

Toward a global land use open
data- a baseline for global land
monitoring

Are insect populations
quietly crashing? p. 576

Advocating science
with stories p. 590

Water abundance in an
exoplanet atmosphere p. 628

Science

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FOREST GEOGRAPHY

Mapping forests of
the dryland biome p. 635



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The extent of forest in dryland biomes

Jean-Francois Bastin



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DRYLANDS MONITORING WEEK 2015

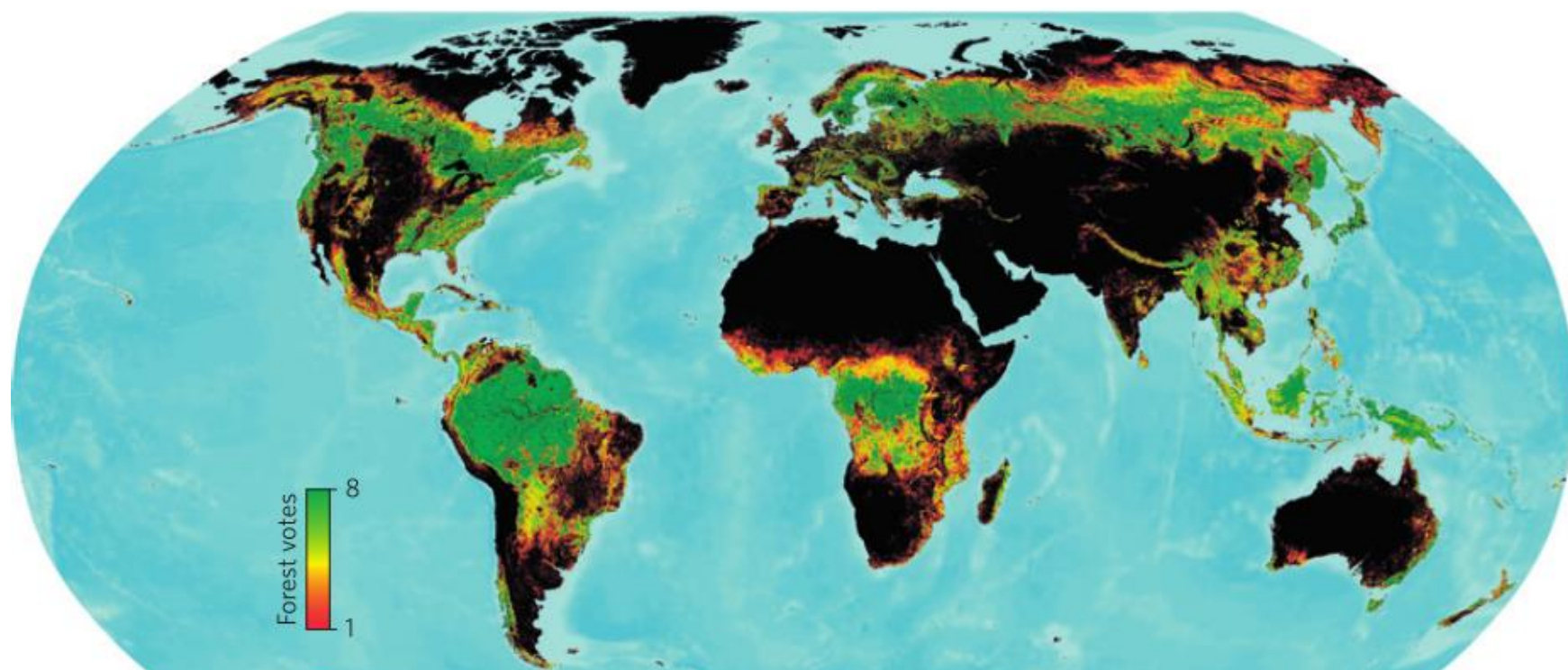
From the 19th to the 23rd of January 2015, in Rome, FAO, WRI and IUCN with funding support of EU-ACP and GEF, organized a workshop on “Monitoring and assessment of drylands: forests, rangelands, trees and agrosilvopastoral systems”.

Gathering 80 participants from countries and international organizations. This event led to the “**Rome Promise**” in which participants agreed to:

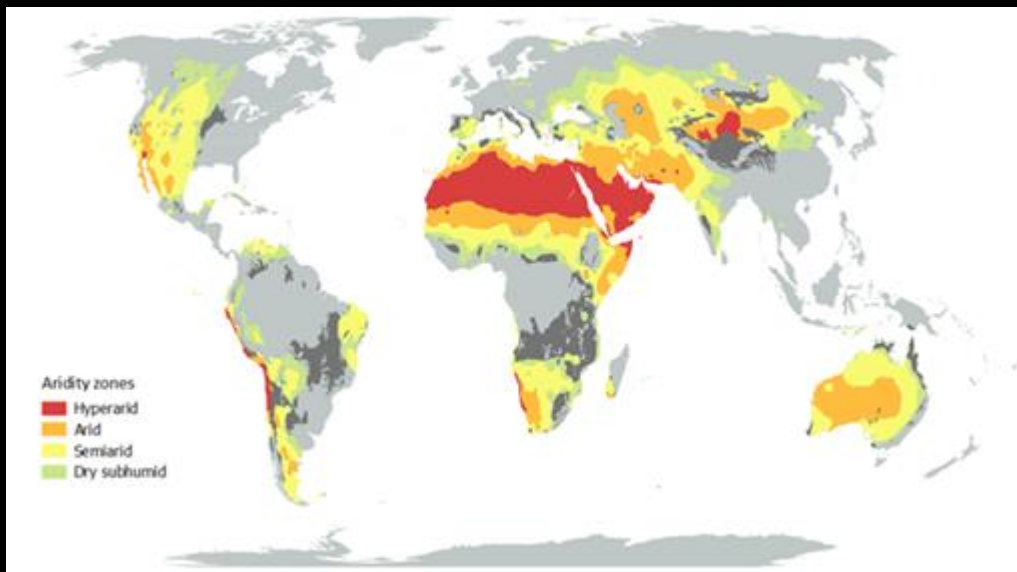
- Form an open-ended collaborative network or community of practice to advance monitoring and assessment of drylands, including understanding of their users
- Communicate the value and importance of drylands monitoring to relevant stakeholders, including policy makers and resource partners
- Develop a dynamic roadmap for collaborative action

Conservation policy and the measurement of forests

Joseph O. Sexton^{1*}, Praveen Noojipady^{1,2,3}, Xiao-Peng Song¹, Min Feng¹, Dan-Xia Song¹, Do-Hyung Kim¹, Anupam Anand^{1,4}, Chengquan Huang¹, Saurabh Channan¹, Stuart L. Pimm⁵ and John R. Townshend¹



WHY do we care ?



