



Independent  
Evaluation Office  
GLOBAL ENVIRONMENT FACILITY

# Geospatial approaches and use of computational social science methods

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Shanghai International Program for Development Evaluation Training, November 25, 2019

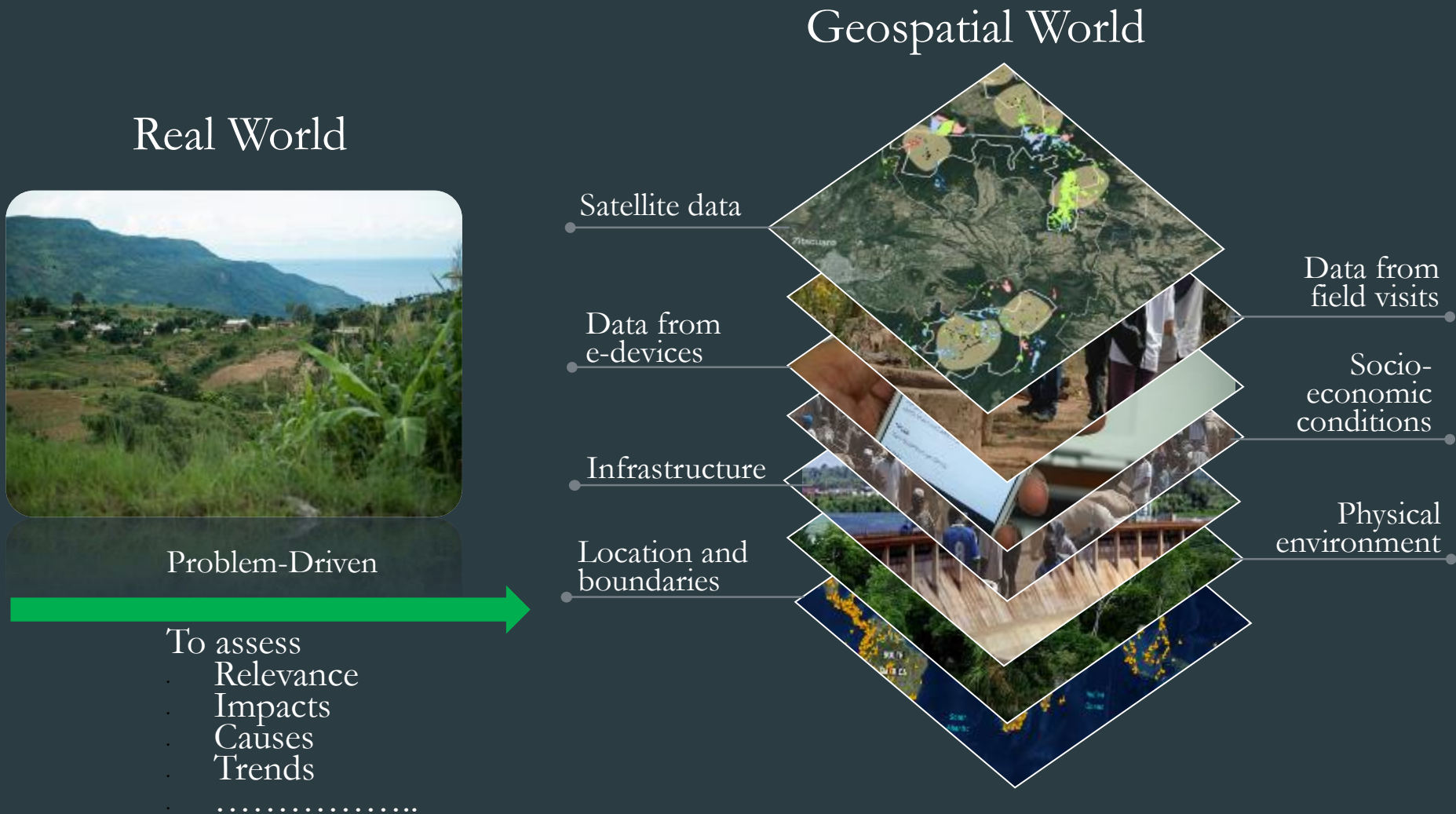


# Learning Objectives

- ❑ What is Geospatial Analysis, Remote Sensing?
- ❑ What is computational social science
- ❑ Why use these in Evaluation?
- ❑ Evaluation Questions we can address with these methods
- ❑ Application in environmental evaluations
- ❑ Challenges and Lessons



# What is geospatial analysis?



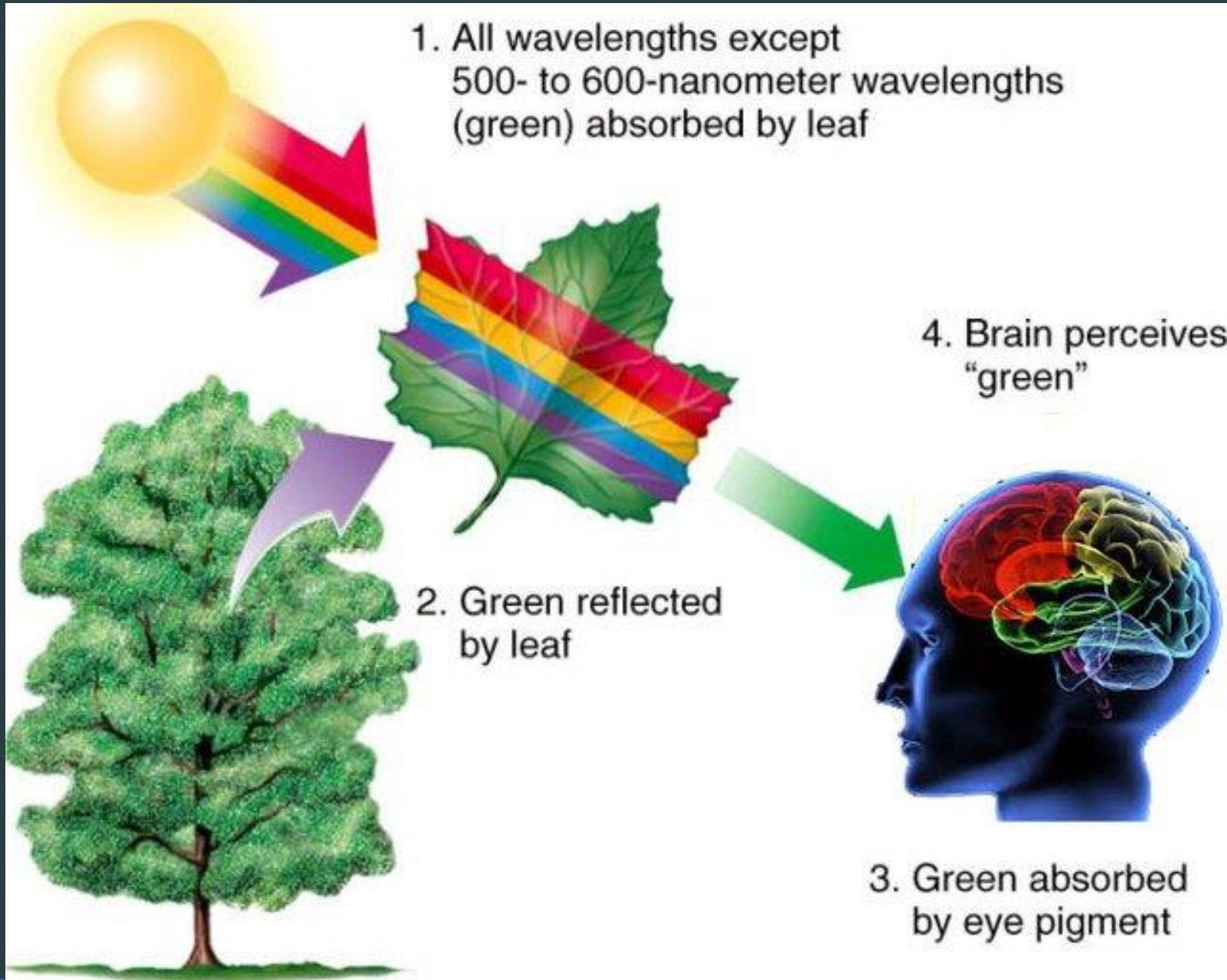
**Spatial analysis** focuses on the *statistical analysis* of patterns and underlying processes

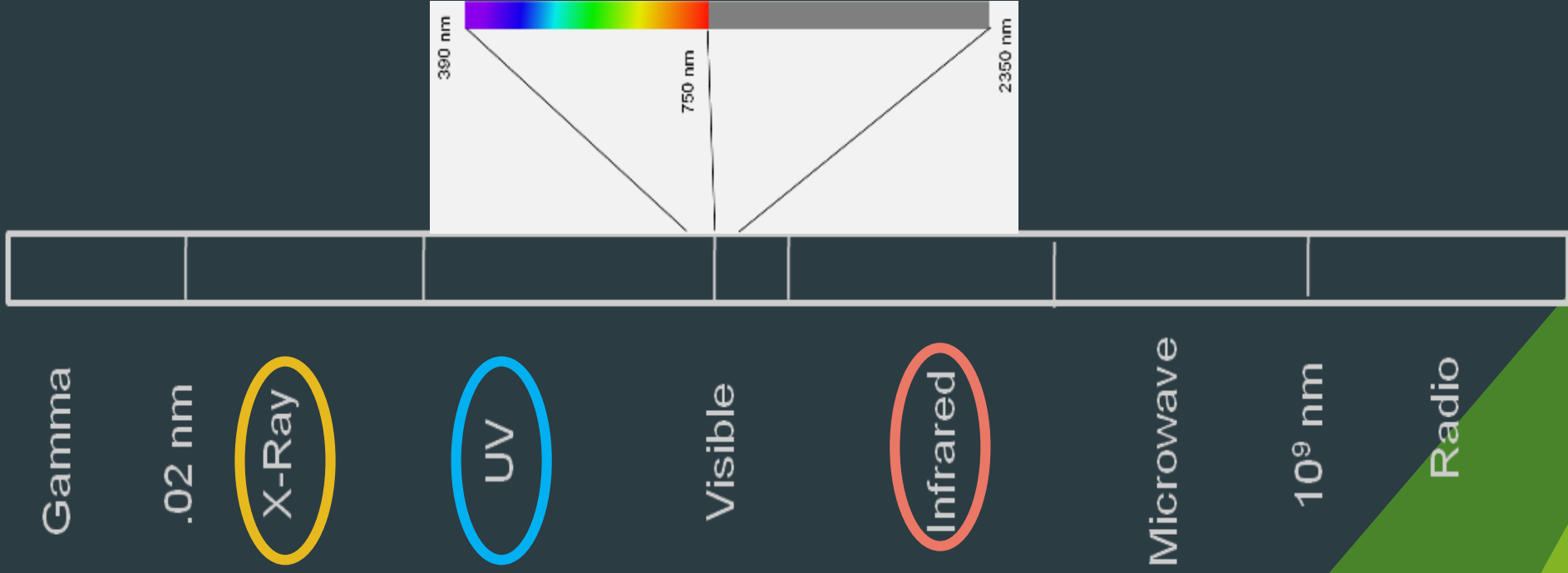
# What is Remote Sensing

- Remote Sensing is the science of **IDENTIFYING**, **OBSERVING, COLLECTING** and **MEASURING** objects without coming into direct contact with them. Similar to humans and animals using eyes, or other senses.
- Satellites record the *electromagnetic energy* reflected or emitted from objects on Earth.









# Gamma Ray Exposure

**Before**

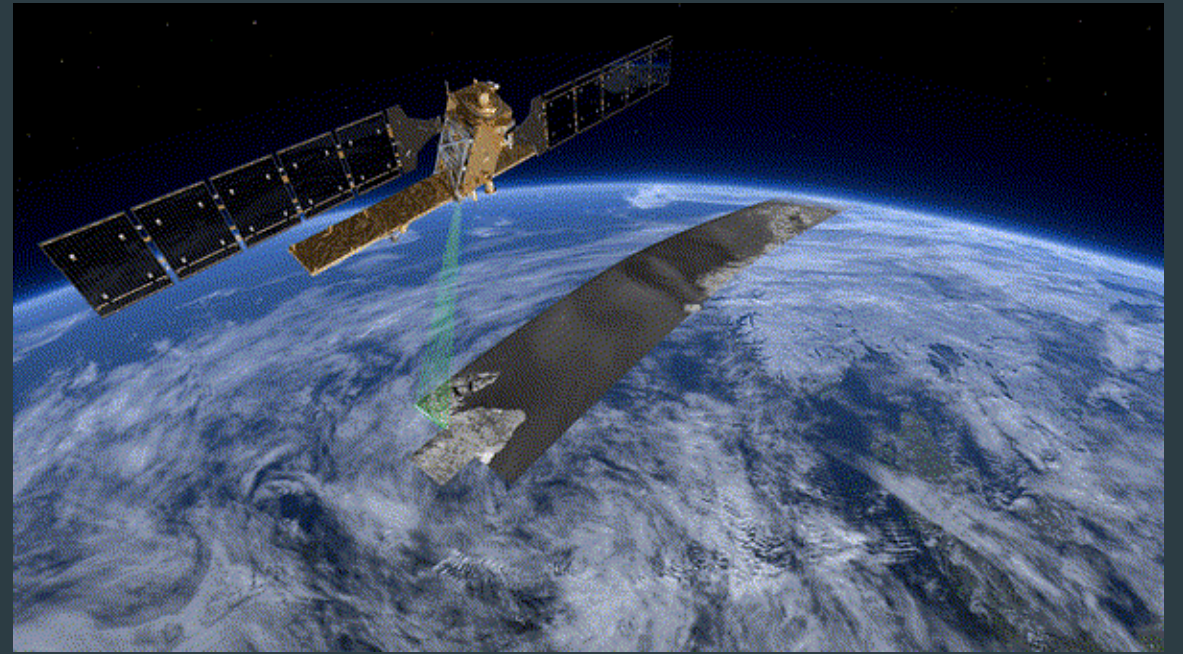
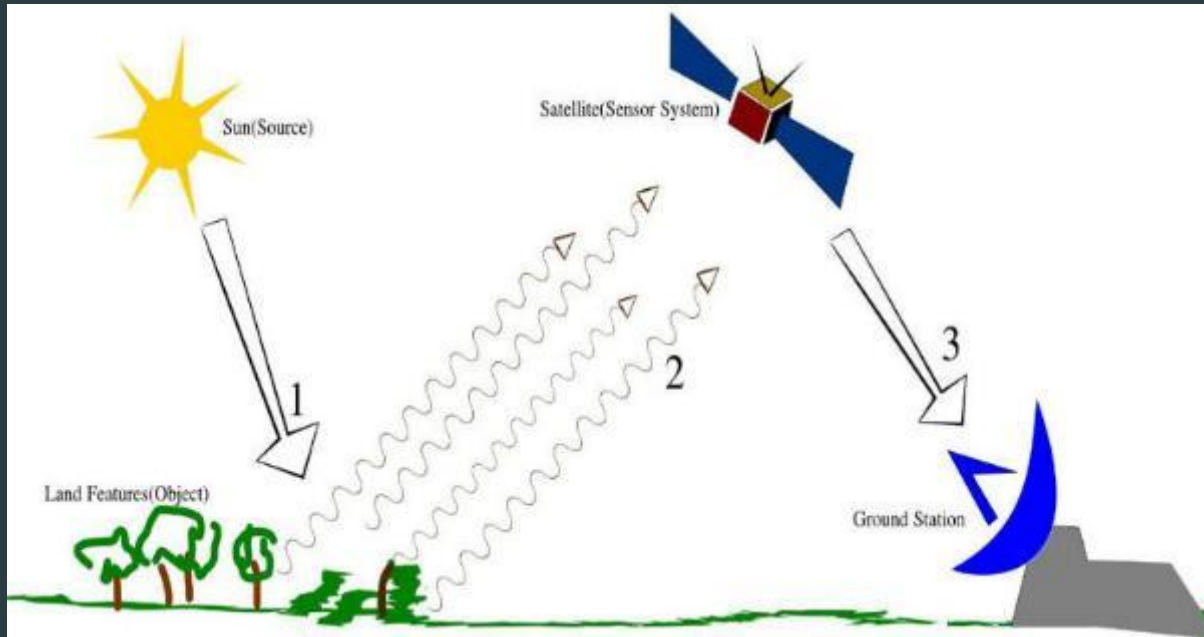
**After**



