

# A look past and a look forward

David Skole

Michigan State University

# Antecedents ca. 1988-94

- There were important antecedents to the NASA LCLUC program
- Two important drivers:
  - Large scale Landsat databases were being used to quantify land cover changes at continental scales, including time series
  - Developing analysis, conceptual frameworks and models for studying the “other global change”: land transformation

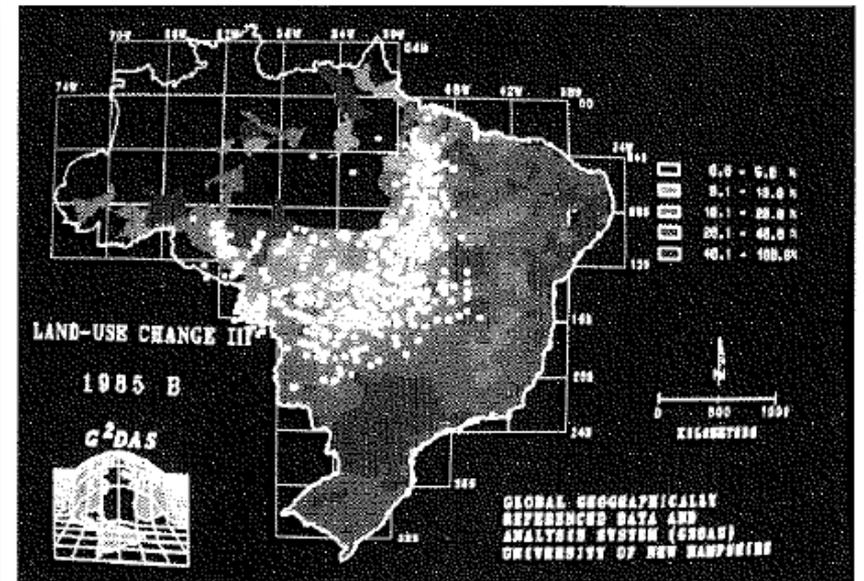
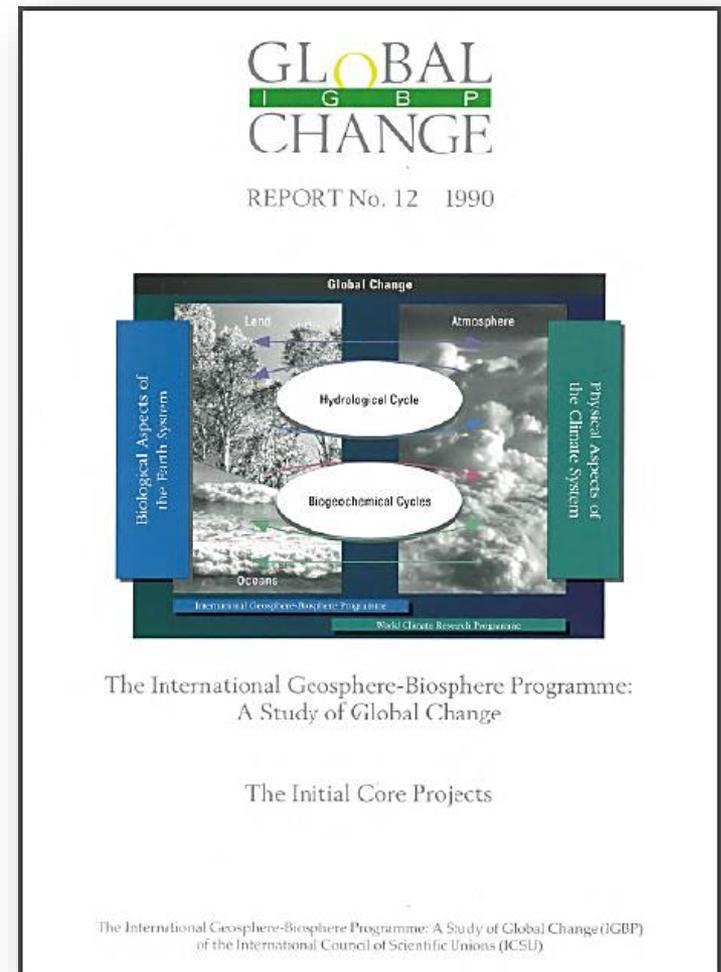


Figure G.

IGBP Report 8. 1988. Pilot Studies for Remote Sensing and Data Management

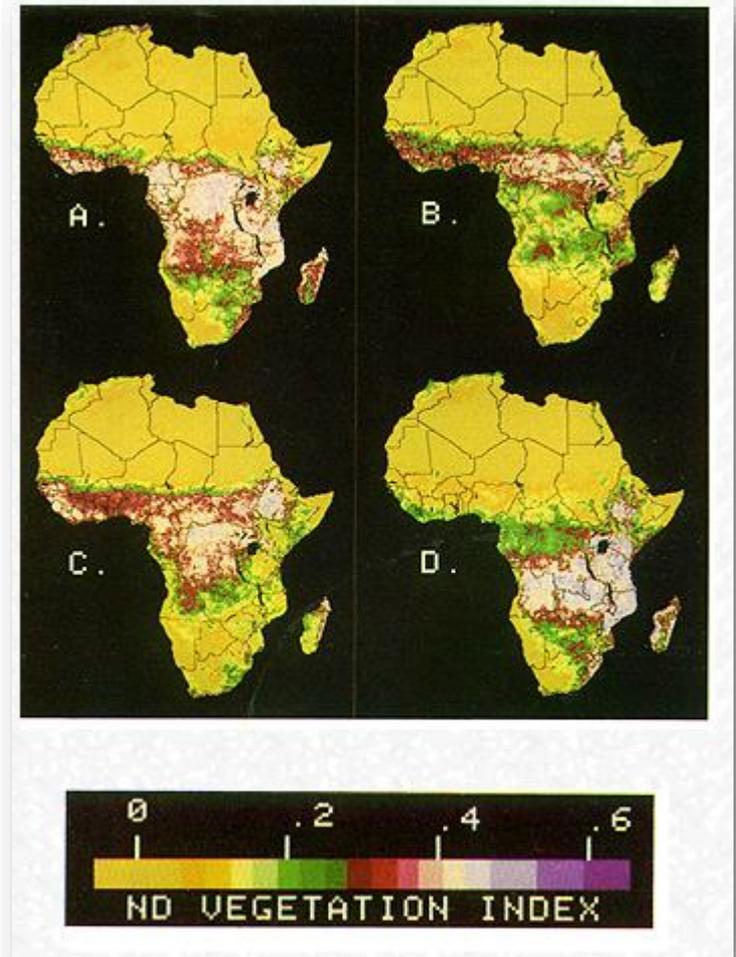
# Pattern to Process

- Global change research agenda was being developed with a focal point on climate change.
- US: US Global Change Research Program, Global Change Research Act of 1990
- International: International Geosphere-Biosphere Programme: Report 12, Core Projects 1990.



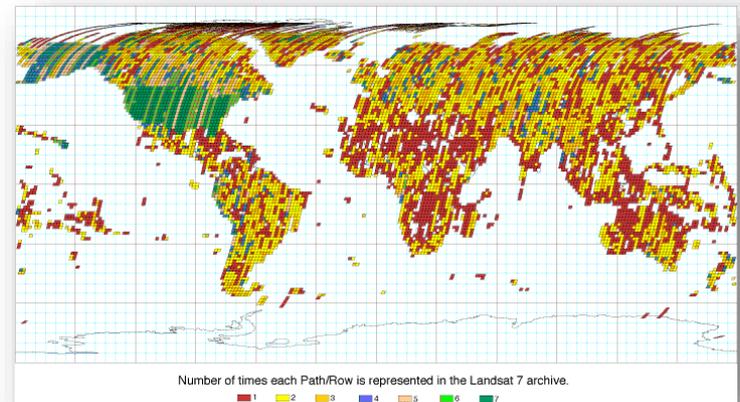
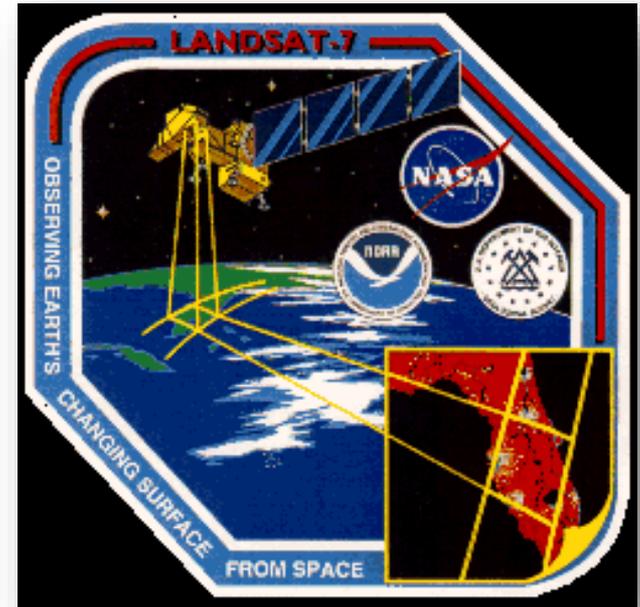
# Large scale remote sensing