- 41.5 % terrestrial lands
- About 2 billions people concerned
- Majority developing countries
- Local livelihoods dependent on vegetation resources

Sorensen (2009). *UNEP-WCMC*

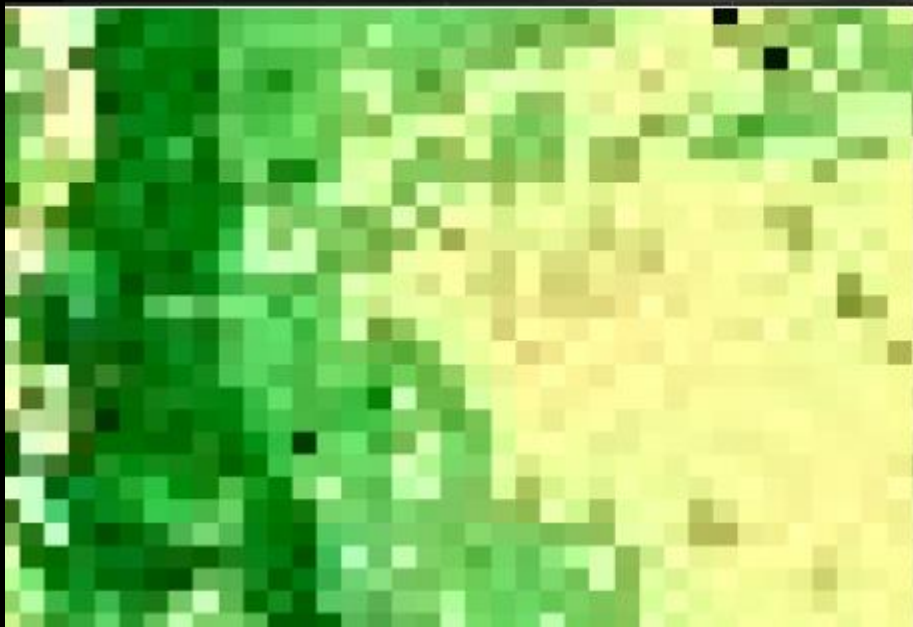
- On the fore of the combat against desertification
- By 2100, +50% of terrestrial lands
- 7 of the 25 hotspots for biodiversity conservation



WHY is it not done yet ?

Issue 1 : « Open forest » and spatial resolution satellite images do not really get along

PLOS Ecology Community



J. Atkins. PLOS Ecology&Community webpage



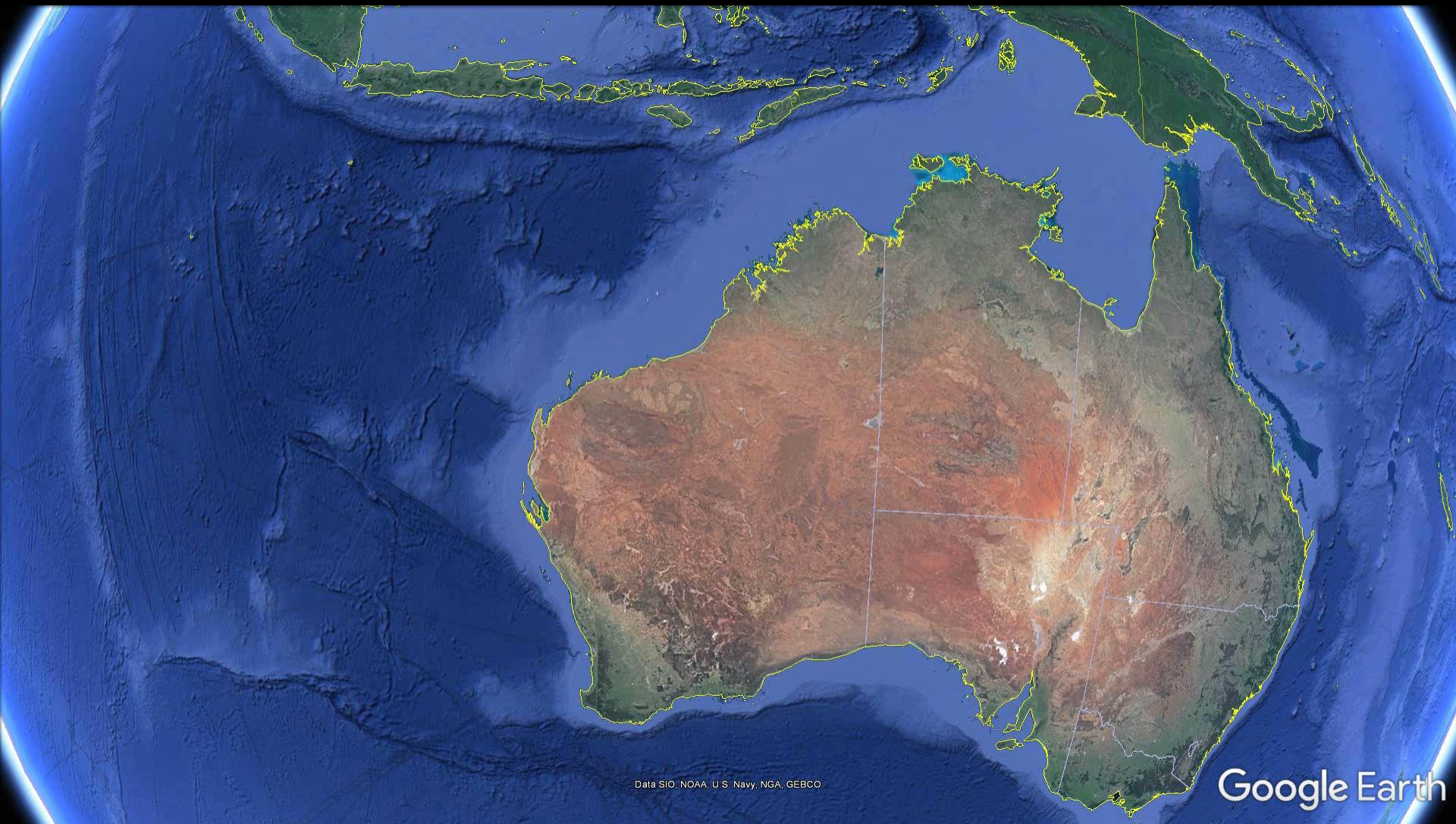
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Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Google Earth





Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Google Earth



WHY is it not done yet ?

Issue 2 : Very high spatial resolution is problematic with automated approaches
→ Considering angles of acquisition conditions (sun-view-sensor geometries)



For details see
Barbier et al. (2011). *Remote Sensing of Environment*
Bastin et al. (2014). *Ecological Applications*



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WHY is it not done yet ?