**Bruce Banner**

**Hulk**

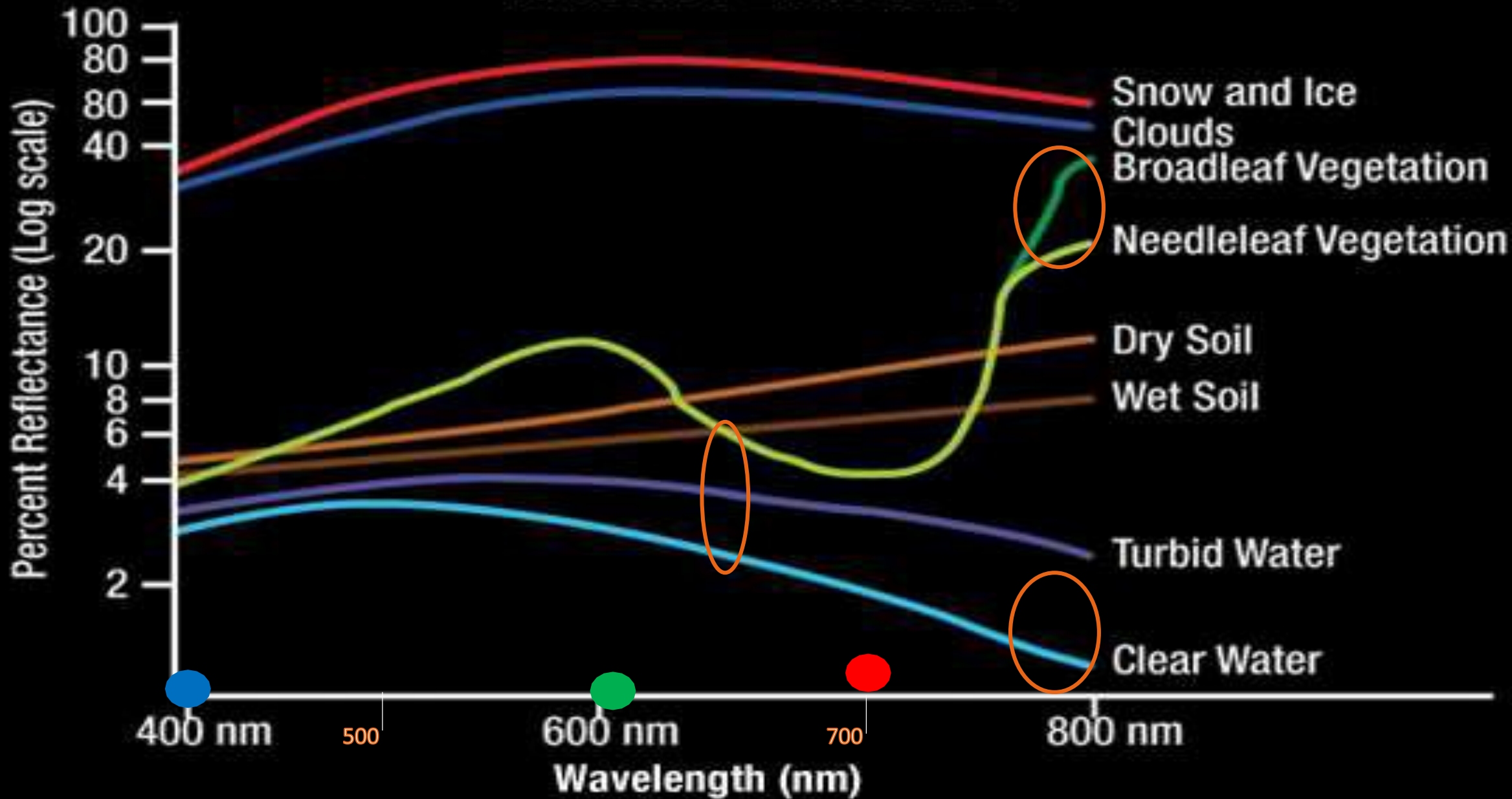








# SPECTRAL SIGNATURES OF EARTH FEATURES







Visible



Infrared

# Geographic Information System (GIS)

Geographic Information System (GIS) is a computer system build to capture, store, manipulate, analyze, manage and display all kinds of spatial or geographical data.



# Why use these in evaluation?



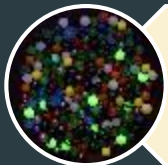
Efficiency



Analysis at different scales



Aiding objectivity and transparency



Applicable to variety of evaluation methods



Helps deal with methodological challenges



# SDGs and remote sensing



Credit: ESA

Source: ESA

Data from satellite imagery and sensor networks make environment and development indicators increasingly measurable

# Satellite Data revolution

## Application in Multiple Areas



Tambopata National Reserve, Peru

- **1,400 active satellites**
- **Many more planned**
- **High resolution data available**

# Questions we seek to answer through evaluation

- ▶ **Relevance of the intervention-** is it in the right context?
- ▶ **Is it effective** -Trends in performance and impacts
- ▶ **Factors associated** with impact
- ▶ **Sustainable**-Likelihood of sustaining the benefits
- ▶ Does the intervention deliver **value for money**?



A photograph of a savanna landscape. In the foreground on the left, an elephant is walking towards the right, carrying a platform with three people (two women and one man) on its back. In the middle ground on the right, a rhinoceros is walking towards the left. The background consists of tall grasses and a line of trees under a clear sky. The word "Biodiversity" is written in white text in the center of the image.

# Biodiversity





Which landscape would you prioritize protecting?



A



B

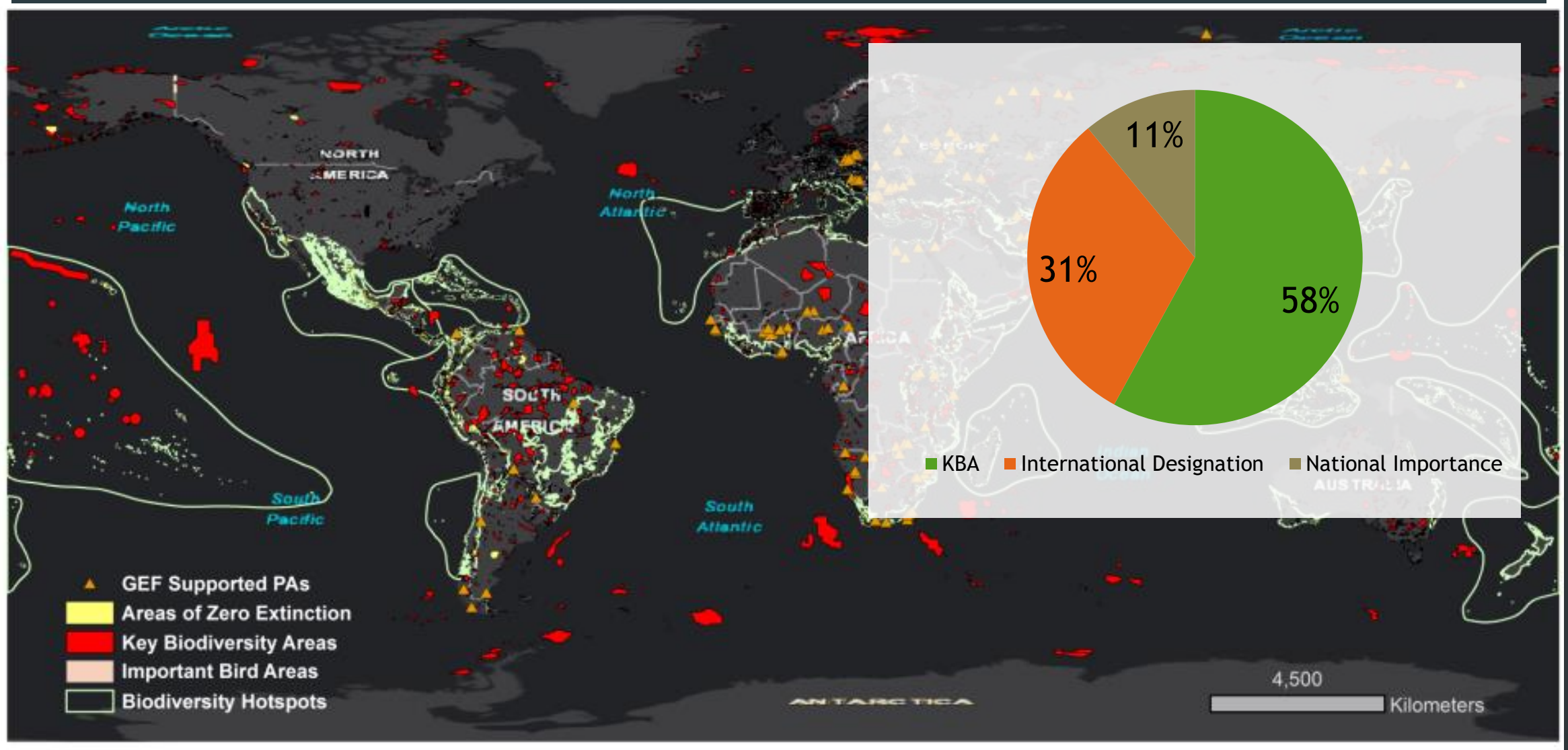






# Biodiversity: Relevance

Study the impact of GEF support to 1292 global protected areas across 147 countries





# Which project has been effective in avoiding deforestation?



2010: Start of the Project



2015: End of the Project



Project Alpha

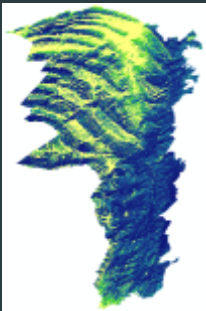
Project Delta

# Forest Cover Change Analysis: Impact

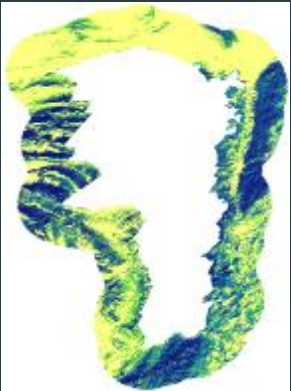


Percent Tree Cover (2000)

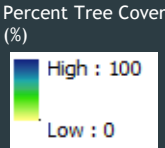
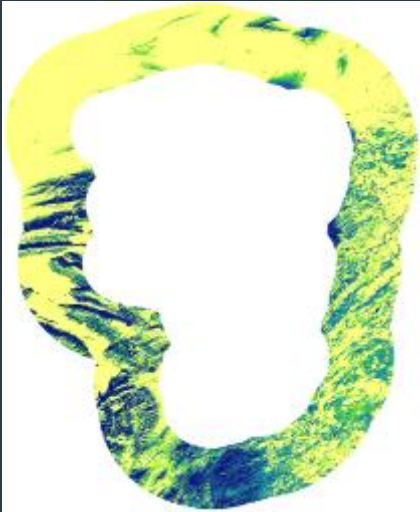
PA



PA - 10km



PA - 25km(excluding the inner)



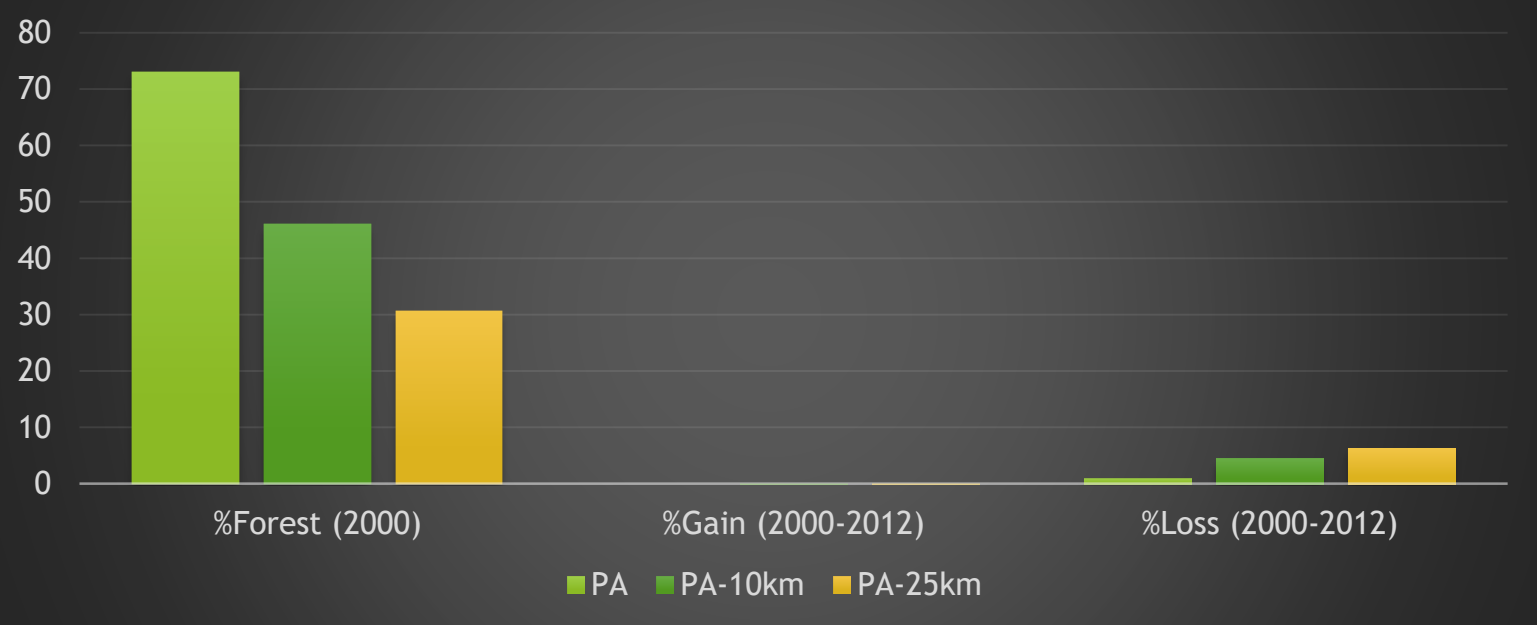
## Cumbres de Monterrey, Mexico



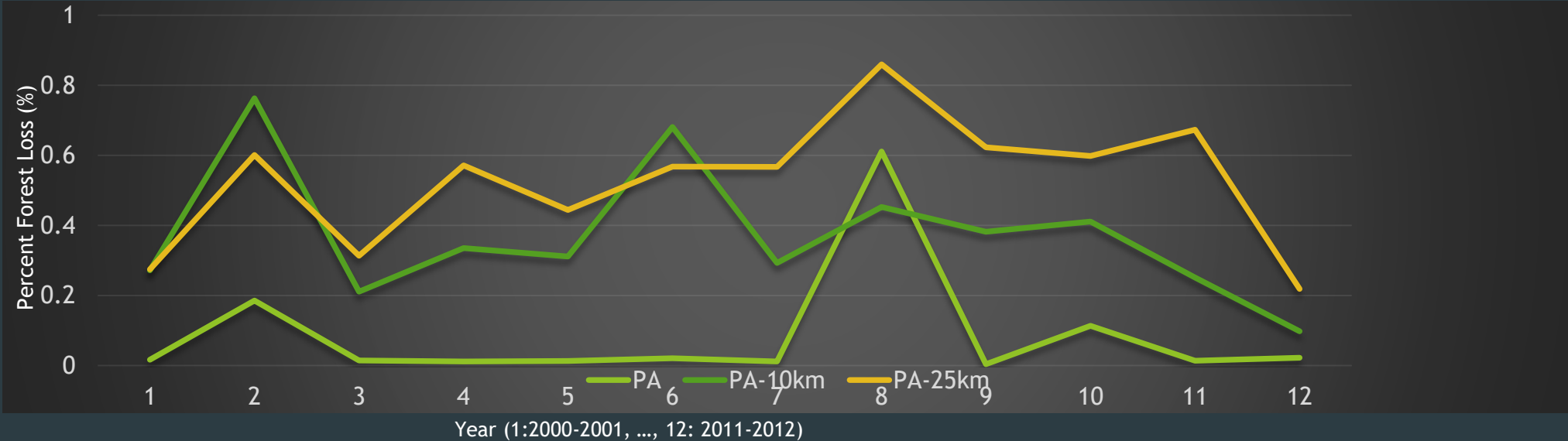
# Forest Cover Change Analysis: Impact



Decadal Forest Cover, Gain and Loss (2000 – 2012)