- The GIMMS Group: developing global scale land cover datasets from NOAA/ NDVI
- Tucker, Townshend, Justice et al. were developing the continental scale land cover
- Malingreau and others developing tropical deforestation maps from 1 km datasets
- Landsat community also began developing continental scale deforestation mapping for the tropics from 30 m datasets



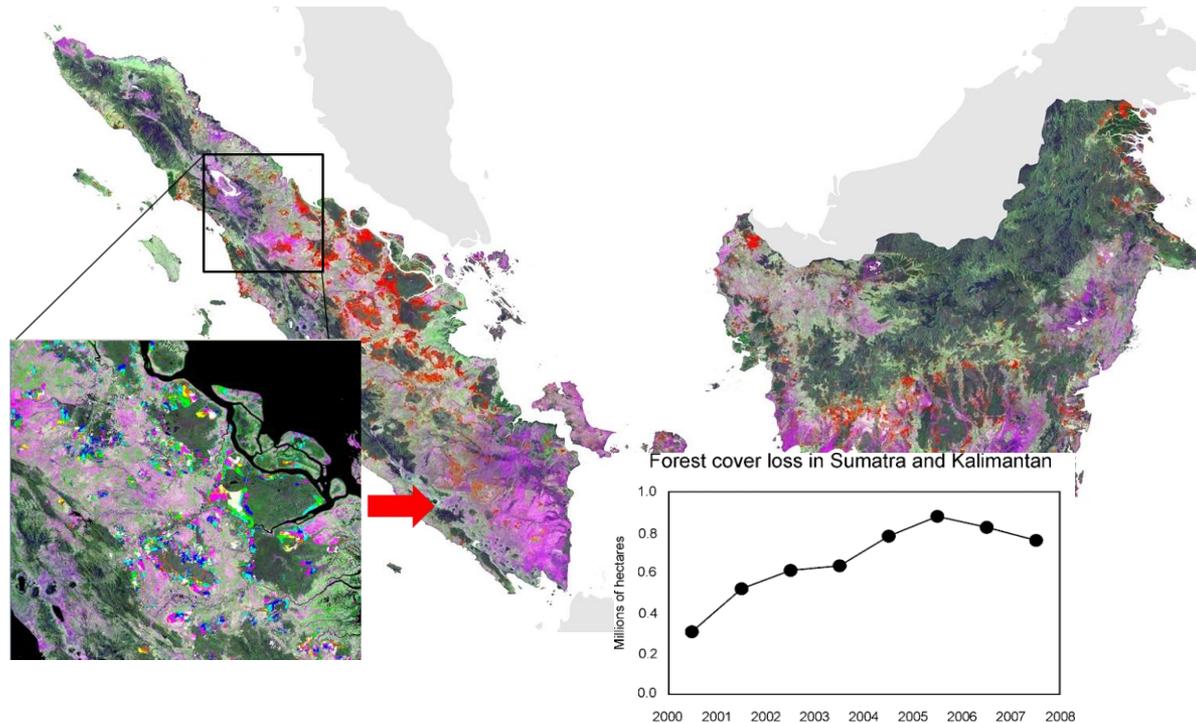
# Remote sensing influences LUCC

- IGBP DIS was developing new international programs around global change monitoring with Earth Observations
- Global processing of 1 km AVHRR datasets
- Early pathfinding for Landsat scale
- Landsat 7 was defined as a global mission 1996



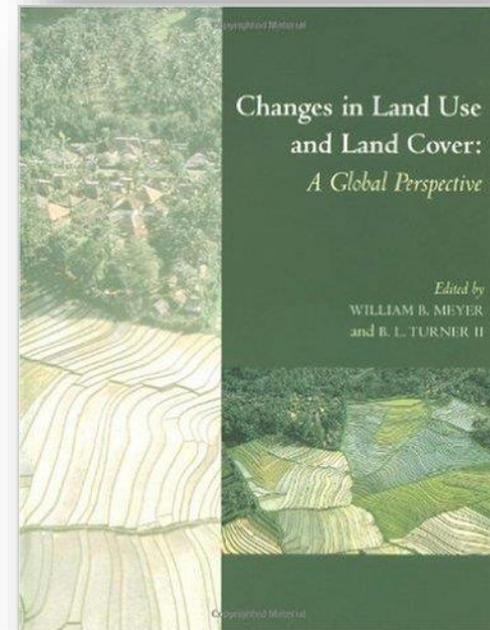
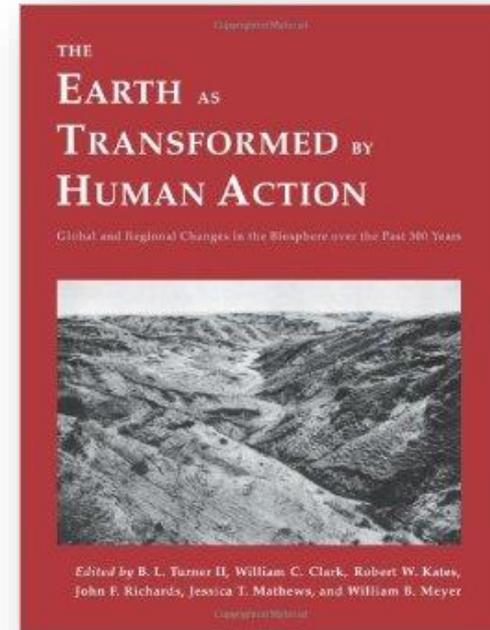
# Datasets and observations

- Experience with 1 km IGBP Land Cover dataset
- Now we are doing that with Landsat with Matt Hansen's work.