Issue 2 : Very high spatial resolution is problematic with automated approaches
→ Considering vegetation specificities (phenology and reflectance)



What do we propose?

Working directly on **Very High Spatial Resolution** images with **human operators**

- An approach equivalent to National Inventories done in developed countries from photo-interpretation of pictures taken by planes
- Close to Geo-WIKI approaches



Collect Earth

Augmented Visual Interpretation for Land Monitoring

 Download last version

 Tutorials

 Case Study



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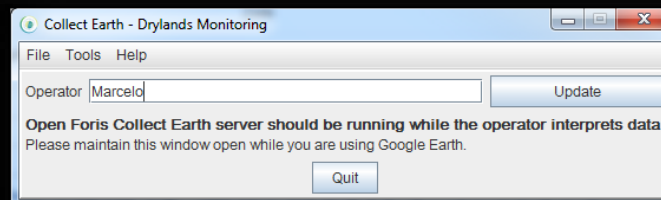
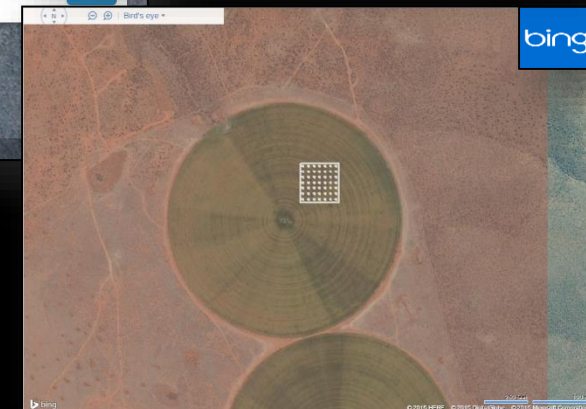
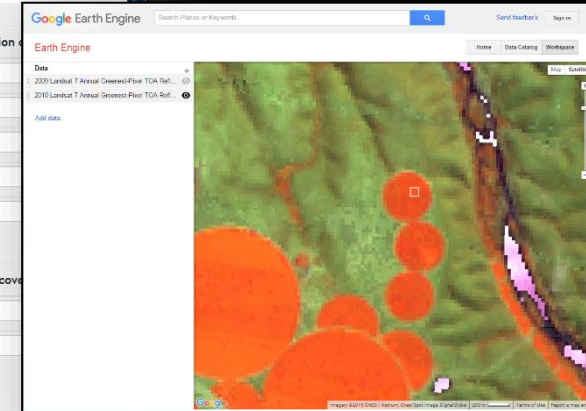
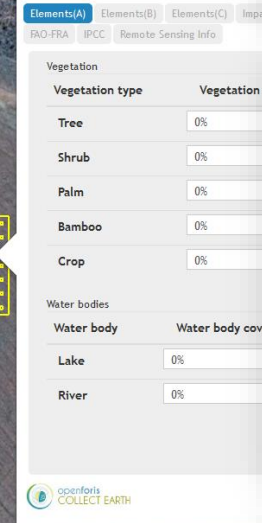
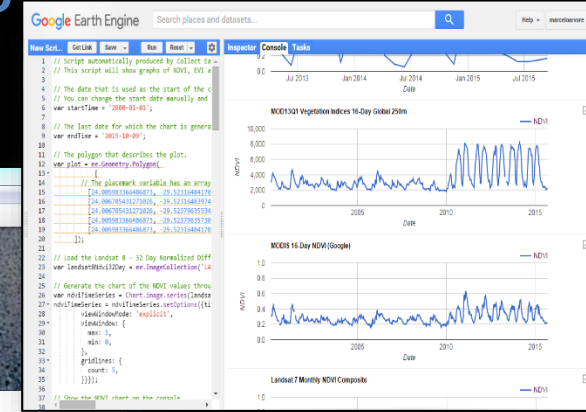
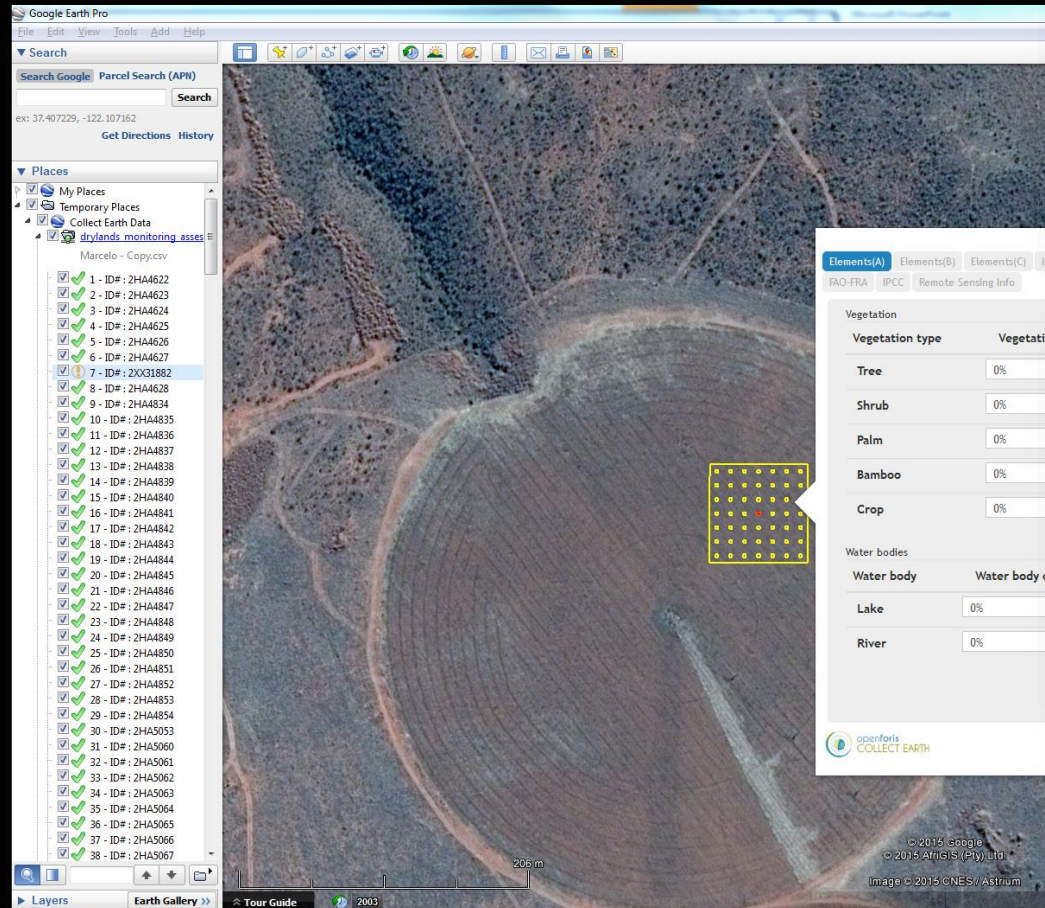
Google Earth

