/sambowers/acacia (coming soon)

To summarise

- Dry forests are globally extensive and under pressure.
- Many existing forest monitoring tools perform poorly in dry forests.
- The SMFM project has produced Earth Observation methods for dry forest monitoring using Earth Observation data.
- The biomass mapping tool is able to map deforestation and degradation.
- These tools are open source, and available for use in novel dry forest situations.
- Now being used by national agencies in Mozambique, Zambia (FREL) and Namibia

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