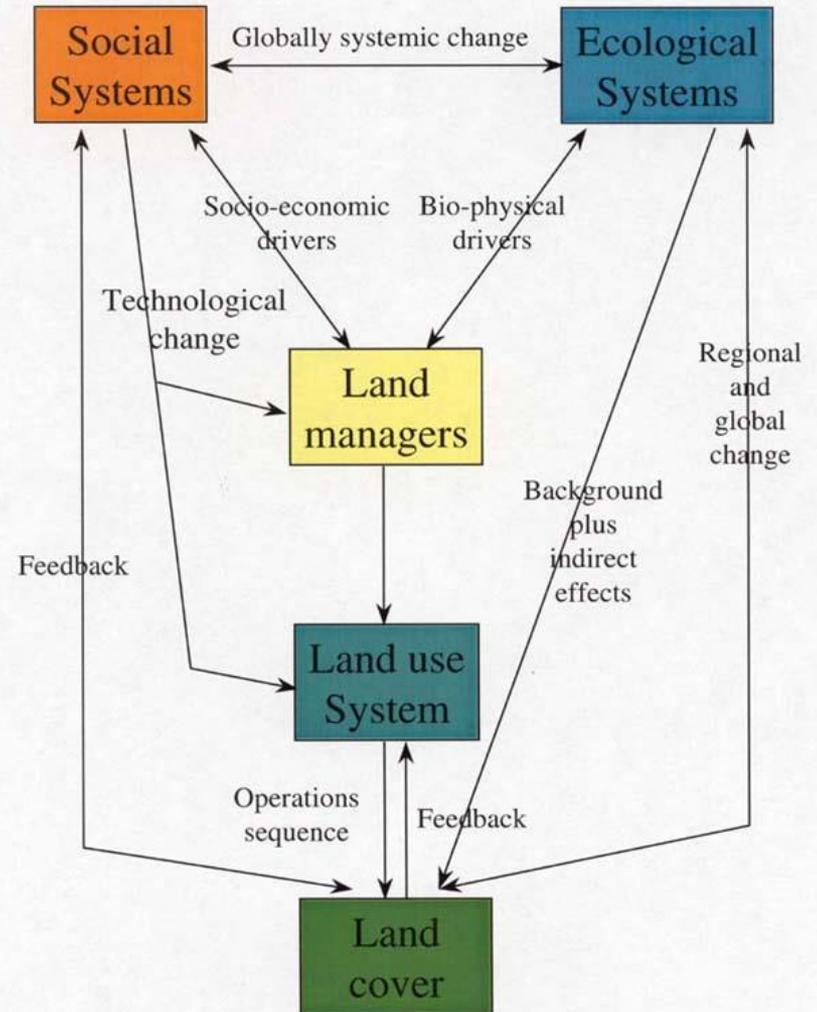
# Land Transformation

- To some degree these Earth Observations and datasets started the community thinking about drivers of these observations
  - The processes behind the patterns
- At the same time: Earth as Transformed by Human Action also 1990
- Snowmass workshop and book, Changes in Land Use and Land Cover → 1994



- The concept was good but early focus on Markov chain models, some agent based models
- How to link the remote sensing with process level understanding

Figure 1.3a



The relationship between bio-physical and socio-economic drivers and other components of the land use-cover system

Source: Adapted from Turner *et al.* (1995)

# Relating Land Use and Global Land Cover Change

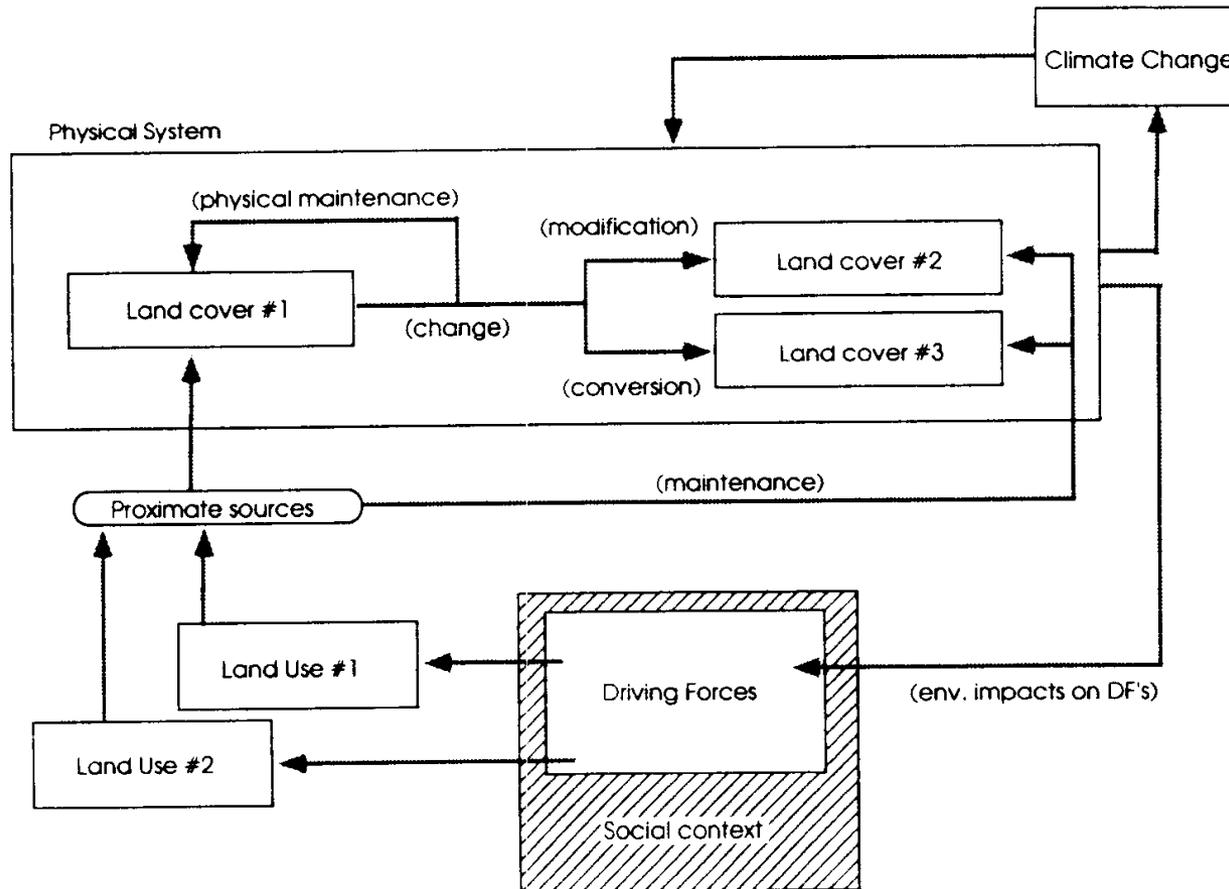
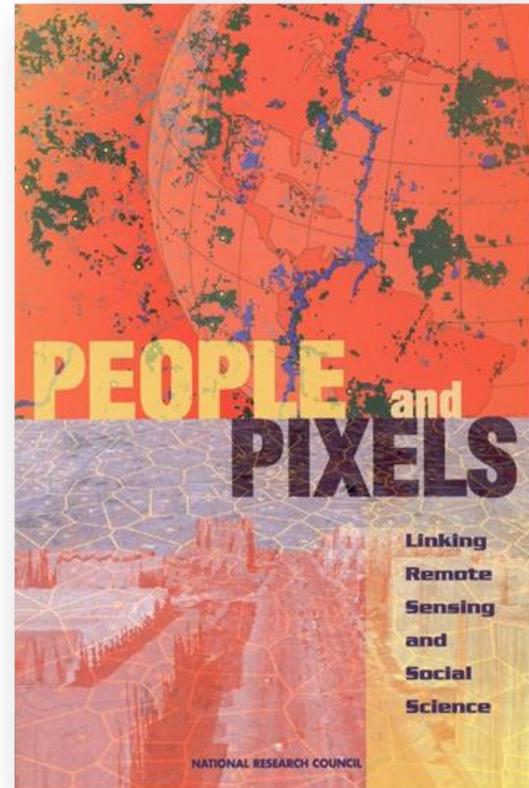


Fig. 2 Linkages among human causes and land use and cover

# Example in the Amazon

- Oil price shocks in the 1970s created a flush of money and liquidity in oil markets and oil exporting economies
- Deposits in commercial banks, which made investments in modernizing Brazilian agriculture.
- Large scale soy beans in the south transformed small holder systems of coffee and black beans
- Displaced landless were provided free land in the Amazon
- Conclusion – both proximate and distant drivers (now teleconnections) of Amazon deforestation were at play.