Google™ earth

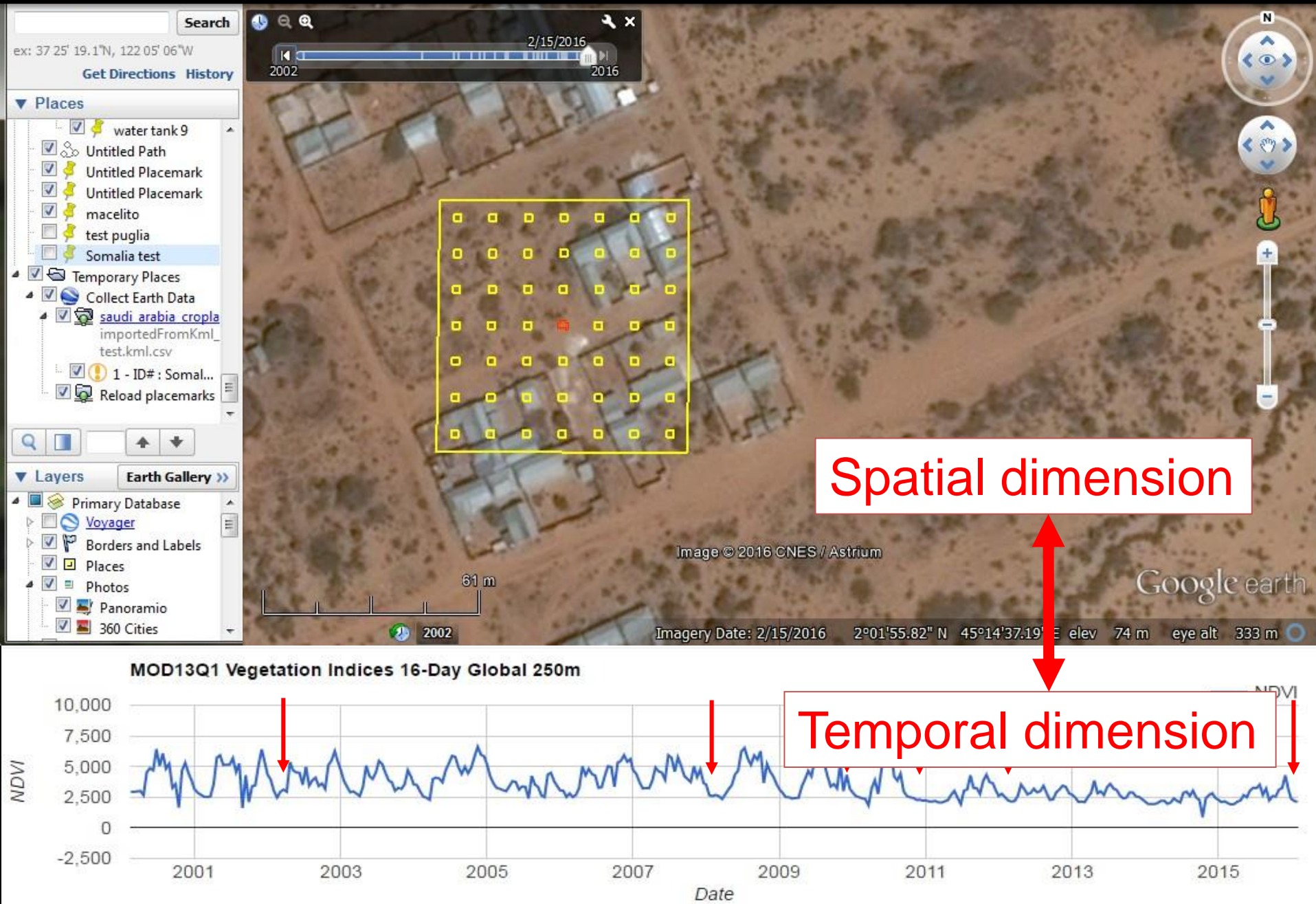


How did we proceed ?