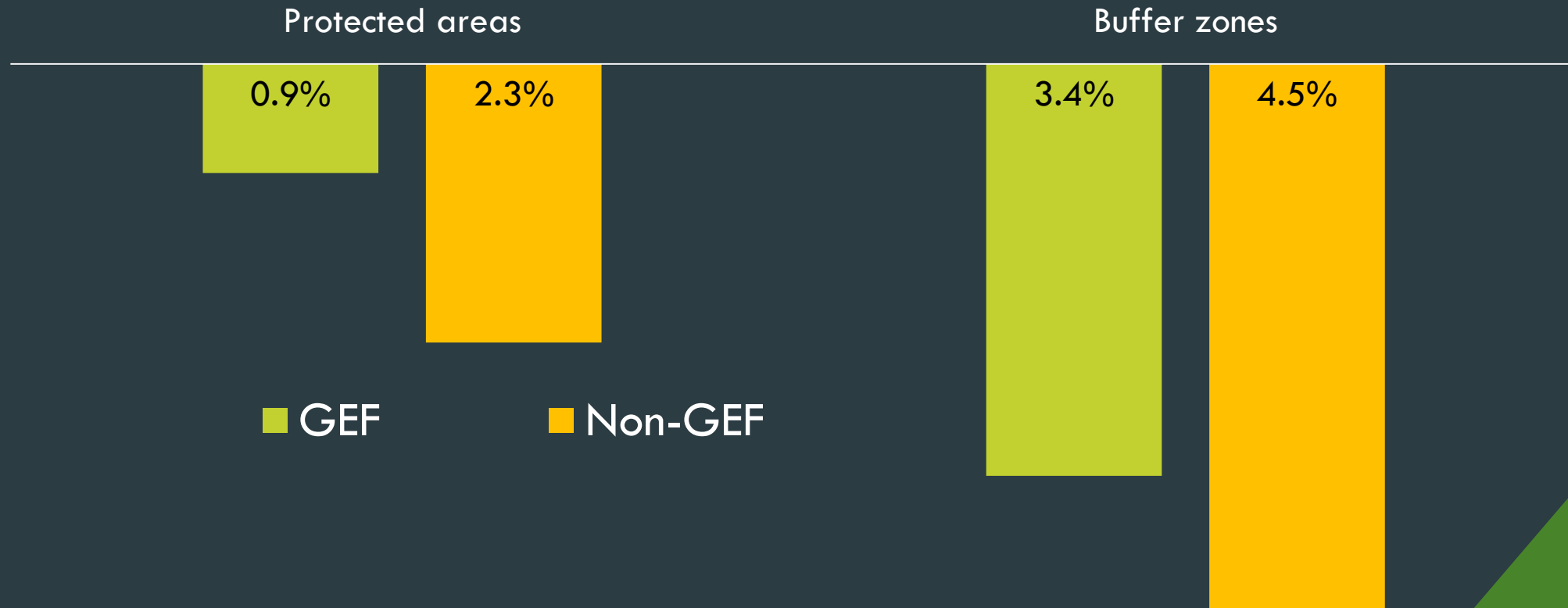


Yearly Percent of Forest Loss (2000 – 2012)



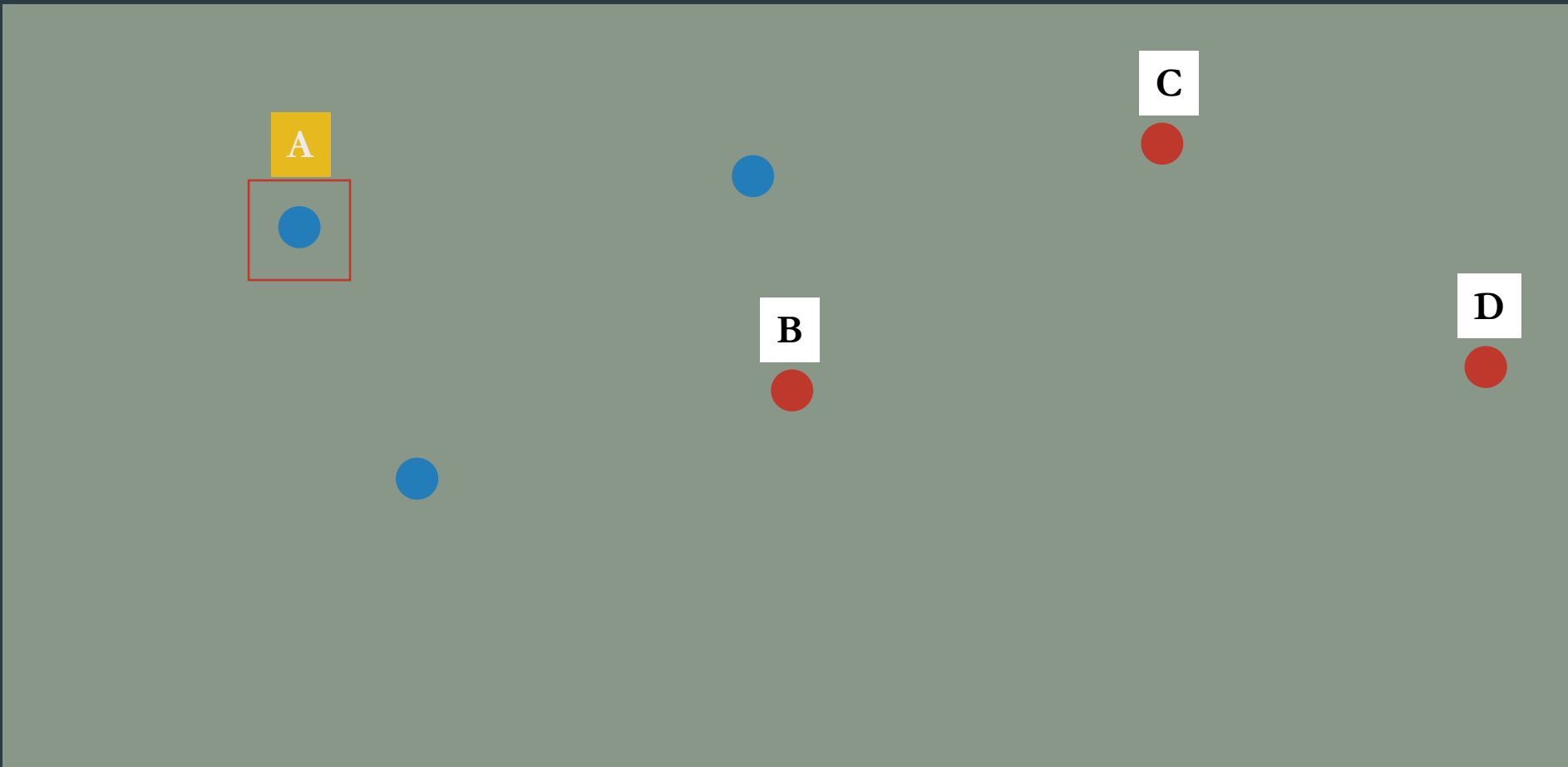
# Biodiversity: Global Analysis

## Forest cover loss (2000-2012)





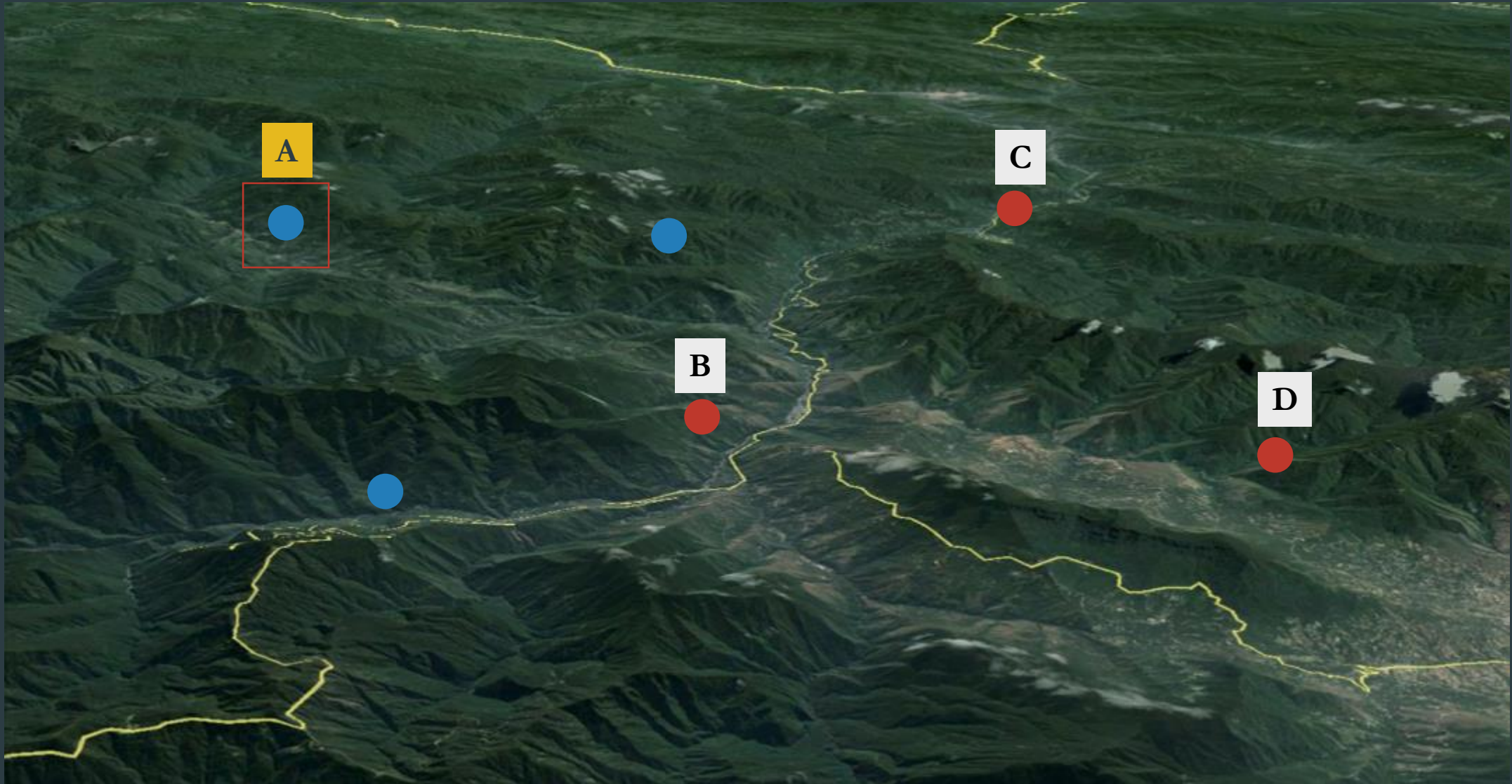
# Finding the right counterfactual ?



● GEF forestry project(Treatment)

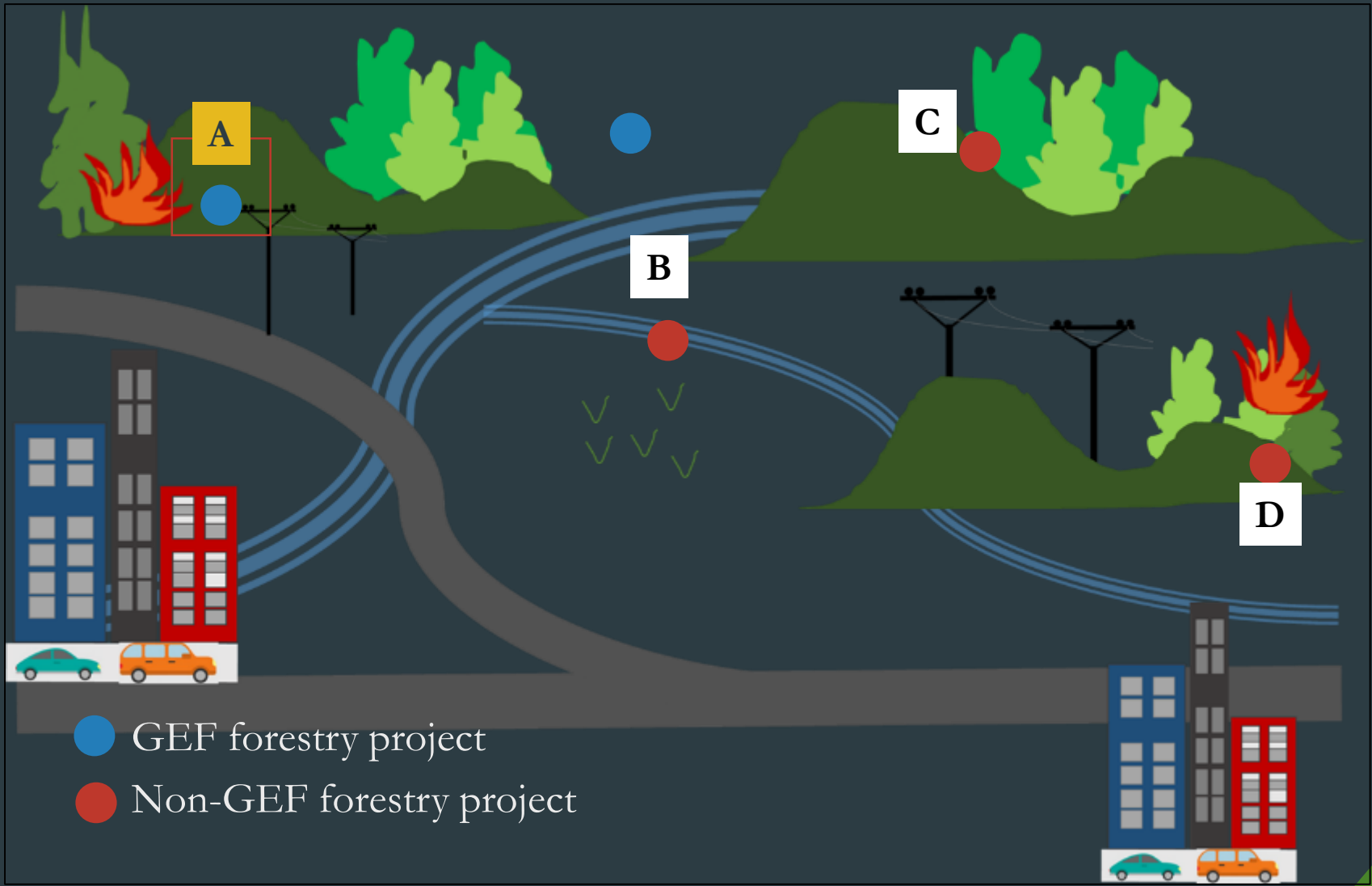
● Non-GEF forestry project(Control)