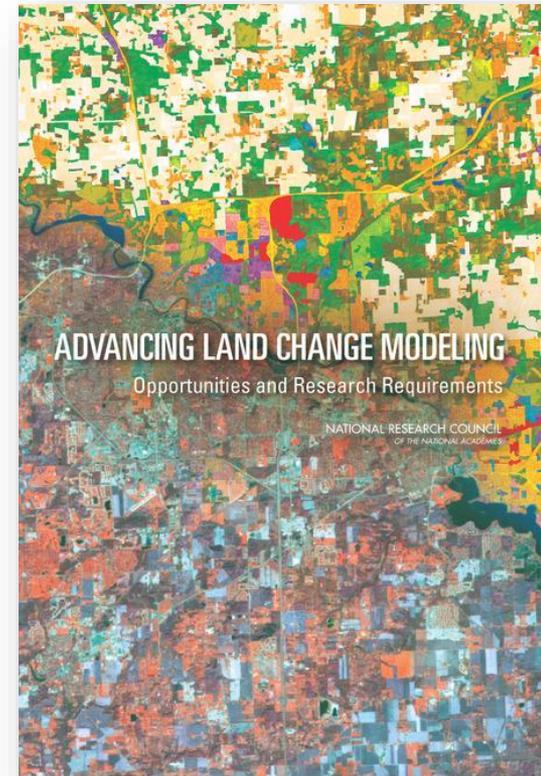
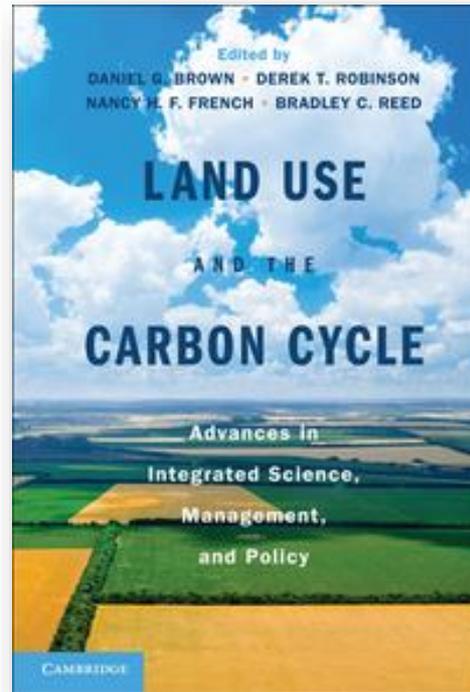


# The stage was set

- IGBP and IHDP Core Project on LUCC
- Snowmass and the book was in some ways a breakthrough.
  - Showed a path for linking social and biophysical sciences in a single interdisciplinary topic important to global change research
  - The USGCRP and International focus was lead by the carbon cycle science community, terrestrial ecosystems, plus atmospheric chemistry and global hydrology
  - LUCC was the ***other*** global change
  - Important in its own right!
  - Note – not until the second ten year plan for USGCRP would LUCC/LCLUC be placed explicitly into it own agenda as single Theme – NB it is no longer.

# LCLUC

- A response to the need for this topic in the USGCRP
- A source of funding for a growing community of scholars in 1996.
- Intensified in with the drafting of the second GCRP Strategic Plan in 2000. LCLUC was a single “Theme”



# LCLUC moves the EO agenda

- On the EO pathway, there have been two major trends:
  - Moving from forest-non forest to a continuum of changes including degradation – e.g. selective logging
  - The inclusion of the urban environment and changes there
- The addition of urban, and other “non frontier” landscapes has been important
- Note about “my dinner with Andre”
- The inclusion of urban and other has in turn driven the LCLUC agenda on the model side – and for other land uses (e.g. IFs)

# LCLUC moves the Process agenda

- The LBA as a major campaign brought to light the need to link pattern to process.
- And linking explicitly observations and process studies with biogeochemistry and the other aspects of global change.
- Focus for interdisciplinary models and understanding of the drivers.
- Campaign gave regional focus
- As did the regional networks, which created a sense of focus on “scales that matter”

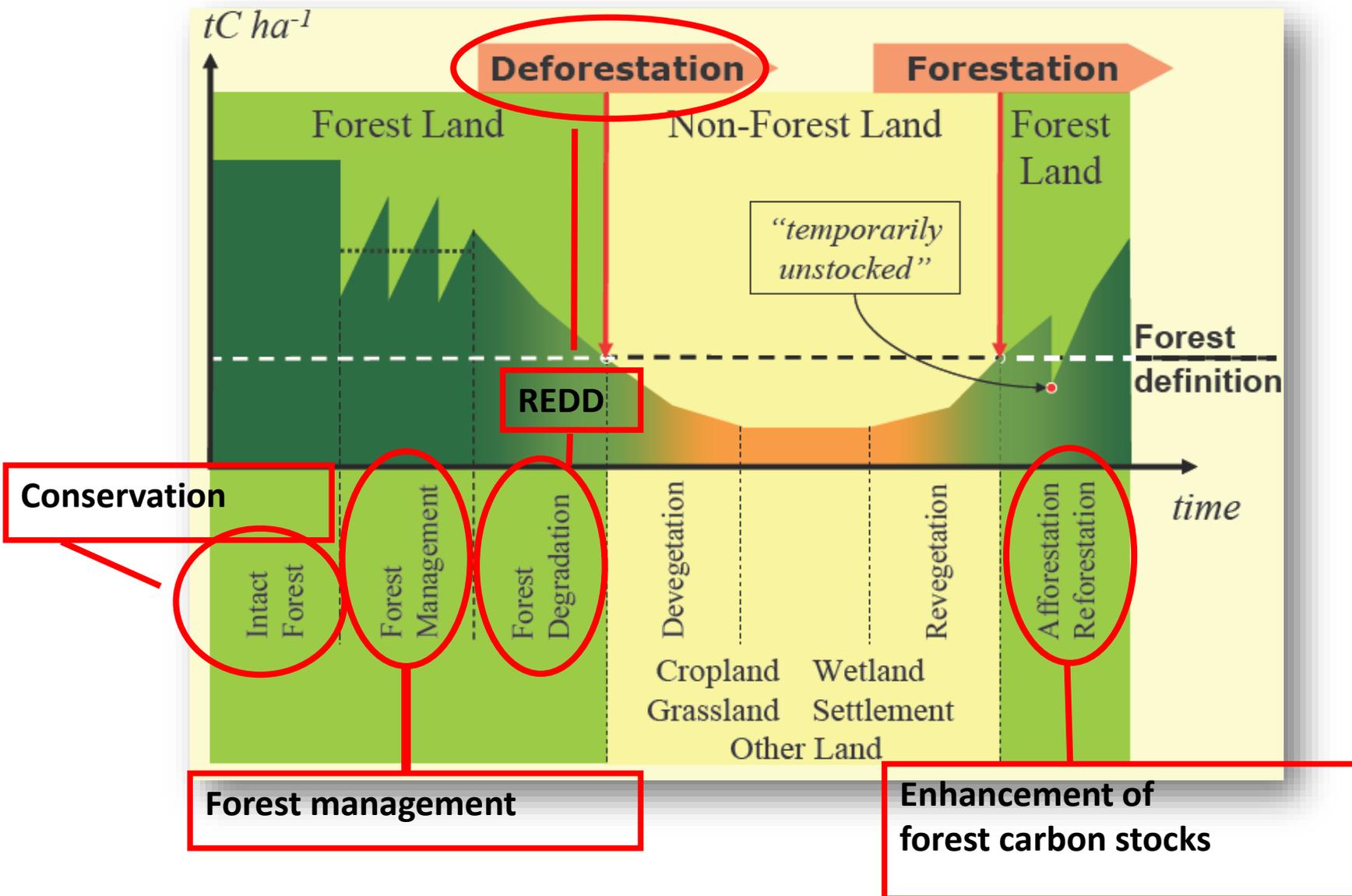
# Where are we now

- Some new and interesting developments:
- Much stronger interdisciplinary community, emerging focal points on teleconnections and moving the science to non-land cover aspects
- The program has left its mark on science. The regional networks cannot be ignored. They have been almost a unique aspect of this program
- This program is providing funding for social science integration like not other agencies are (except perhaps NSF)
- A lot has been achieved but we still find ourselves trying to “make the case”
  - The LCLUC elements of the next Decadal Survey will be shoe horned in with “terrestrial and marine ecosystems and natural resources management”
  - And making the interdisciplinary linkages with the social sciences has been an on going struggle.