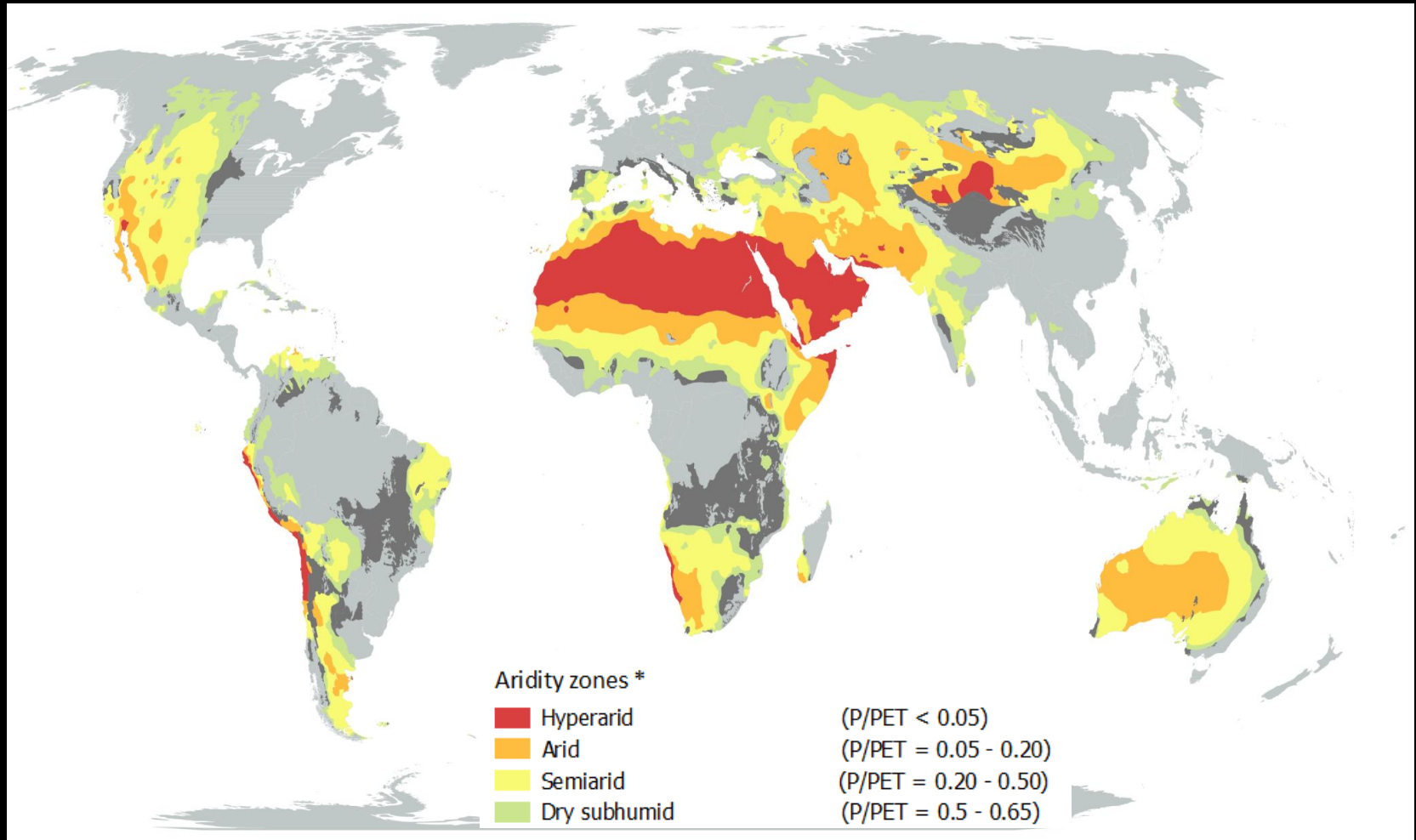
Augmented visual interpretation



Combining Very High spatial and temporal resolution data

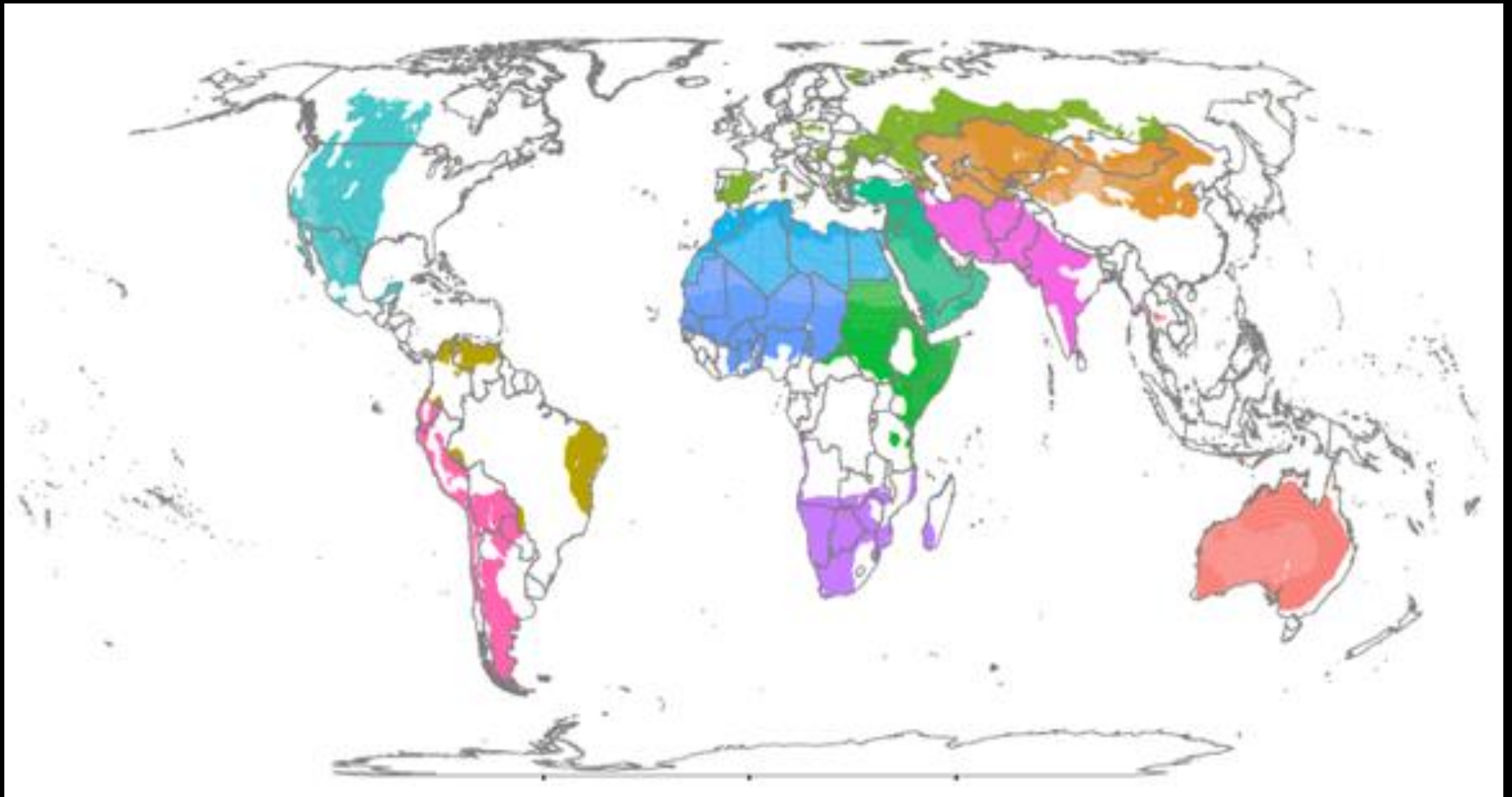


How to use collect earth for the drylands assessment?



How did we proceed ?