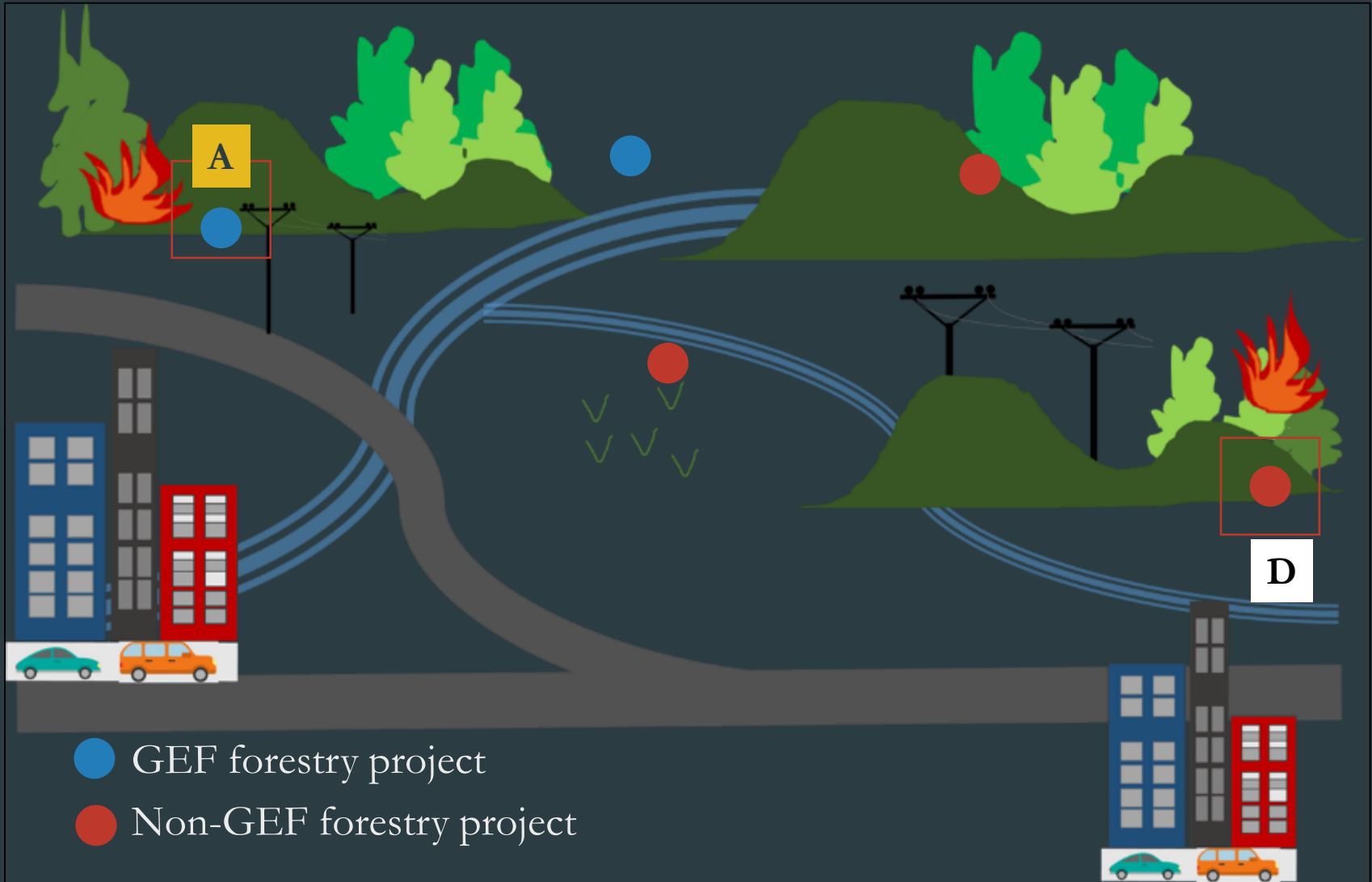




● GEF forestry project(Treatment)

● Non-GEF forestry project(Control)

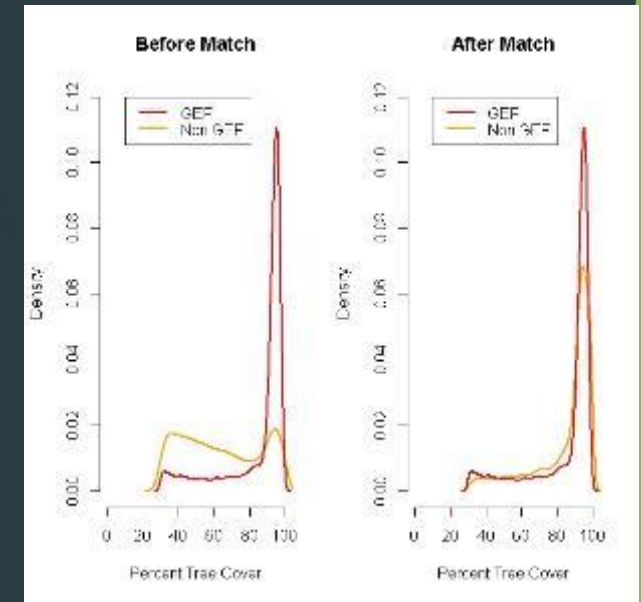
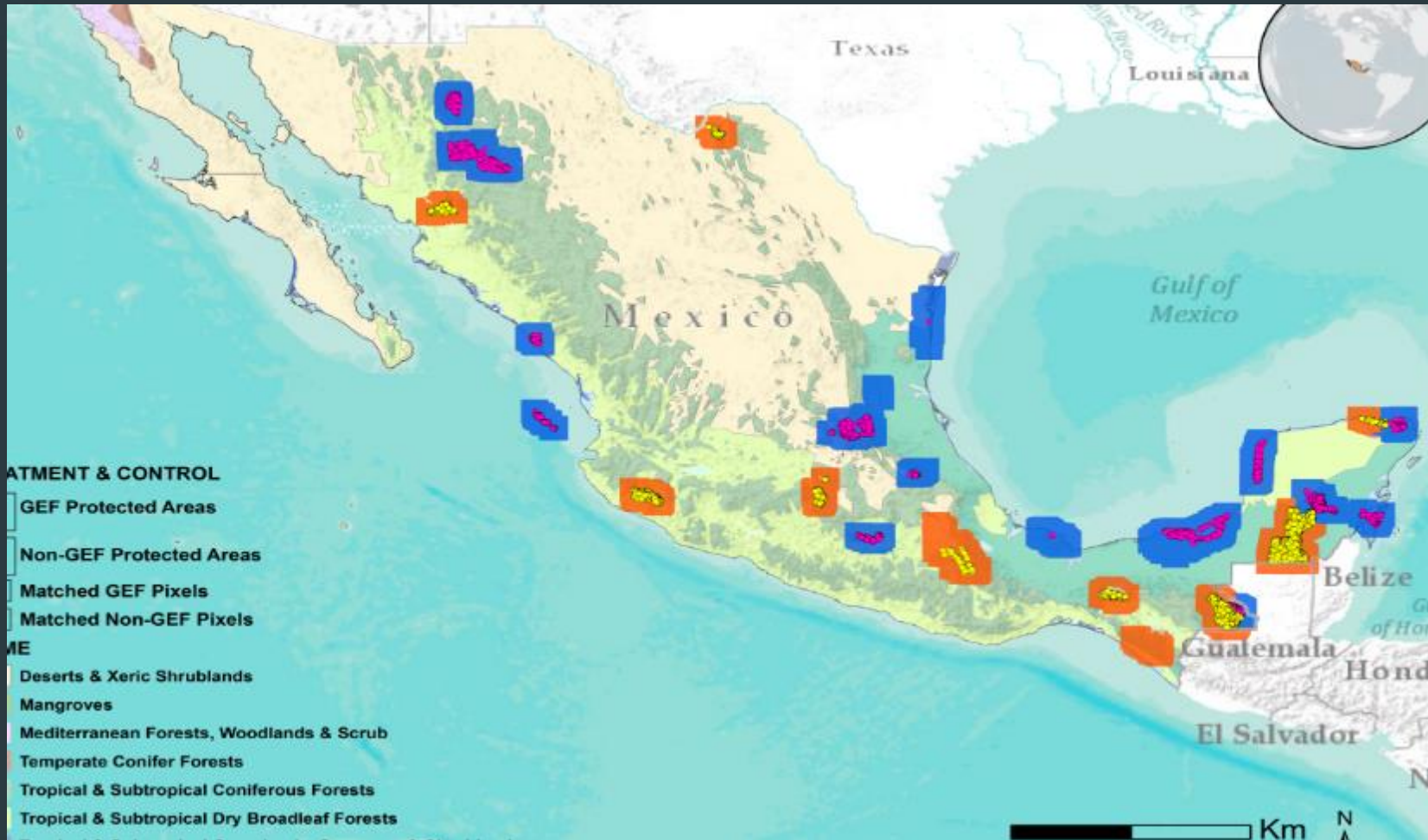




- GEF forestry project
- Non-GEF forestry project



# Did the intervention cause the change?



GEF-supported PAs have  
23% less forest loss

Quasi-experimental evaluation design based on Propensity score matching



An aerial photograph of a semi-arid landscape. The terrain is dry and sandy, with scattered, small, dark green trees and shrubs. In the lower center, there is a small, rectangular building complex with a flat roof and some structural elements. A paved road or path runs horizontally across the lower third of the image, passing near the building. The overall scene suggests a rural or agricultural area in a dry climate.

# GEF Land Degradation and SFM Projects



Distribution of GEF  
land degradation projects



# Methodology

- Analysis both at portfolio level, and case study at country level



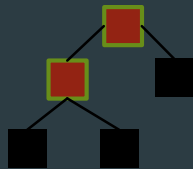
Precise geolocation



Satellite data



Integration with socio-economic data (SFM)



Causal trees machine learning



Estimation of carbon sequestered

**Novel approach to address data gaps through integration of satellite data with local survey data (Uganda)**

# Impact and Value for money

LD  
\$1:1.08

SFM  
\$1:1.17



Vegetation productivity

forest loss and land fragmentation

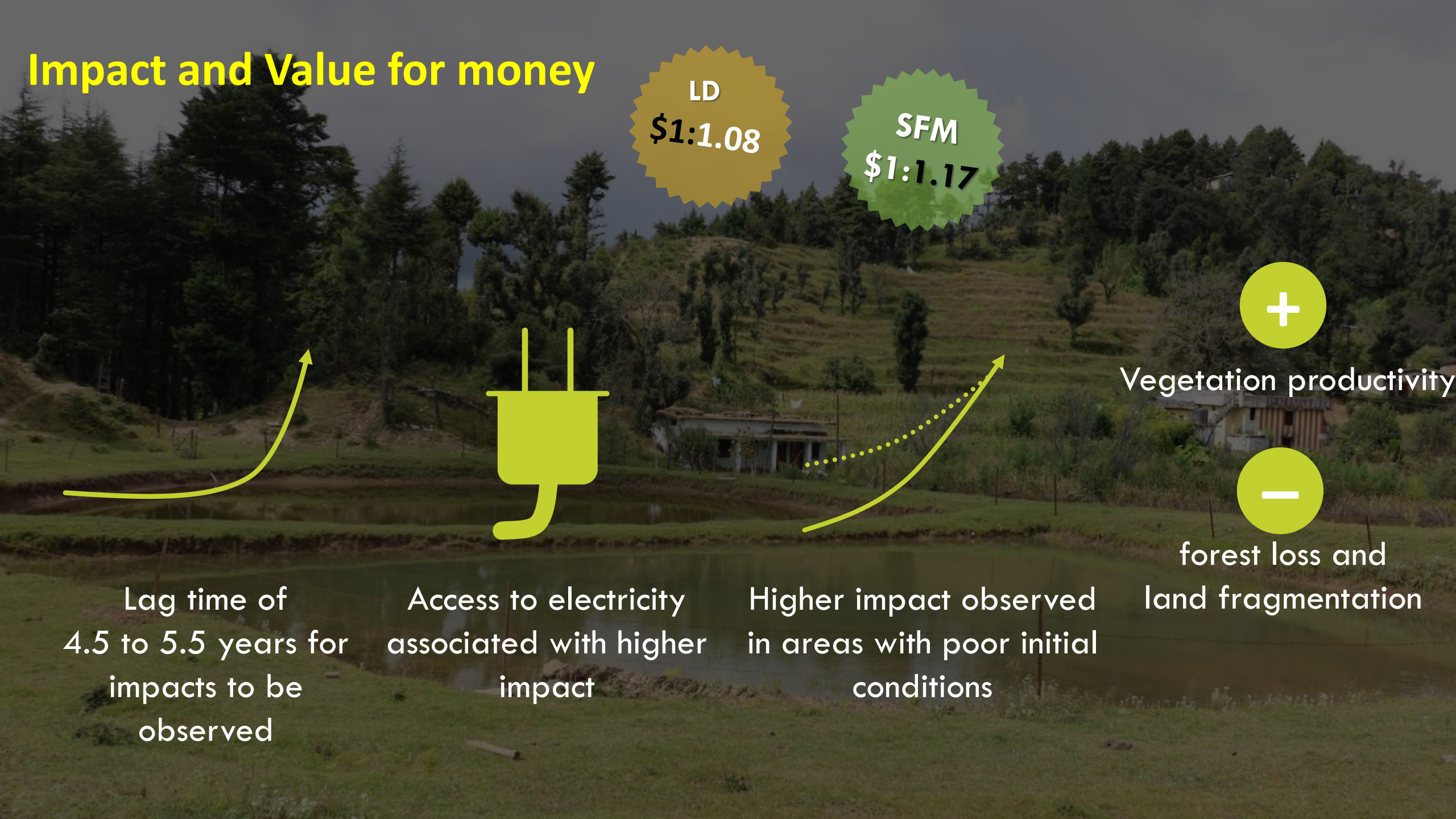


Lag time of 4.5 to 5.5 years for impacts to be observed

Access to electricity associated with higher impact



Higher impact observed in areas with poor initial conditions



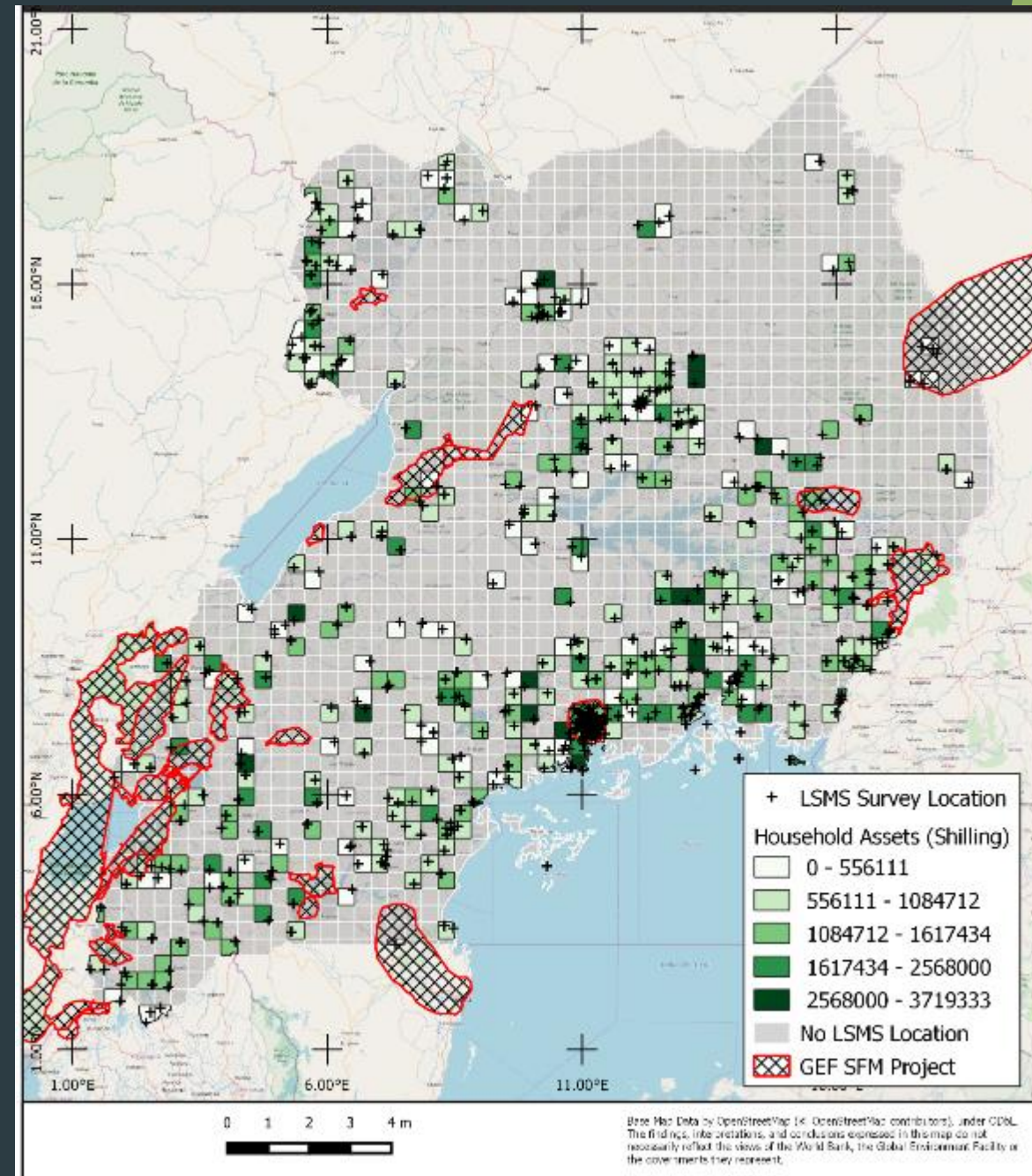


# Sustainable Forest Management(SFM): VALUE FOR MONEY

## Socioeconomic Co-benefits(Uganda)

- ▶ Households in proximity to GEF SFM interventions have more in **Household Assets** as compared to households further away.