# New pathways

- There are two opportunities:
  - Making the science more relevant. Linking closer to policy and applications; to the development agenda
  - Expanding the observations and models outside the comfort zone of closed forest systems.
- The first: making the work link to climate change policy – e.g. REDD+
- The second: developing more observations of open woodlands and managed systems
  - IFs as one area already being tackled
  - But also agricultural landscapes; and not just urban but extending the current urban to settlements
- Trees outside of Forests
- In other words: places where people live

# REDD+ using IPCC definitions



# The Five REDD+ Activities

The scope of REDD+ was agreed in Cancun. Developing countries are encouraged to contribute to mitigation actions in the forest sector by undertaking the following activities:

I. Reducing emissions from deforestation

II. Reducing emissions from forest degradation

III. Conservation of forest carbon stocks

IV. Sustainable management of forests

V. Enhancement of forest carbon stocks

# Three Pillars of a the MRV Function in a National Forest Monitoring System

## **National Forest Inventory**

- Emissions factors
- Field sample plots
- Allometry for carbon

## **Satellite Forest Cover Monitoring**

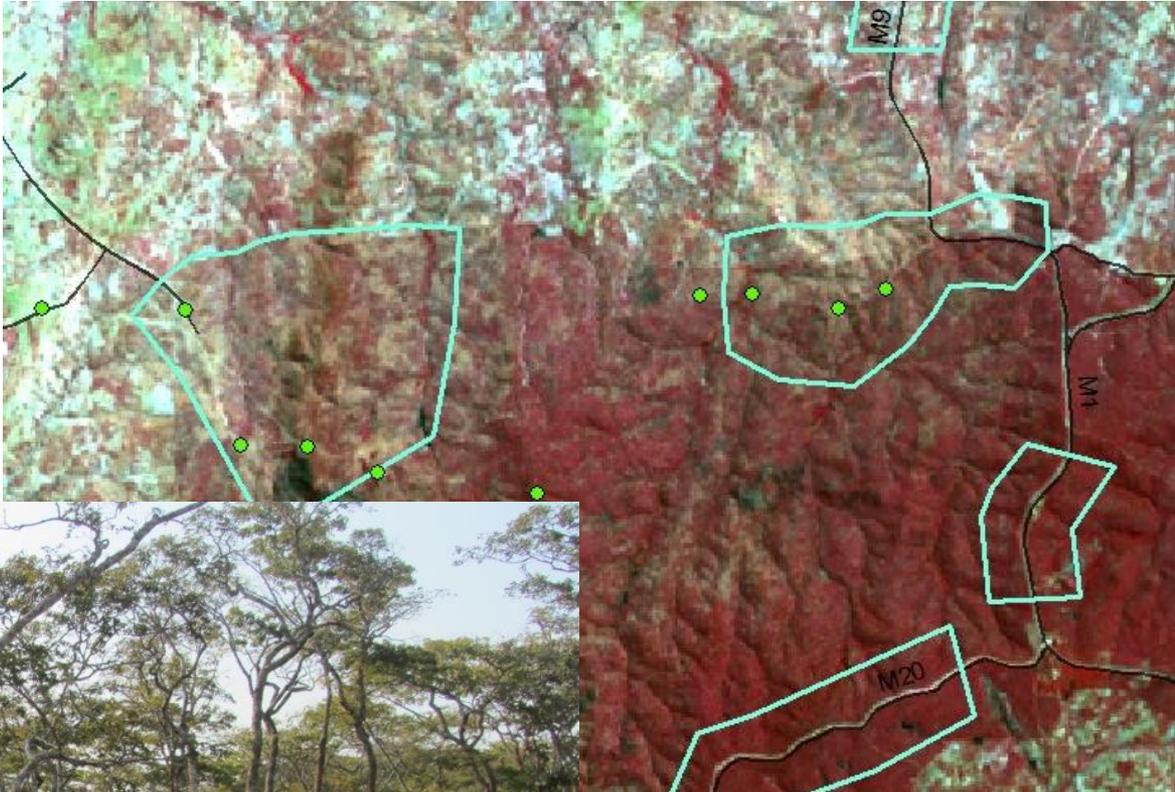
- Activity data
- Deforestation, degradation mapping
- Forest carbon mapping

## **GHG Inventory and Reporting**

- Emissions, removals estimation
- Reporting using standard IPCC
- Tools for computation, data management