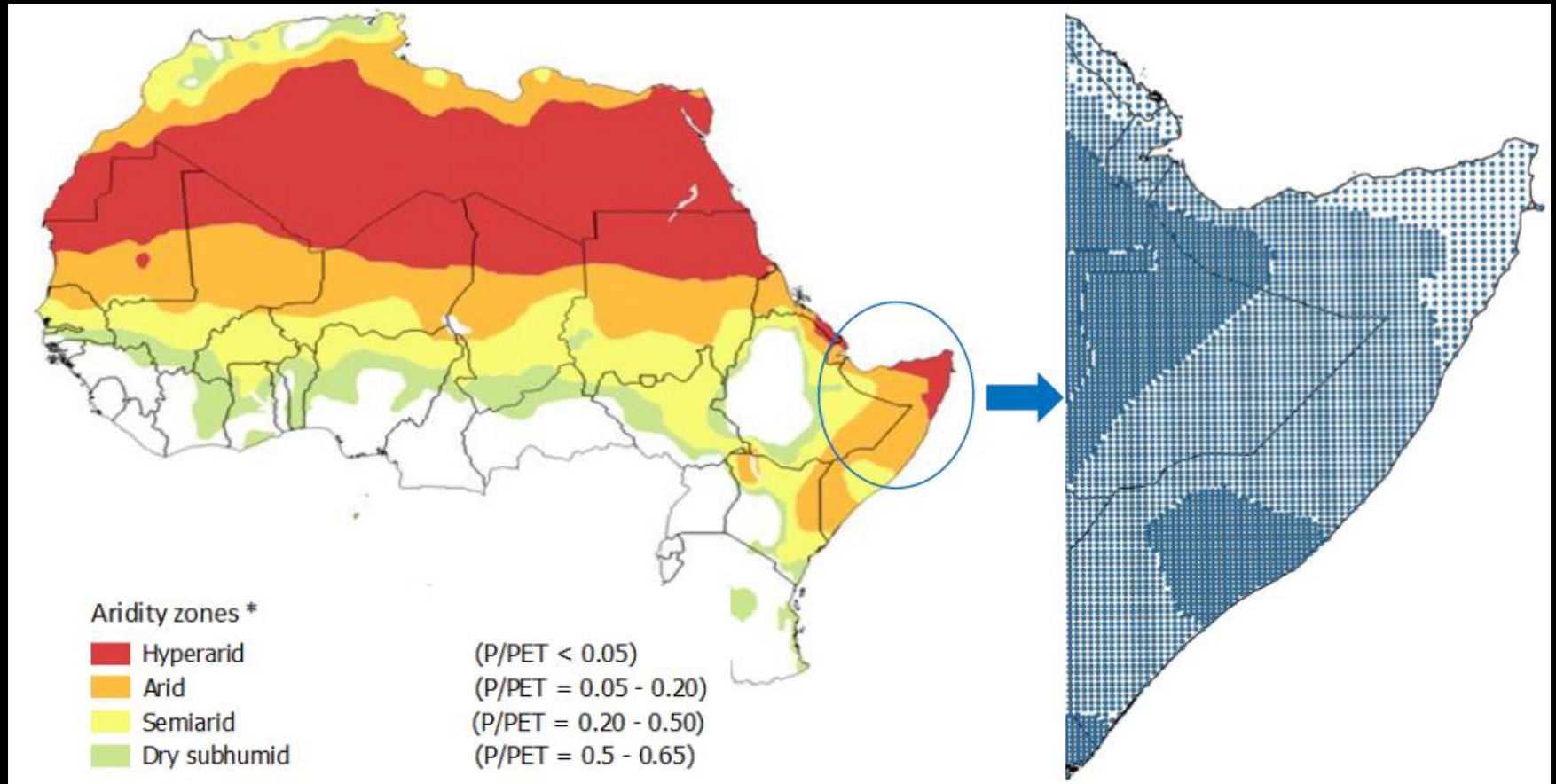
15 partner institutions and 239 operators, +210 000 plots



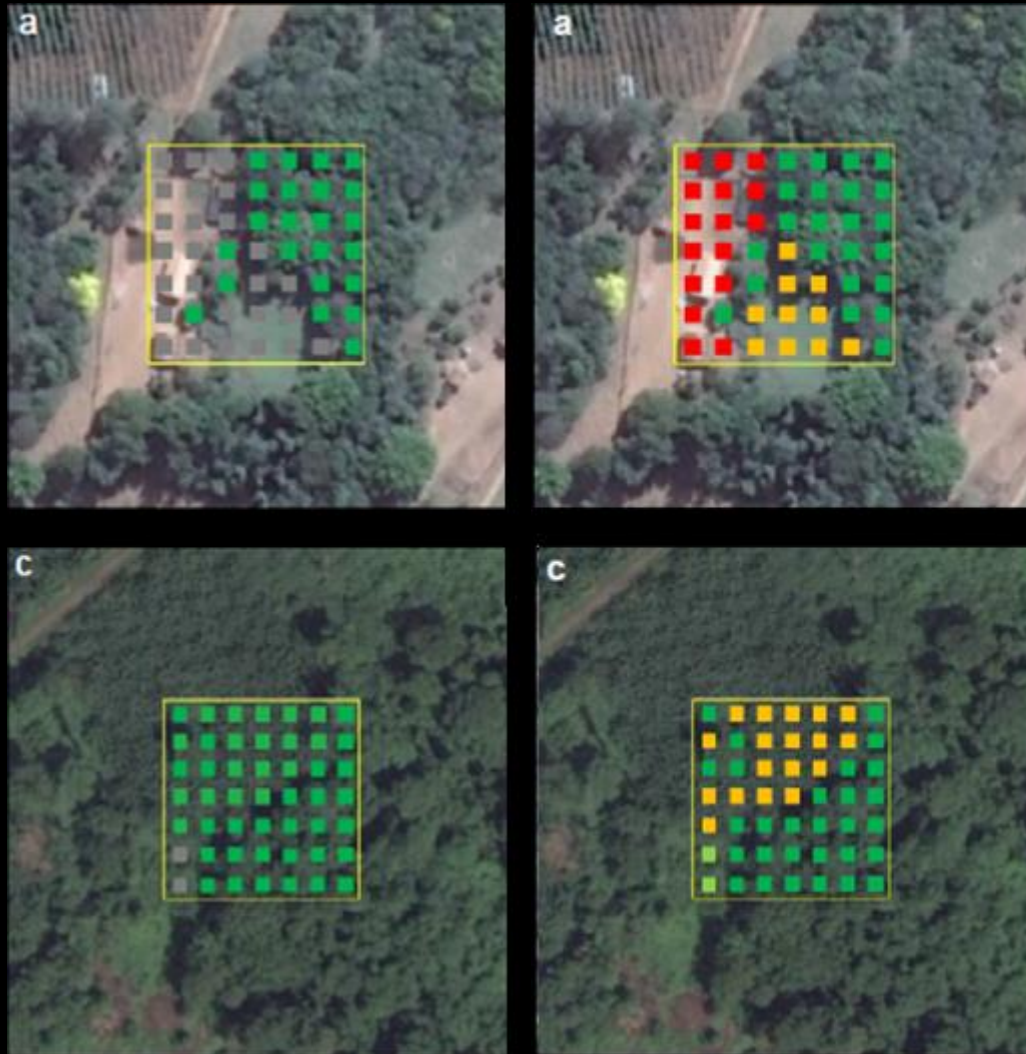
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How did we proceed ?