**Positive Correlation with GEF,  
not causation**

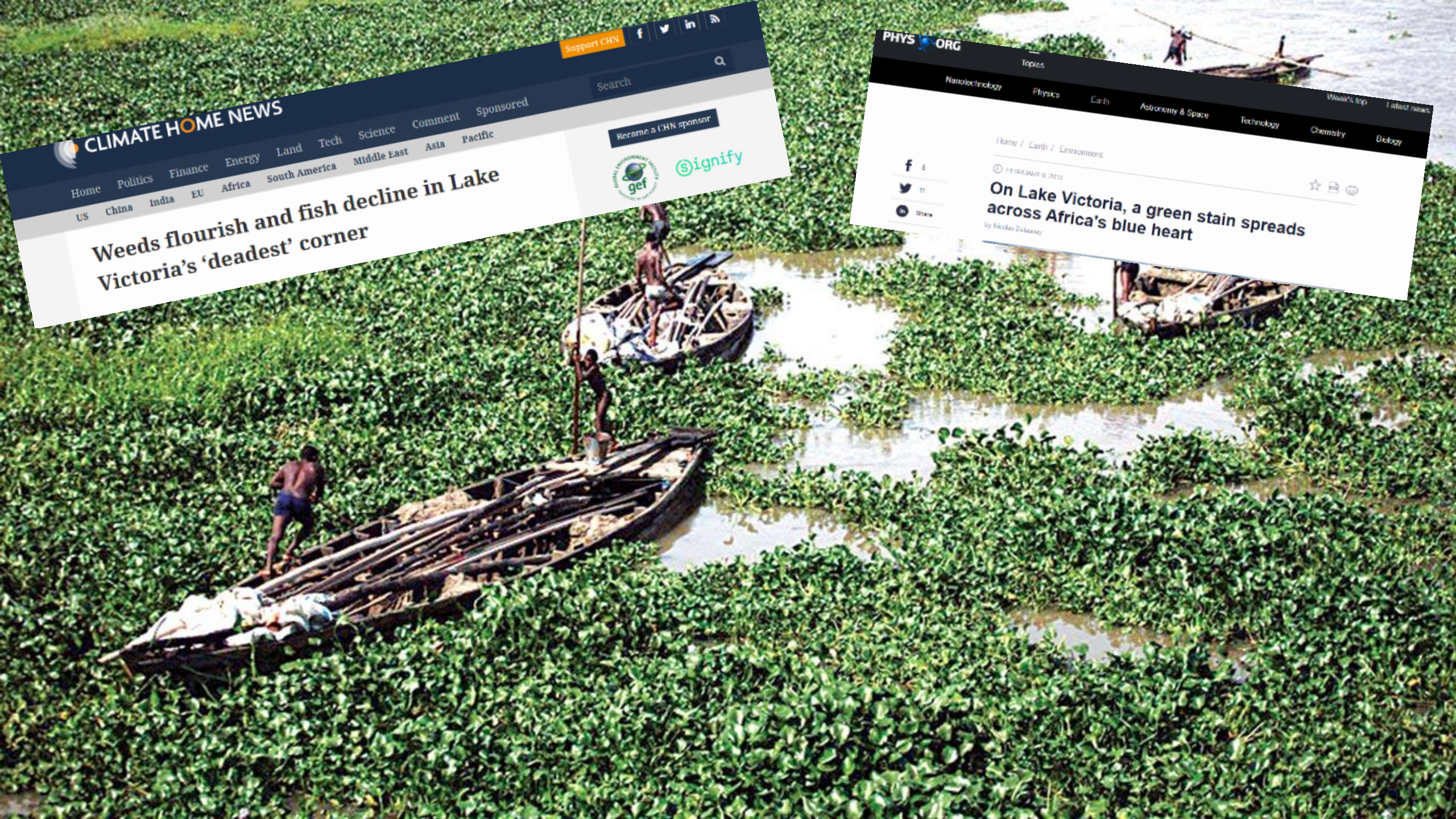




# International Waters







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# Weeds flourish and fish decline in Lake Victoria's 'deadest' corner

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Home / Earth / Environment

6 FEBRUARY 18, 2015

## On Lake Victoria, a green stain spreads across Africa's blue heart

by Nicolas Delany

f 6

t 11

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# Lake Victoria: Vegetation presence



2000

2003

2005

2007

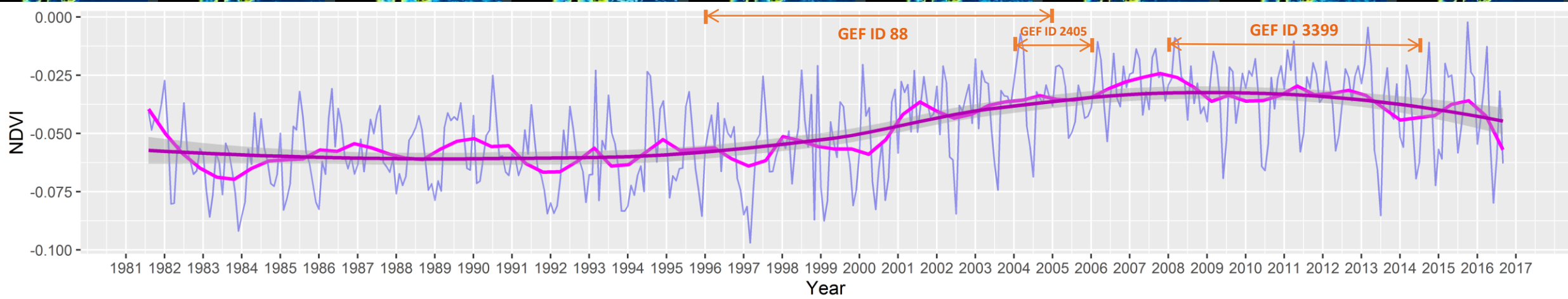
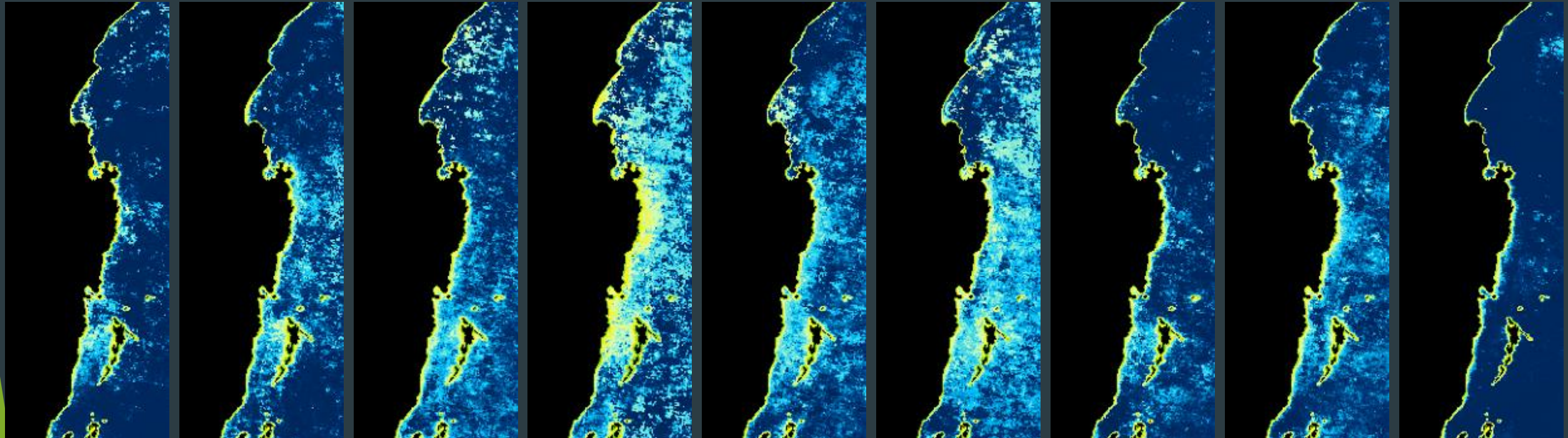
2009

2011

2013

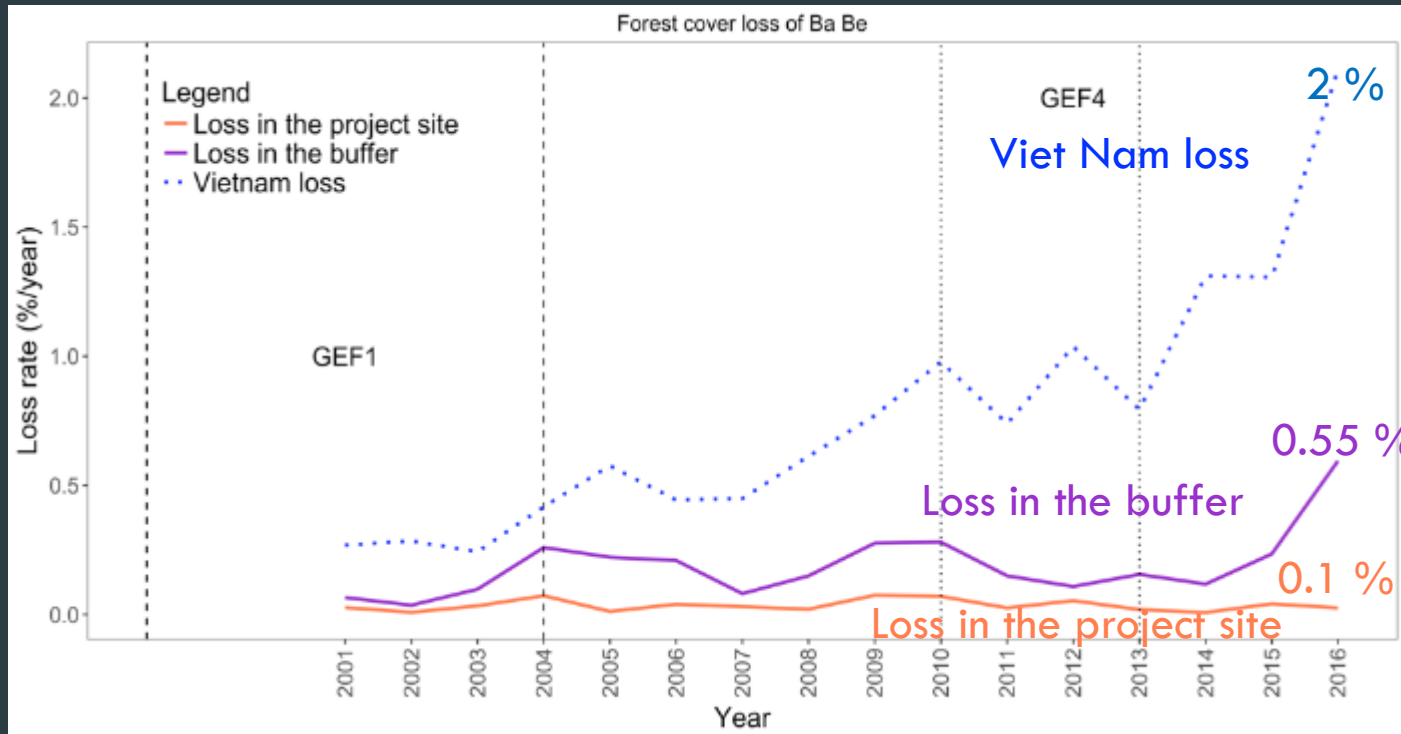
2015

2016

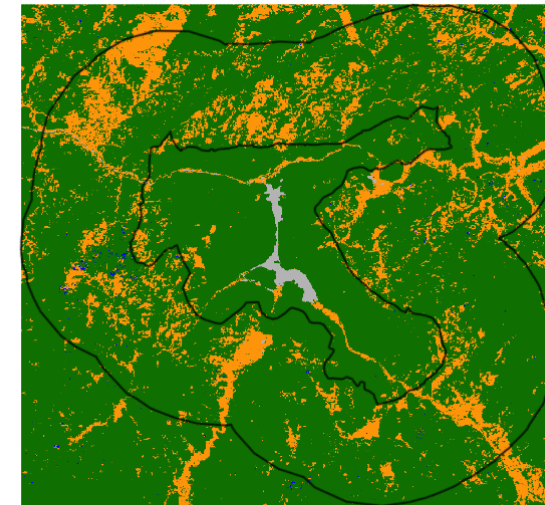


# SUSTAINABILITY

## Ba Be: Sustainable Forest Management, Viet Nam



2000



Cover

- Forest
- Non-forest
- Forest gain
- Forest loss
- Water
- No data

Region

- GEF1\_209\_Ba Be

## SUSTAINABLE OUTCOME

Forest loss did not increase despite unprecedented increase in the buffer and at country level