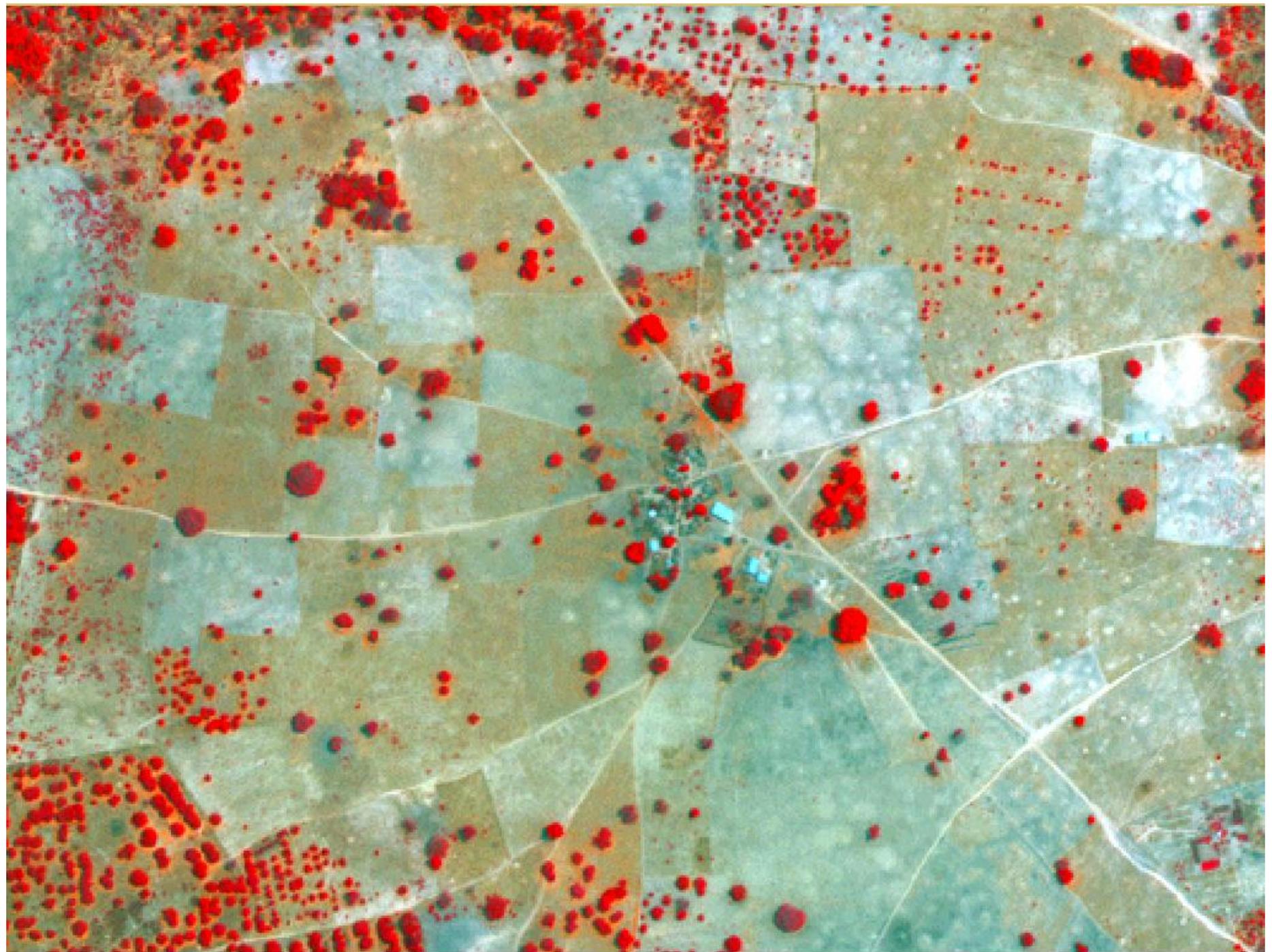


# Degradation of carbon stocks

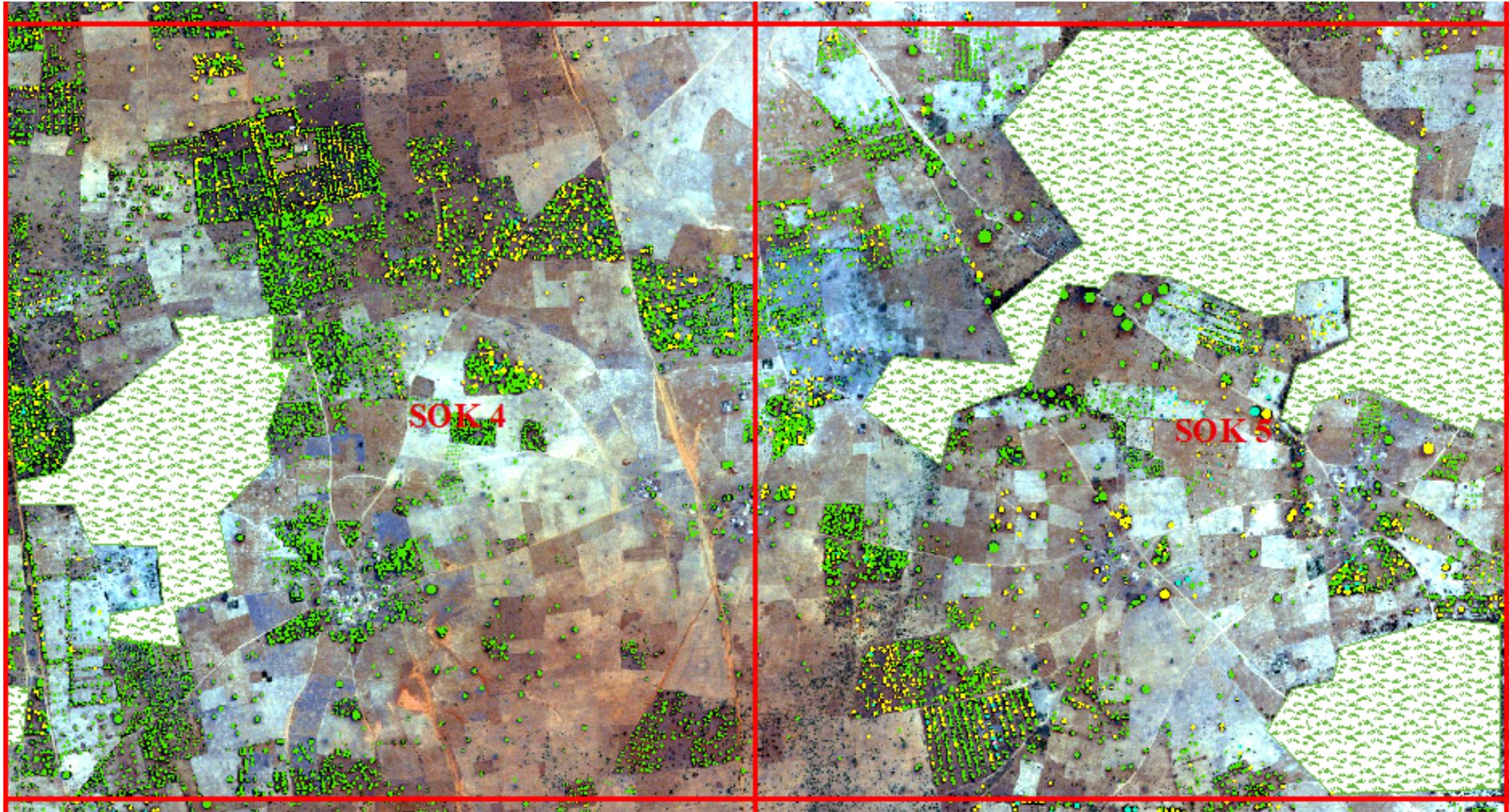