Systematic and stratified sampling design



Assessing tree cover and forest land use



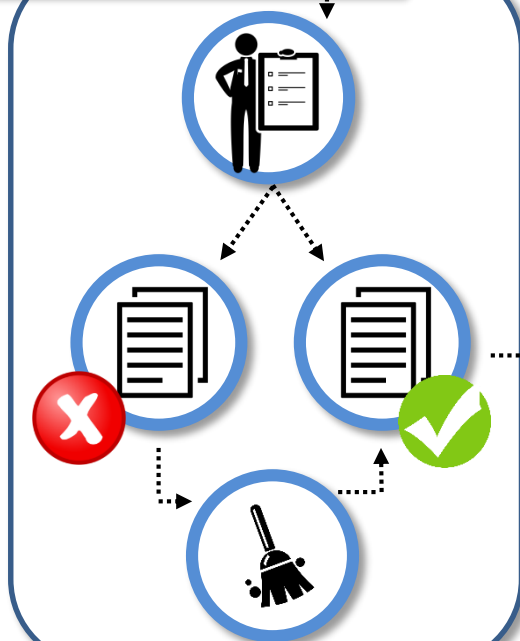
1

Harmonized data collection



2

Data cleansing



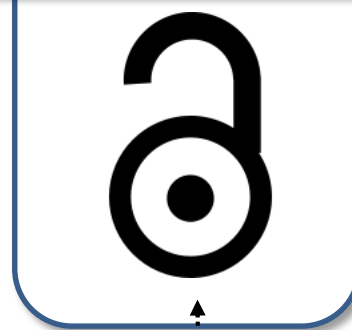
3

Uncertainty analysis



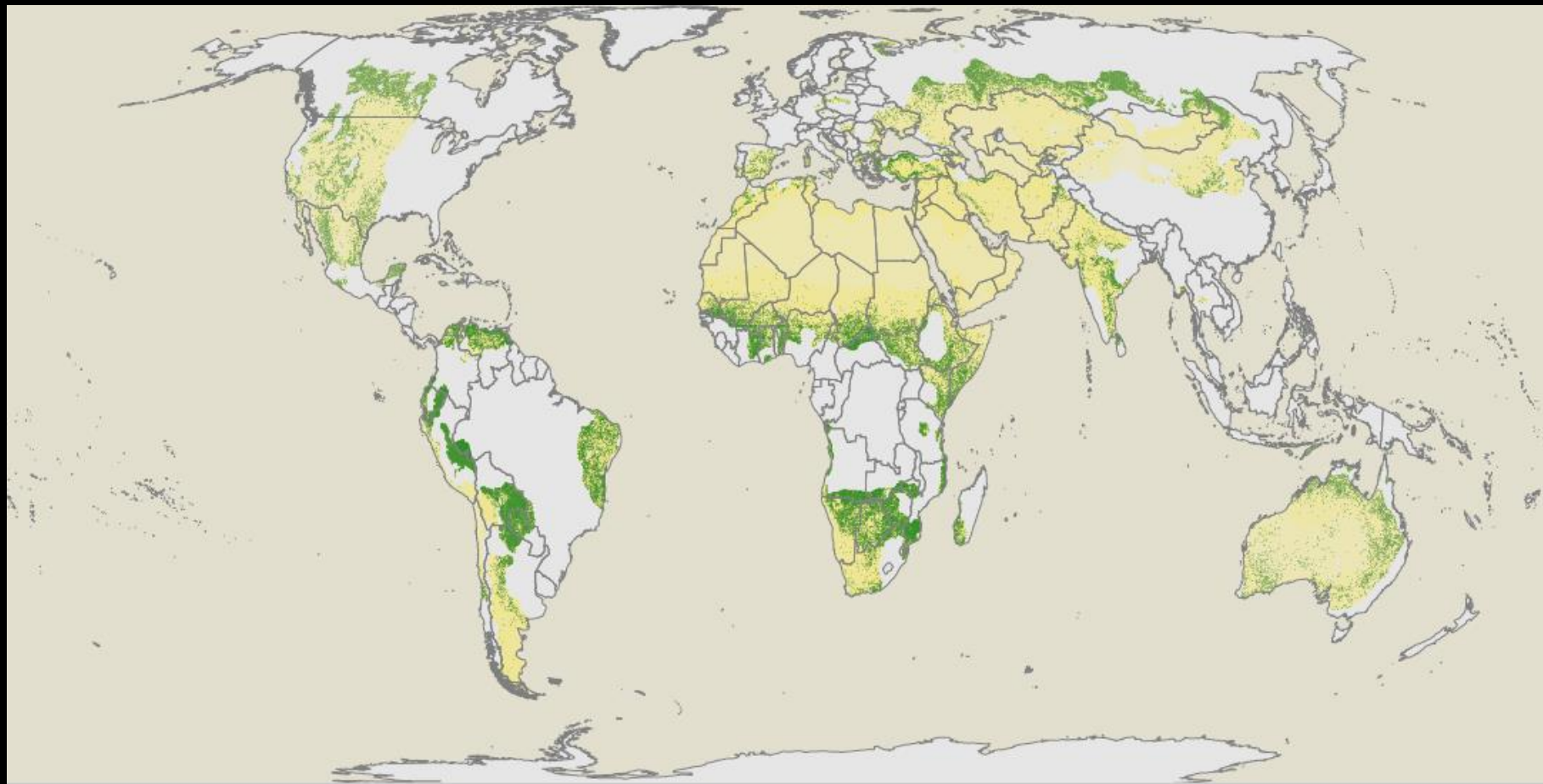
4

Ensuring transparency



Main results (1)

Forest cover



Main results (1)

- **1,324 Mha** ($\pm 7.4\%$) of area covered with more than 10% of tree cover, and **1,079 Mha** ($\pm 3.5\%$) as forest Land-Use according to FAO-FRA definition
 - An area equivalent to Tropical or Boreal forest extent
- **About two-third** of these areas present a closed canopy (tree cover $\geq 40\%$; 777 Mha / 724 Mha)

Main results (2)