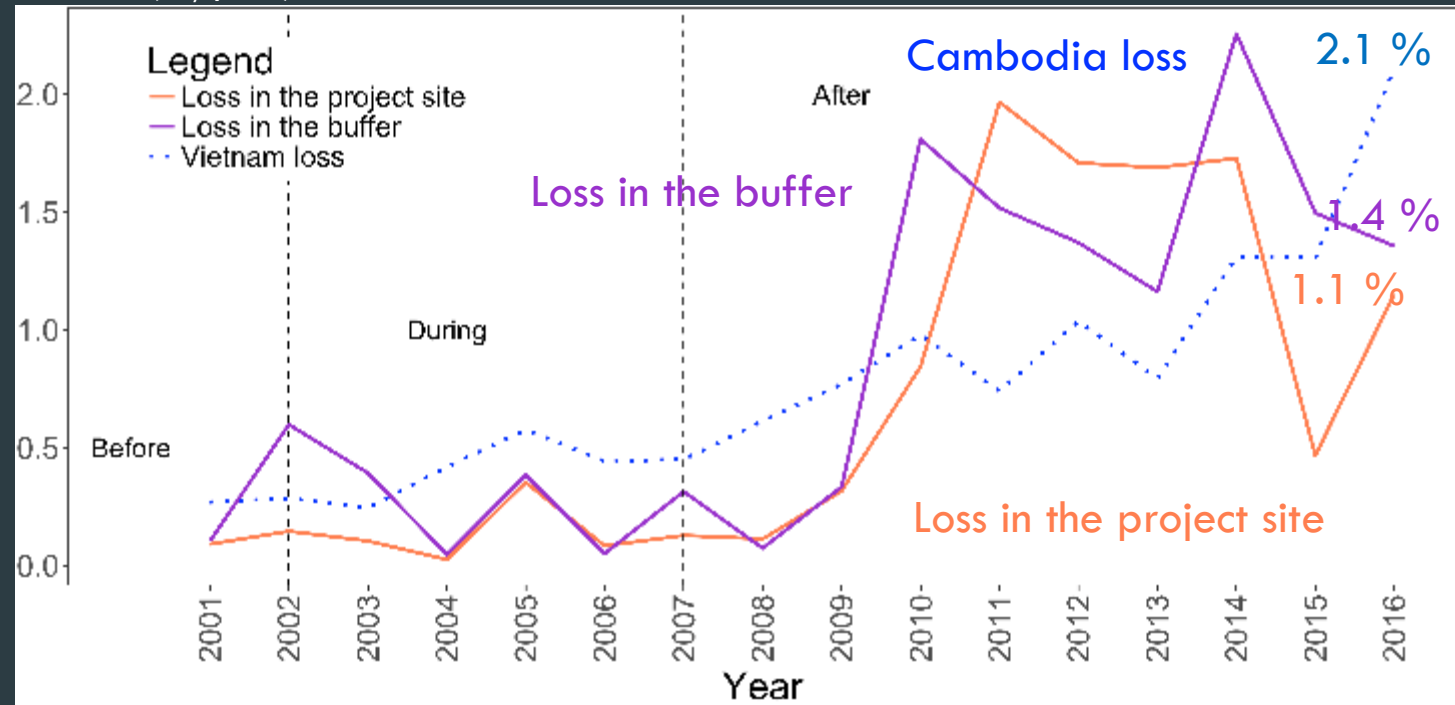
# SUSTAINABILITY



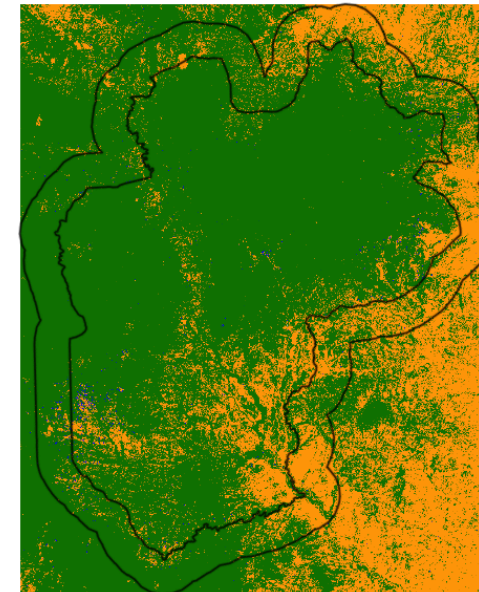
## Cardamom Mountains

### Integrated Protected Area System, Cambodia

Loss rate (%/year)



2000



Cover  
Forest  
Non-forest  
Forest gain  
Forest loss  
Water  
No data

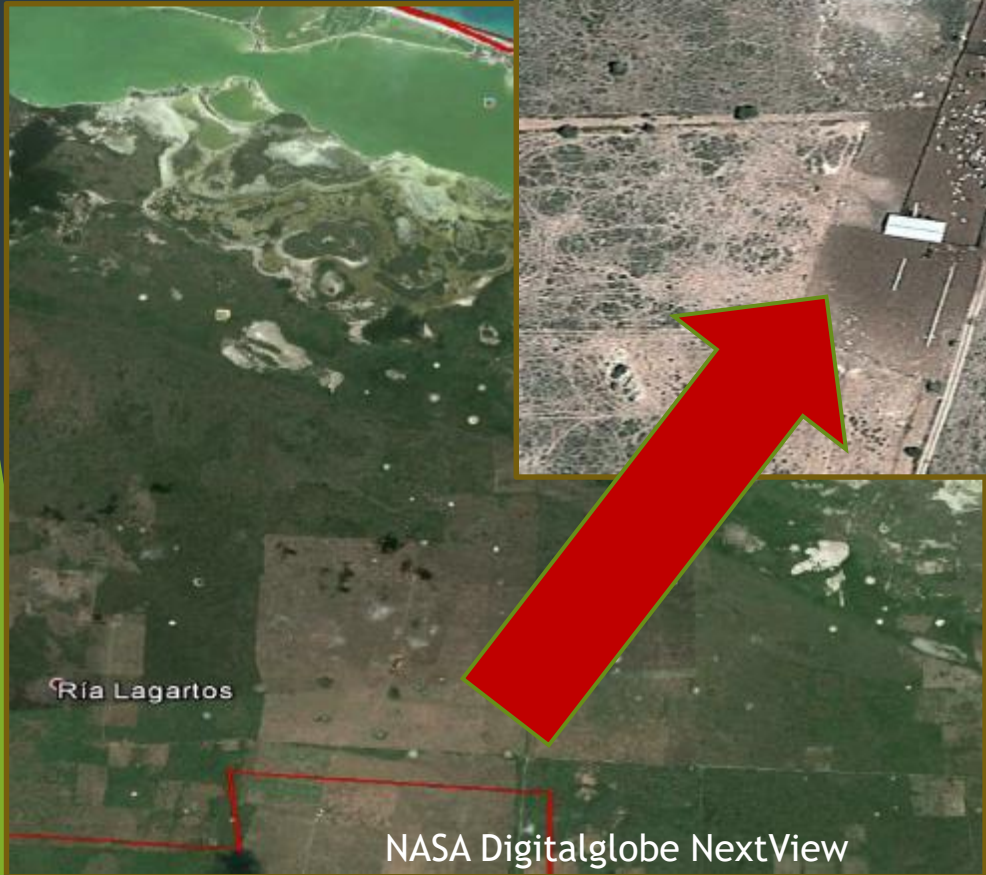
Region  
— GEF2\_1086\_Phnom Aural

Was this intervention sustainable?



Few other applications

# Identify the drivers



2.5 m



30 m zoomed in to  
2.5 m

Images at 2.5 to 0.5 m resolution used to identify drivers of change that hinder success of GEF support



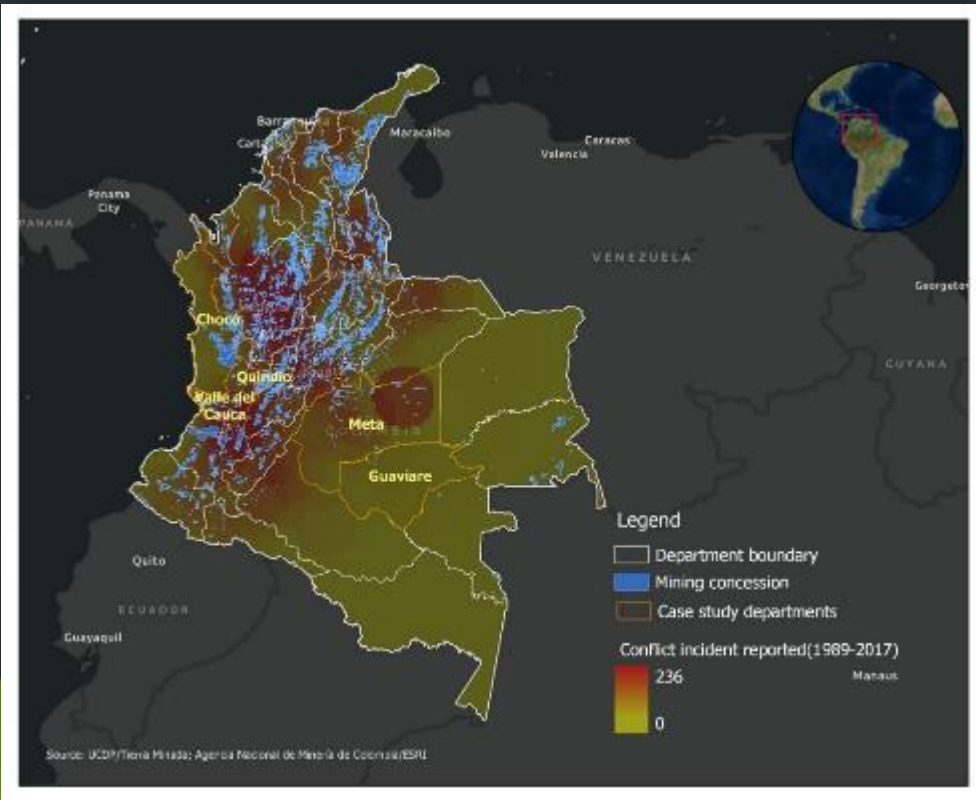
Hard to reach, isolated and unsafe areas

## Tracking illegal mining in Choco, Colombia





# Tracking illegal mining in Choco, Colombia

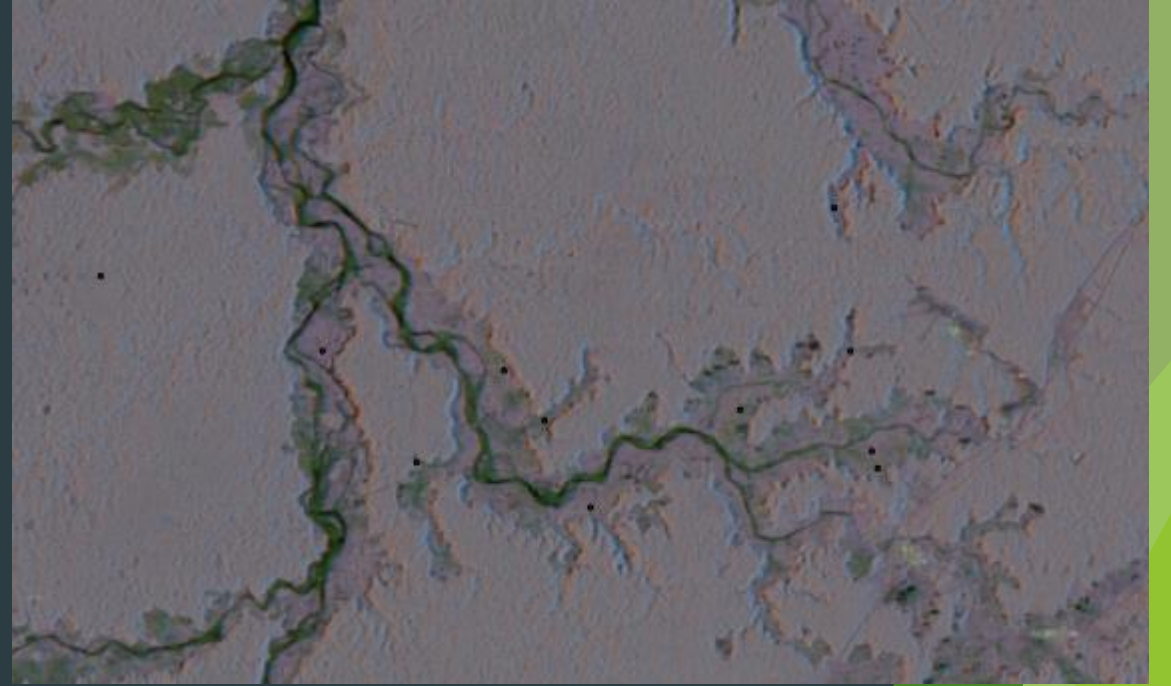




# Challenges in mining mapping using remote sensing data



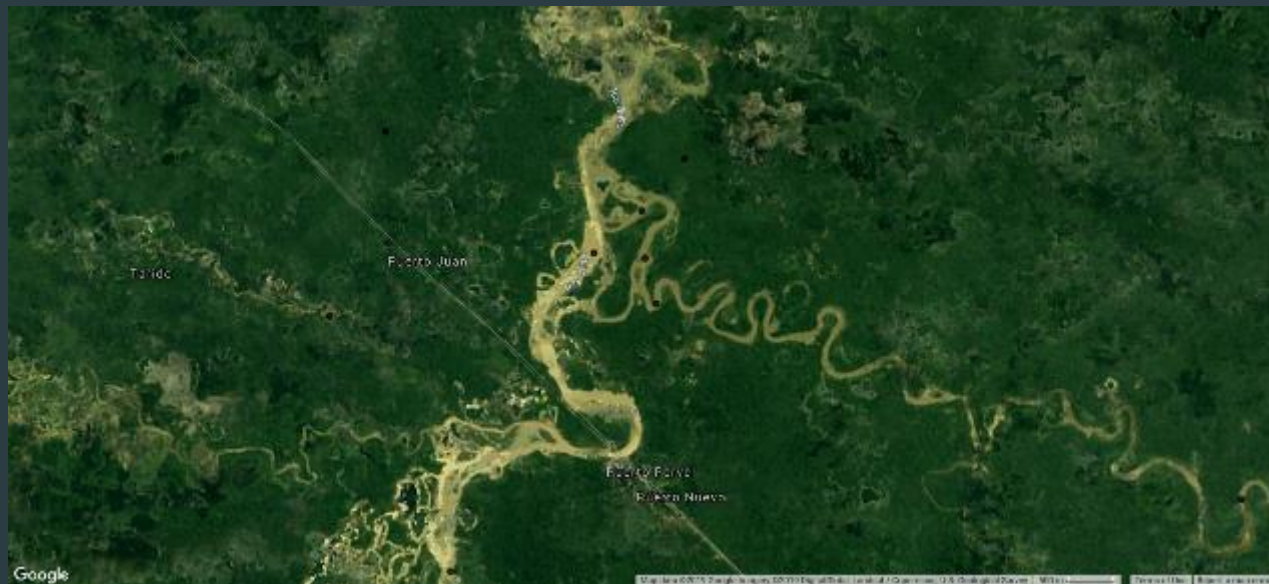
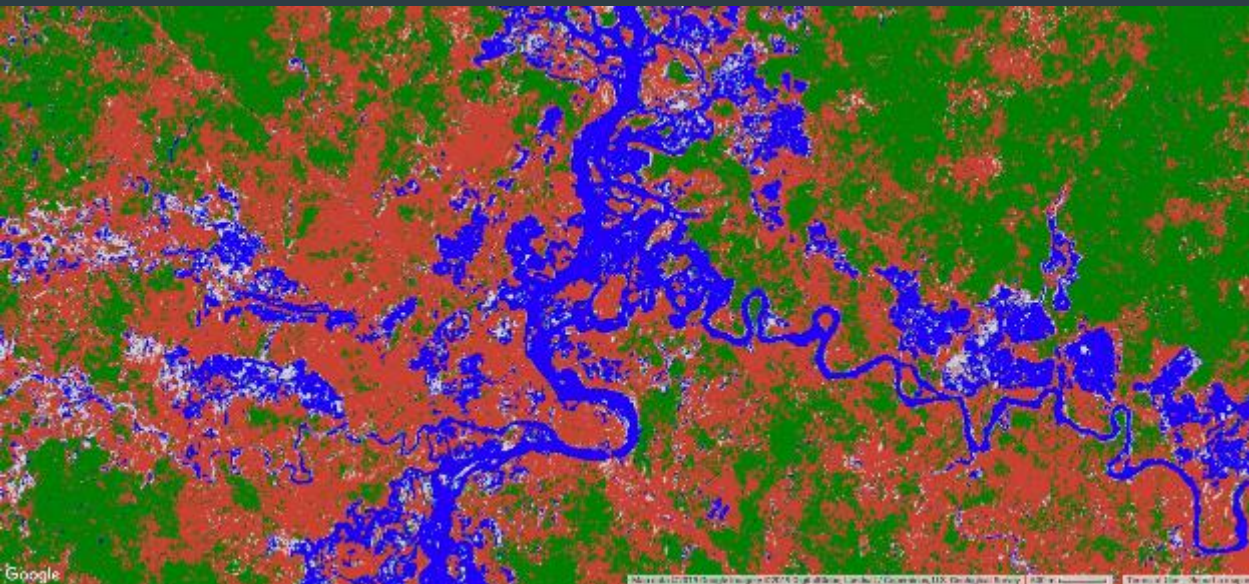
Optical