# Woodlands - TOF

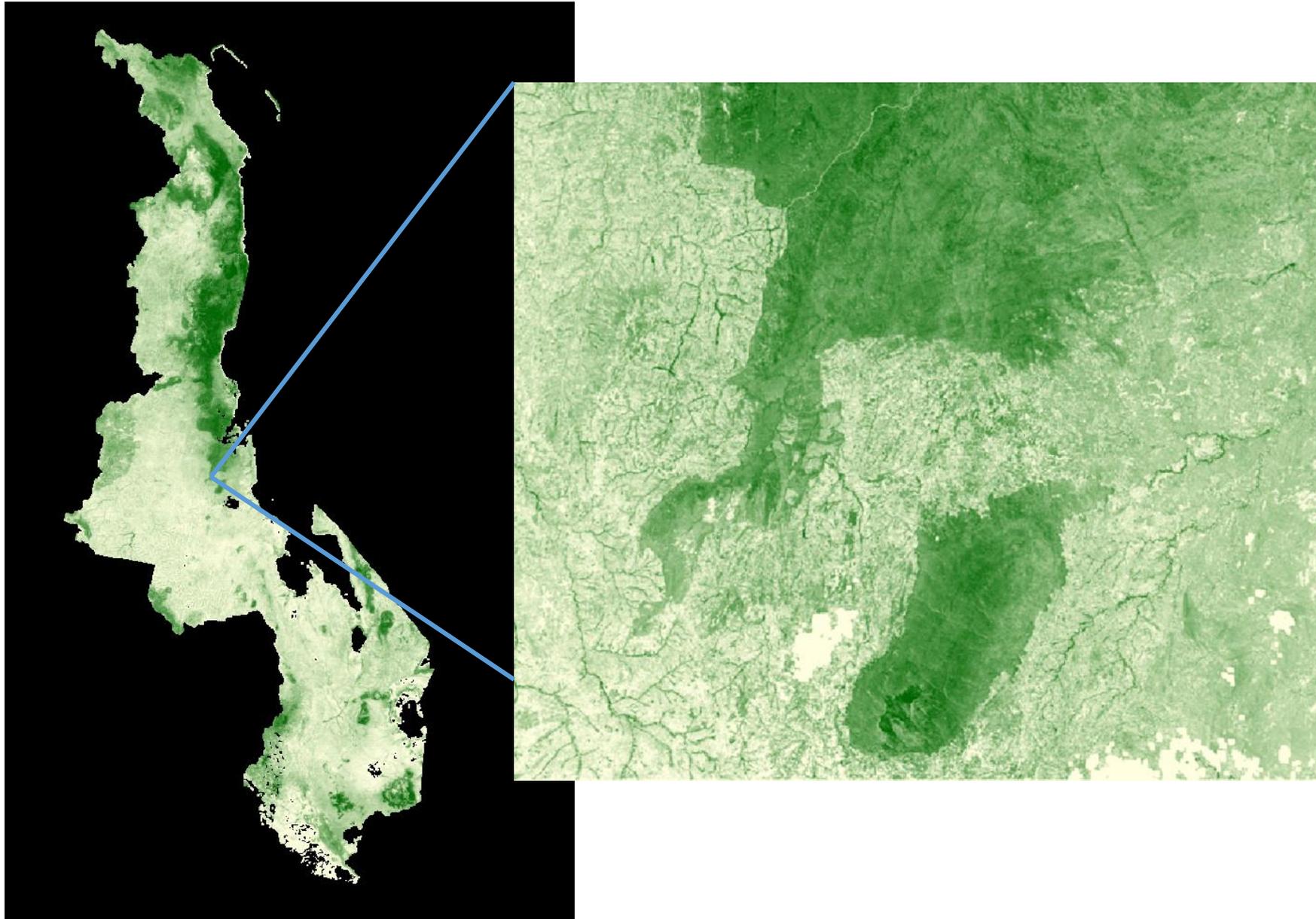




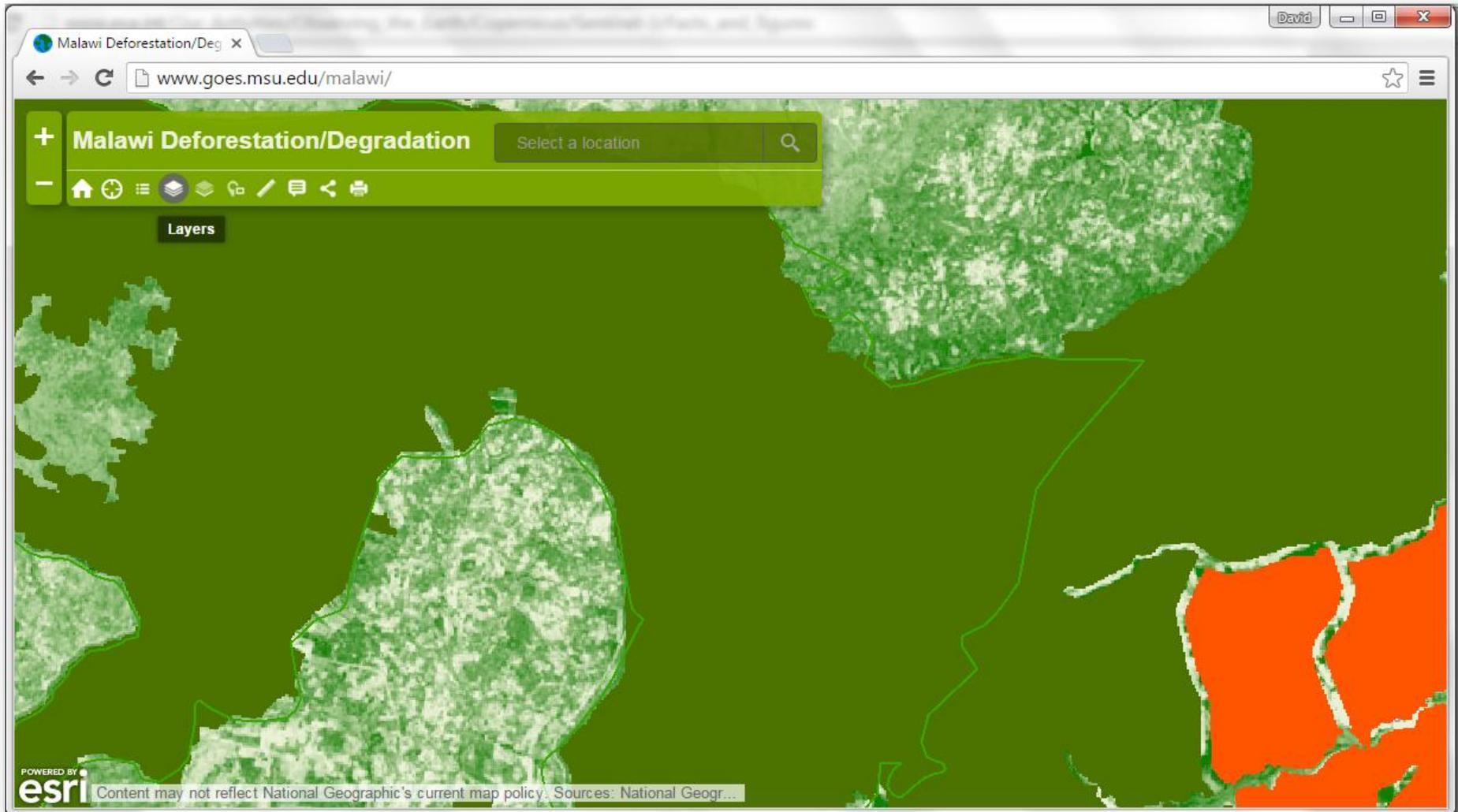
## Carbon map for block 4 & 5 in the Sokone site