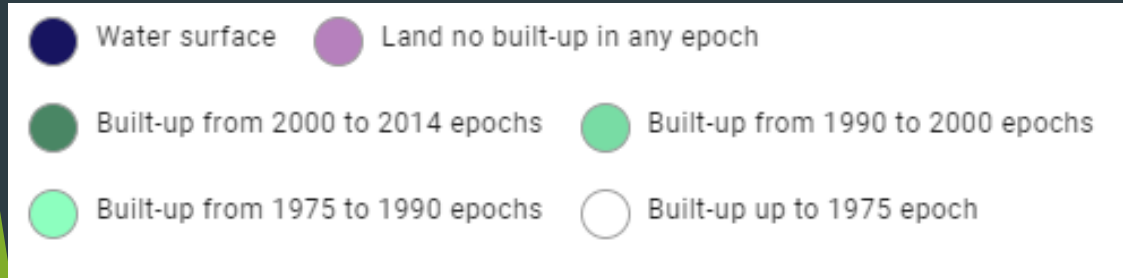
Radar



# Results









# Triangulating Across Methods





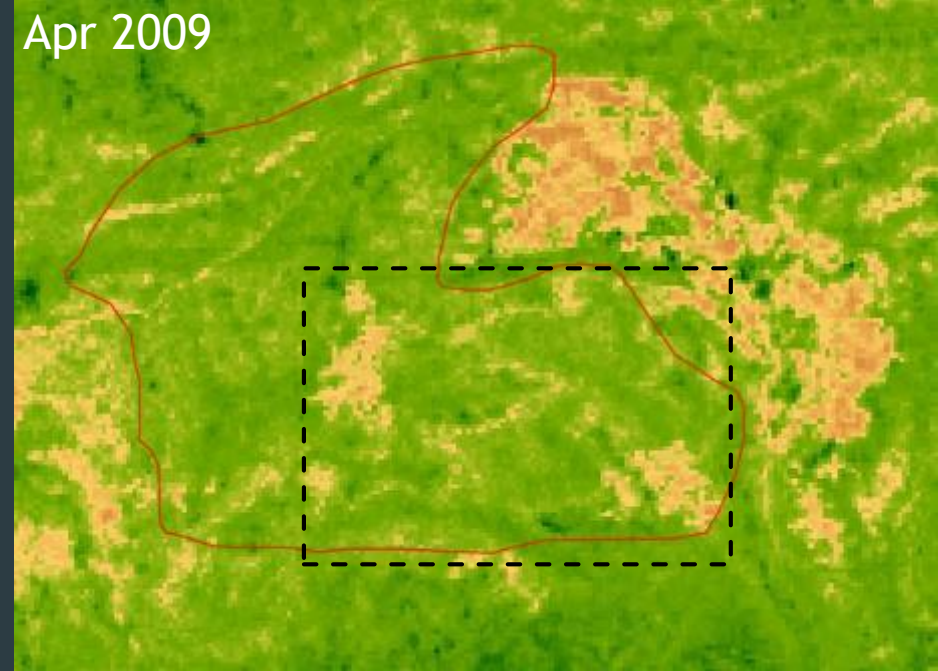




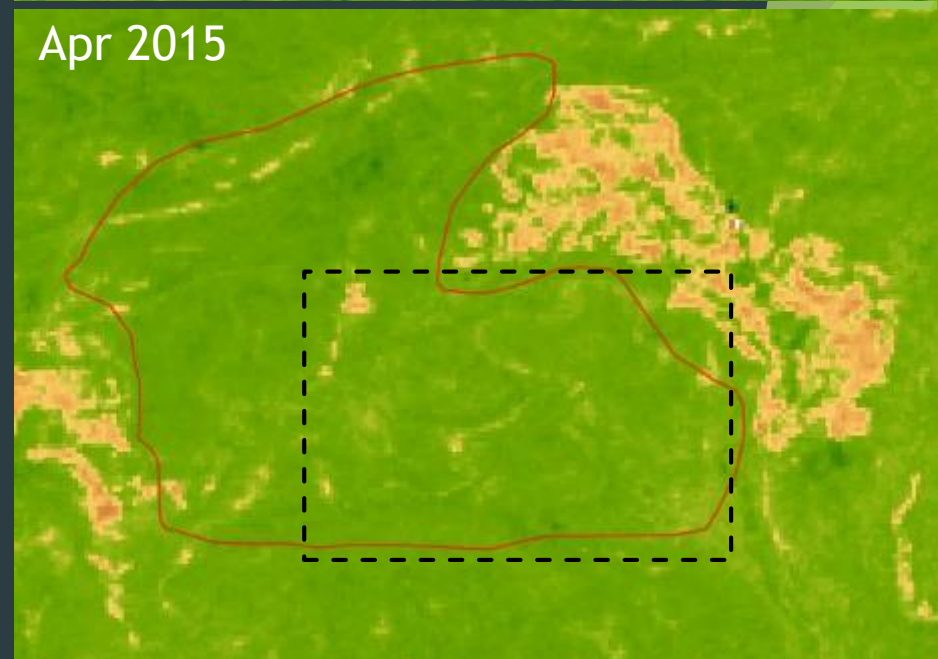
# India: SLEM PMIS 3472(2009-2015)


## Time series analysis using Satellite data

Apr 2009



Apr 2015



Question	Response
Whats the current date and time	2016-09-18T13:27:00.000+05:30
Where is this interview taking place?	21.76722166205057 78.66110602300134 486.3959563433866 24.0
Can I take a picture?	
Name of Interviewee(s)	Premal anke
What is your role in the project?	beneficiary
Name of Organization	Borpani
Is the project creating any positive impact in the area/region/site?	yes
Did this project contribute to better land management ?	to_a_moderate_
Has the project increased productivity in rangelands? (Y/N)	yes
Has the project allowed for creating of new jobs and livelihood?	yes



## Beneficiary survey

### Bamboo Forest







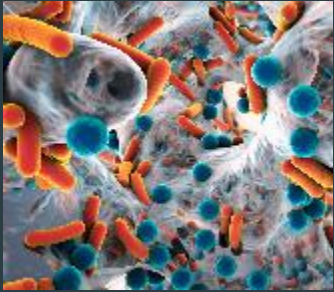
# Innovative Methods in M&E



# Computational Social Science?

Combination of Big Data, Computer Science, and Social Sciences

- ▶ Instrument enabled discipline!



microbiology

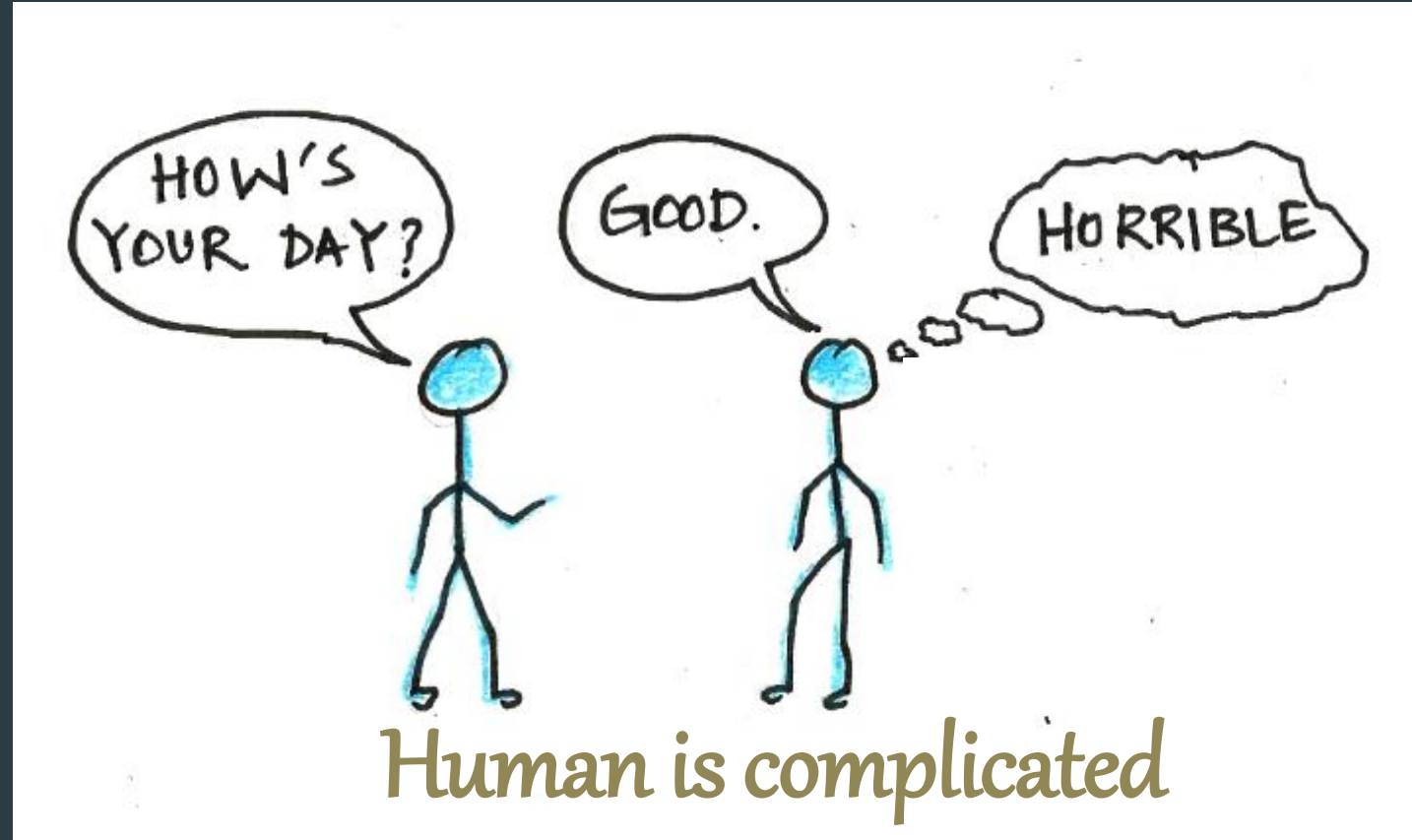


microscope



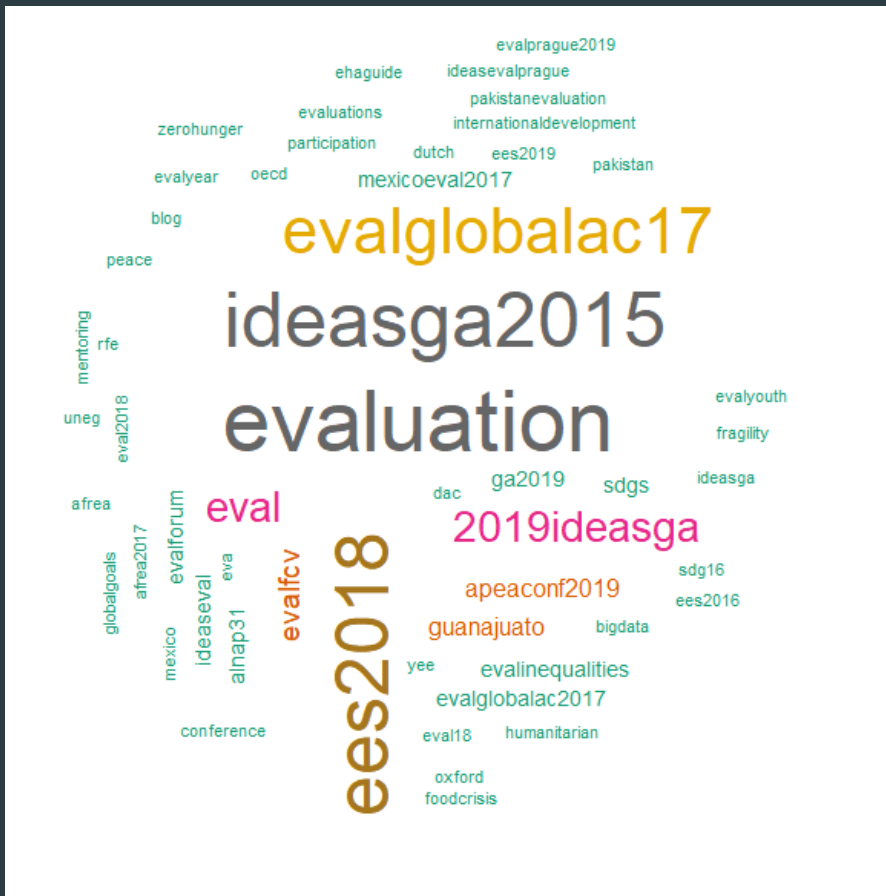
# Why do we need it ?

- Social phenomena involve many individuals interacting to produce *collective entities*
- Micro-macro problems are hard to study empirically



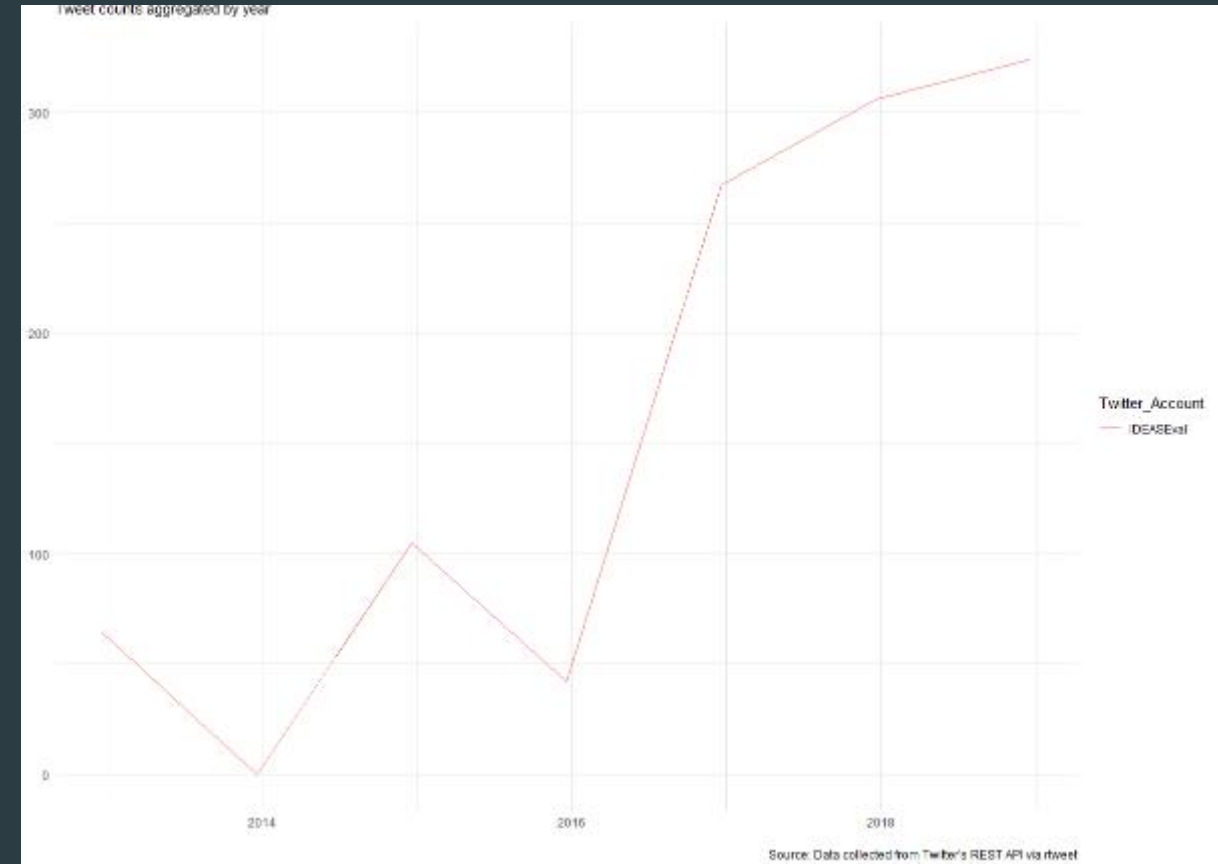
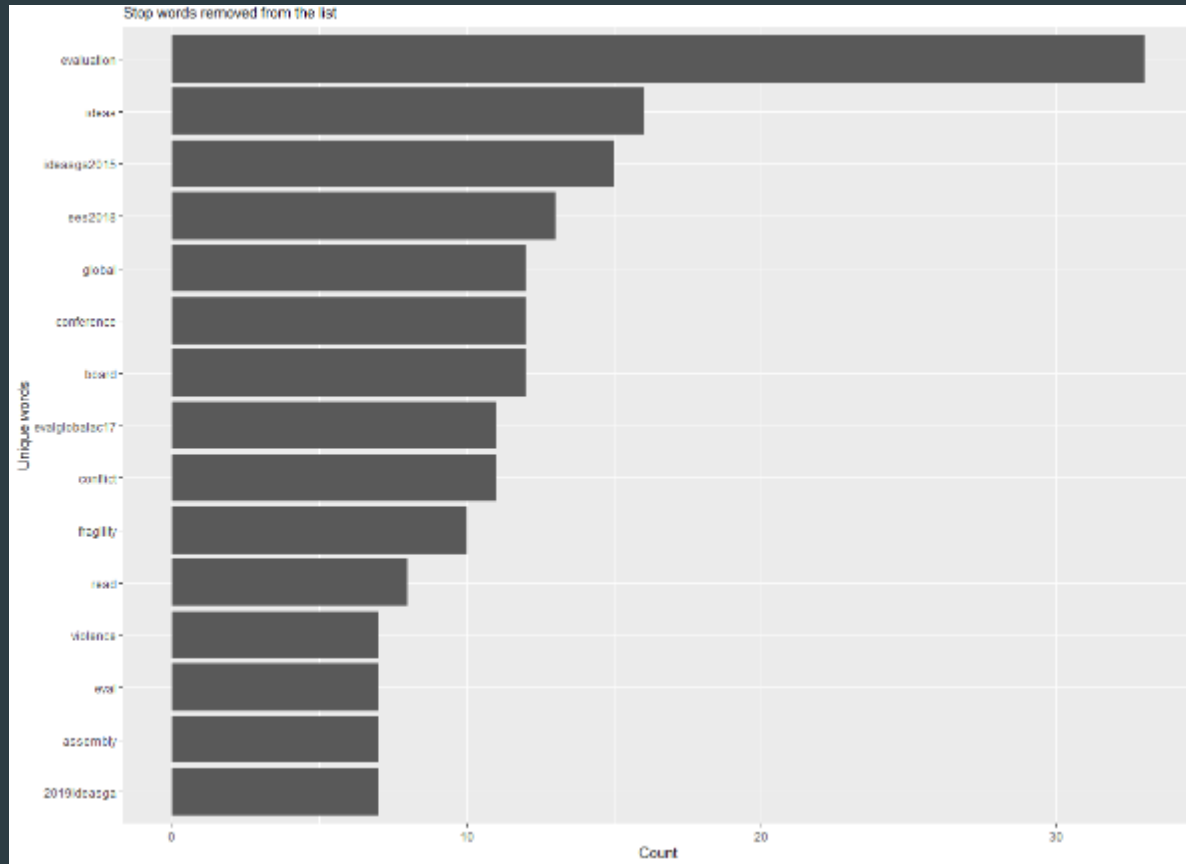


# Example: Social Media Data Analysis



"@IDEASEval"

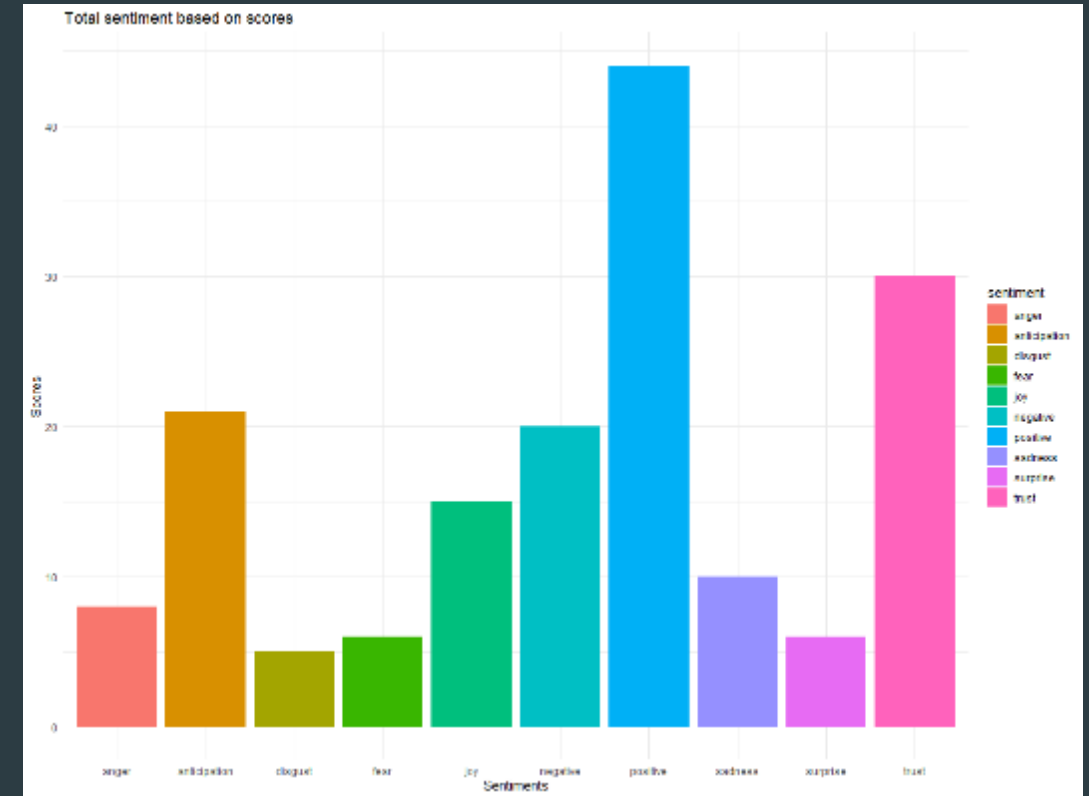
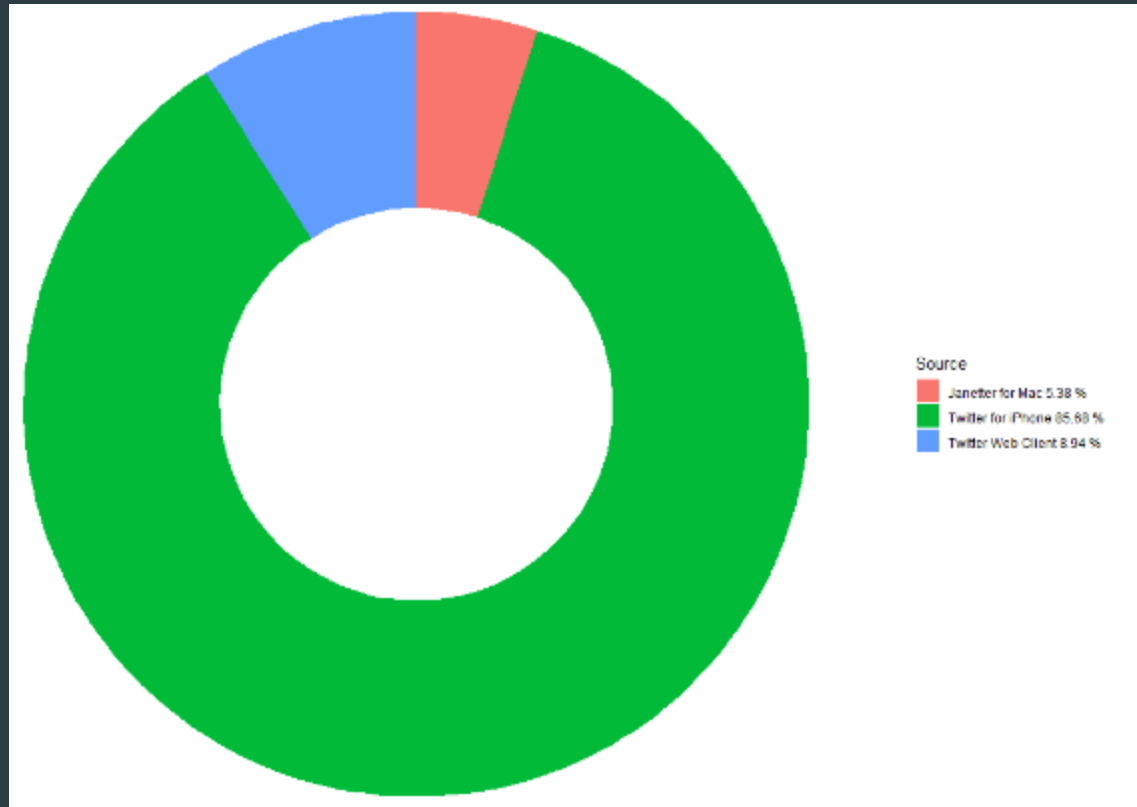
# Example: Social Media Data Analysis



"@IDEASEval"



# Example: Social Media Data Analysis



"@IDEASEval"

# Challenges

- ▶ Need to manage costs
- ▶ Require good technical skills
- ▶ Requires multidisciplinary teams for evaluation
- ▶ Requires keeping up with dynamic learning and upgrading of skills
- ▶ Data ethics





# Lessons for the future



**Partner with  
global institutions**

**Use mixed  
approaches and  
methods**



**Continue exploring  
new methodologies and  
data sources**

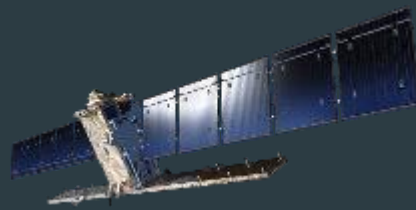


**Approach evaluation as  
a dynamic learning  
process**





# Resources



## Interactive tools

<http://www.globalforestwatch.org/> : GFW offers data, and tools for forests monitoring

<https://global-surface-water.appspot.com/> : Global Surface Water

## Data visualization and download

<http://earthexplorer.usgs.gov> : NASA-USGS Earth Explorer for raw data

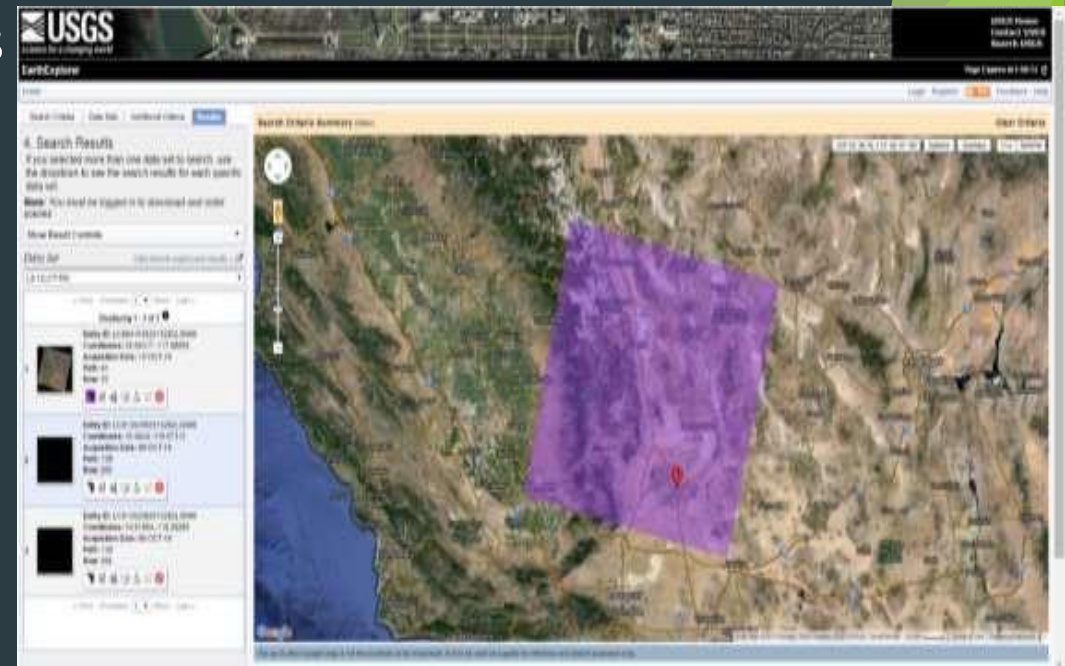
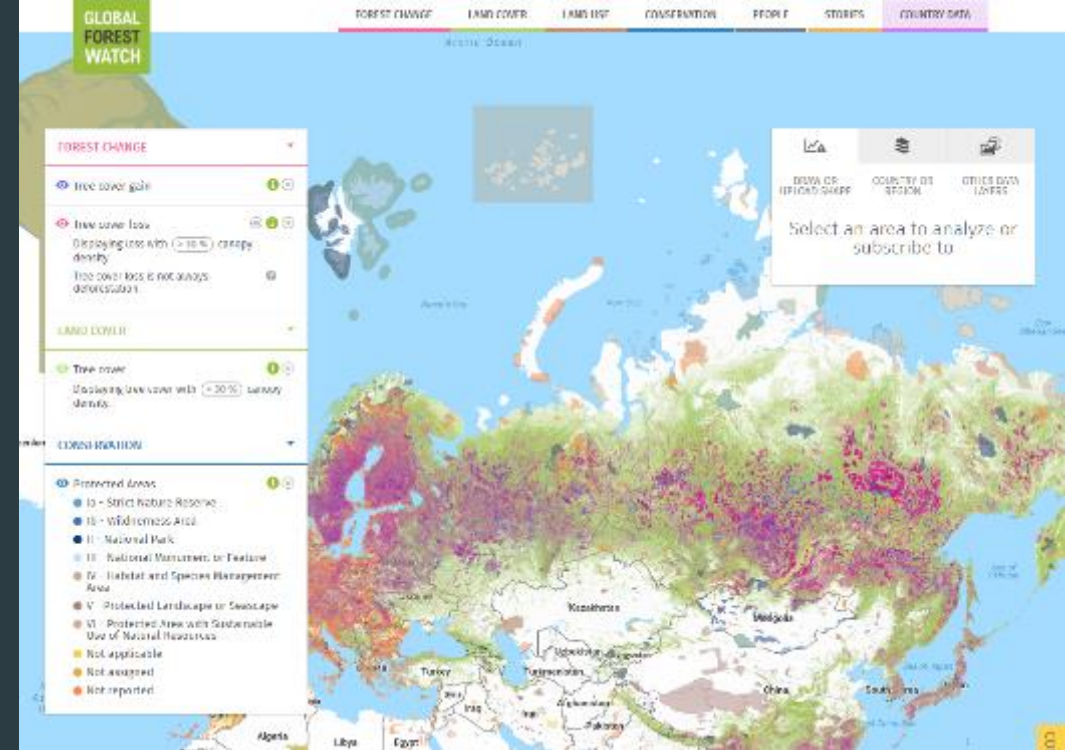
<https://scihub.copernicus.eu/> : Copernicus Open Access hub

## Analytical tools(Open Access or Free)

<http://www.qgis.org/en/site/> : QGIS

<https://earthengine.google.com/> : Google Earth Engine(requires CODEING)

<https://www.google.com/earth/> :Google Earth Pro





# Thank you

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