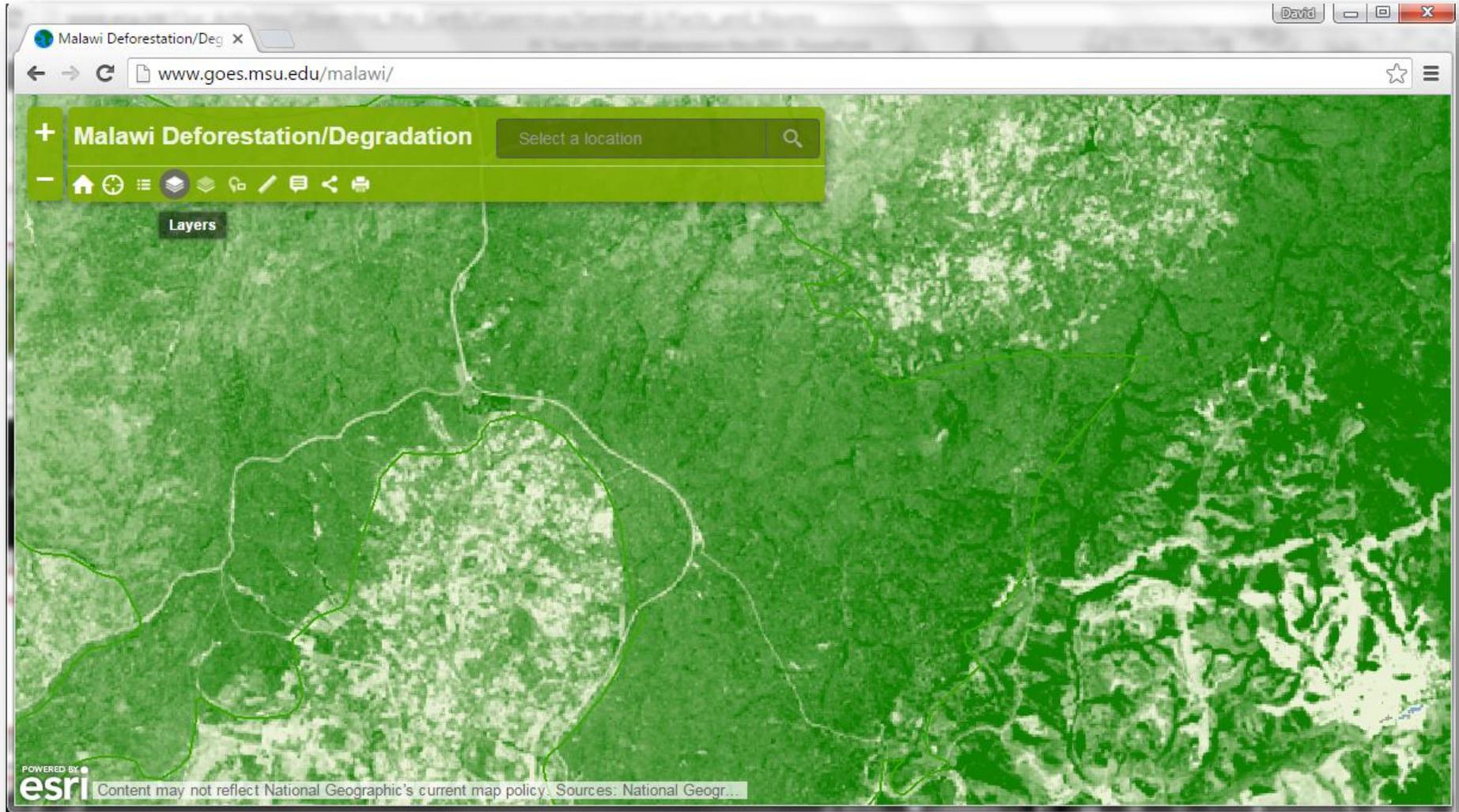
# New 2013-2015 fC Mosaic



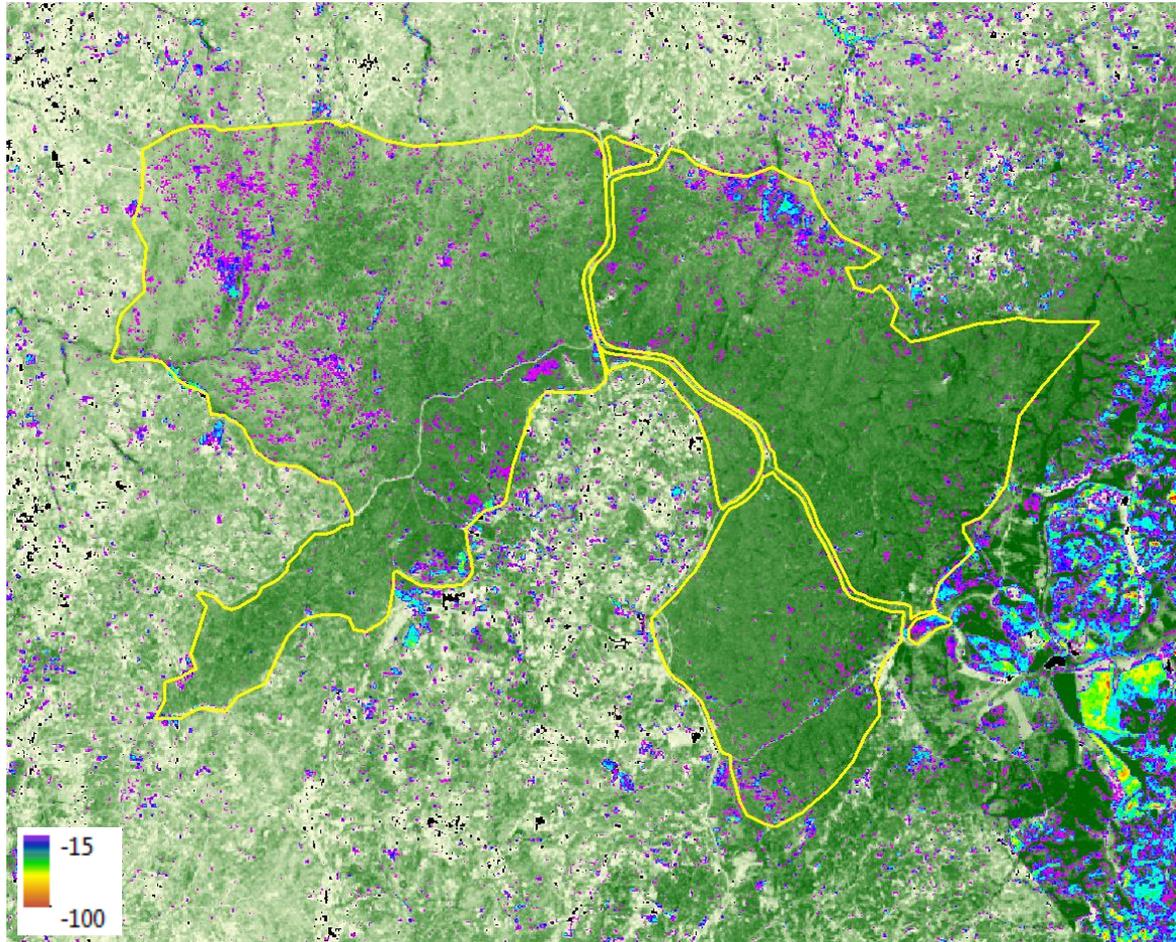
# Malawi National Database



# fC Tool Database



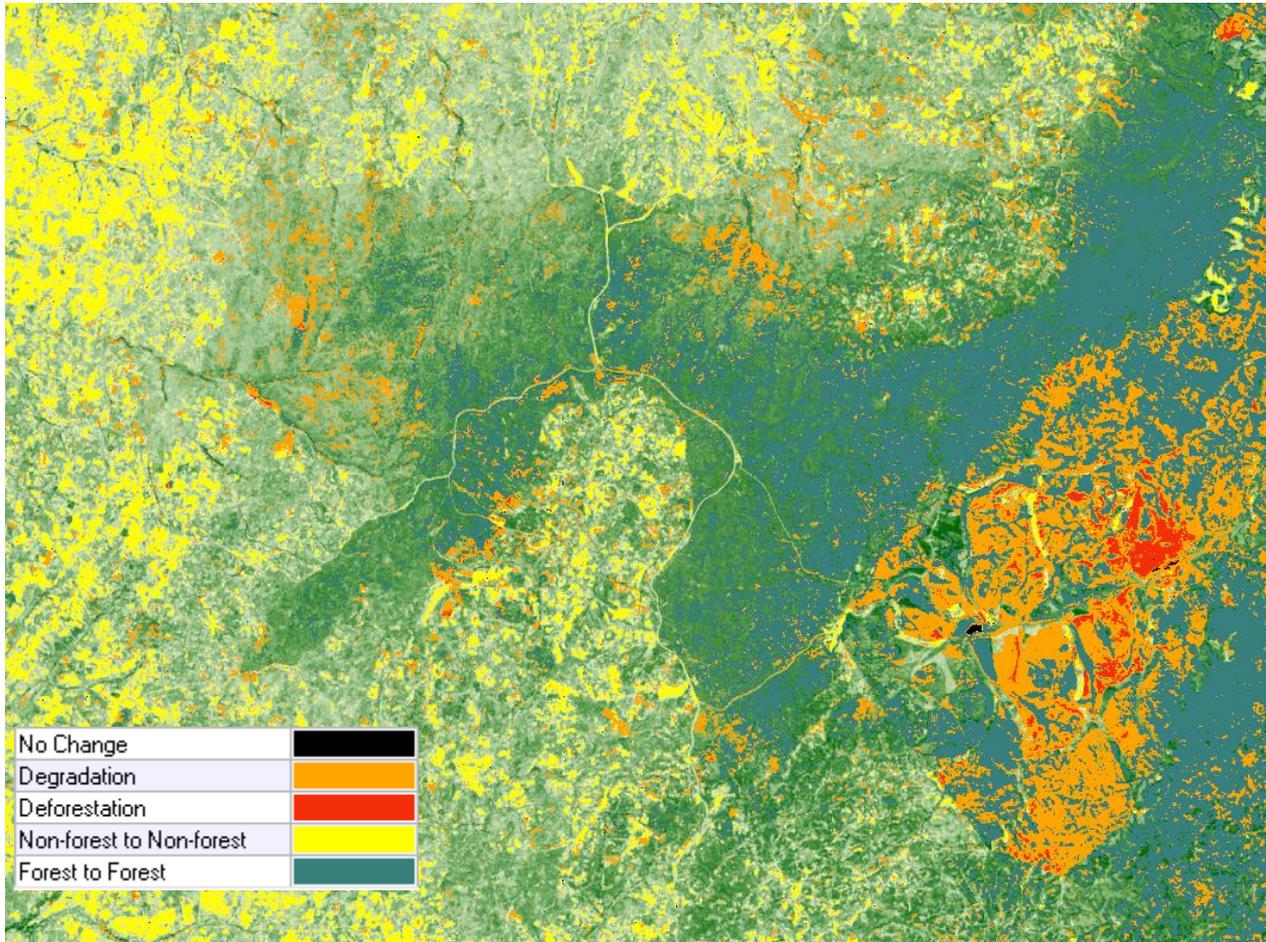
# Perekezi Change 15-100



# Perekezi: Change Algorithm v3 Results

Minimum Detected Change: 15

Non-forest Threshold: 15



# Industrial Forests

- Shifting geography, drivers:
  - Source regions matching demand regions
  - Changes in policies
  - Changes in investments
  - Changes in silvaculture
- But not all places respond as might be expected
  - Indonesia: “chaotic” policies responding to a plethora of drivers: most important “actor” looks like governance and new emphasis on community-located forest enterprises (cf. the HTR’s over the HTI’s)

# Directly supporting climate mitigation actions

- Assessment of current and past rates and locations of deforestation and forest degradation
  - ✓ Identification of “hot spots” to guide household surveys and focus group interviews down to village level
  - ✓ Identification and quantification of types of forest change
  - ✓ Creates a framework for Activity Data for both Deforestation and Degradation
- Other uses:
  - Measurement and mapping of Activity Data for estimation of GHG, and monitoring
  - Supports baseline estimation and RELs
  - Measurement of Emission Factors based on forest carbon stocks AGB mapping
  - Creating a basis for the Field Inventory plot allocations – pre-sample requirements in conjunction with the sample estimator tool

# The (new) “Other” Global Change

- Whats going on at NSF
  - Three areas: improving forecasts, changing the forecast through active design, and enabling the future
- A time in which human society and technology are increasing the pace and rate of environmental change in ways for which no precedent exists,
- Human systems are becoming dominant forces in ecosystems and the environment resulting in novel landscapes, natural and managed ecosystems,



# The (new) other global change

- So linking pattern to process is no longer good enough.
- The patterns have to be better, for sure
  - Land transformation beyond converting forests
  - Settlements, urban areas, and other managed landscapes
  - The agricultural landscape is important
- But the processes are more complex, if not more interesting:
  - Coupling LCLUC to policy needs, Not just REDD+ MRV, but also governance, poverty and other development goals
  - Understanding a globally teleconnected world, which is (by the way) not new, but perhaps the community is now ready.