■ Comparing apples with apples

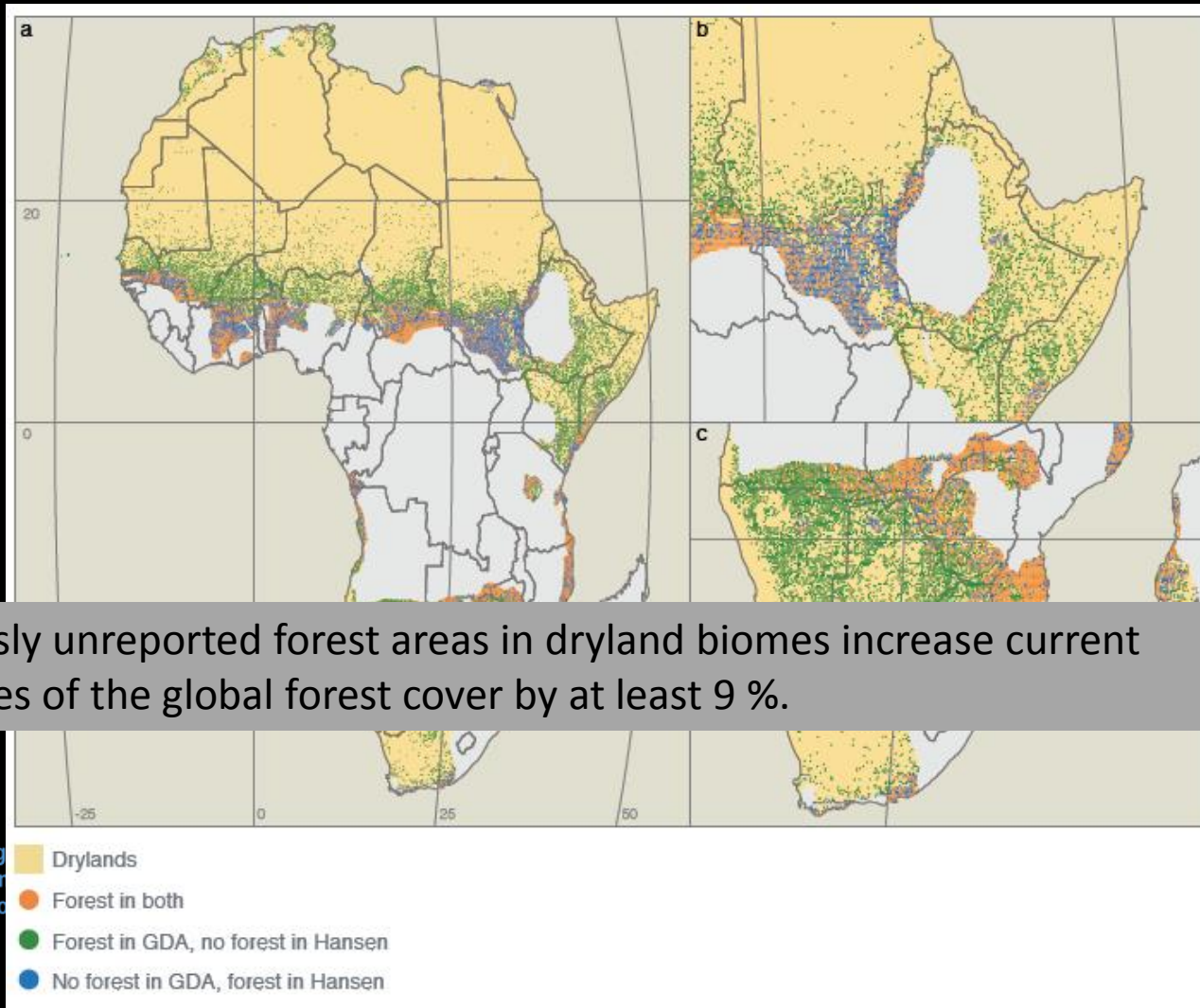
Source	Global FRA RSS (2010)	Globcover (2009)	Hansen et al. (2013)	Sexton et al. (2013)	FAO - GFS (2016)	
Product	Landsat	MODIS	Landsat	Landsat	Very high resolution	
Method	sampling	wall-to-wall	wall-to-wall	wall-to-wall	sampling	
Year	2005	2008	2000	2010	2015	2015
Forest land use	Yes	Yes	-	-	Yes	-
Forest cover	-	-	≥10%	≥10%	-	≥10%
Africa	67	83	216	114	286	364
Asia	43*	148	154	200	213 (97*)	299
Europe	22*	49	97	116	63 (26*)	92
N-America	166	155	173	196	204	238
Oceania	29	28	55	55	114	124
S-America	123	46	205	268	197	208
Total	450	509	900	949	1079 (917*)	1327

→ Increase from **400 to 500 Mha**

→ Extent doubled in Africa and Australia

Main results (2)

- Comparison with Hansen's map for illustration purpose



KEY POINTS

- A new role for **FAO** ?
- A new tool and a new big data **in between** ground data and remote sensing
- User and Policymaker **friendly**
- **Independent** from any environmental layer
- **1st** global use of **VHR** images
- **Version 0** - will only improve in time with re-assessments

The near future :

A version 0 at global level : Please use the data on drylands, question it, and help us making it better!



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Now that we know where the trees can grow
in drylands , let's act!

Thank you for your attention



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Google Earth Engine

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Explorer Data Catalog Workspace

Data +
Add data

Map Satellite

North Pacific Ocean North Atlantic Ocean South Pacific Ocean South Atlantic Ocean Indian Ocean Southern Ocean

Canada United States Mexico Greenland Iceland Norway Sweden Finland Poland Ukraine Kazakhstan Mongolia China South Korea Japan Russia

United Kingdom Germany France Italy Turkey Iraq Iran Afghanistan Pakistan India Thailand Indonesia Papua New Guinea Australia New Zealand

Algeria Libya Egypt Saudi Arabia Mali Niger Chad Sudan Ethiopia Kenya Tanzania Angola Namibia Botswana South Africa

Venezuela Colombia Peru Brazil Bolivia Chile Argentina

ANTARCTICA

Map data ©2016 500 km Terms of Use

The image is a screenshot of the Google Earth Engine Explorer web application. At the top, there is a browser address bar showing the URL 'https://explorer.earthengine.google.com/#workspace'. Below the address bar is the Google Earth Engine logo and a search bar with the placeholder text 'Search Places or Keywords...'. To the right of the search bar are links for 'Send feedback' and 'Sign in'. Below the search bar is the 'Explorer' section, which includes a 'Data' panel on the left with a '+ Add data' button, and a 'Map' panel on the right with 'Map' and 'Satellite' view toggles. The main area of the interface is a world map showing various countries and oceans. The map is centered on the Atlantic Ocean, showing North America, South America, Europe, Africa, and parts of Asia and Australia. The map is labeled with the names of many countries, including Canada, United States, Mexico, Greenland, Iceland, Norway, Sweden, Finland, Poland, Ukraine, Kazakhstan, Mongolia, China, South Korea, Japan, Russia, United Kingdom, Germany, France, Italy, Turkey, Iraq, Iran, Afghanistan, Pakistan, India, Thailand, Indonesia, Papua New Guinea, Australia, New Zealand, Algeria, Libya, Egypt, Saudi Arabia, Mali, Niger, Chad, Sudan, Ethiopia, Kenya, Tanzania, Angola, Namibia, Botswana, South Africa, Venezuela, Colombia, Peru, Brazil, Bolivia, Chile, and Argentina. The map also shows the names of the oceans: North Pacific Ocean, North Atlantic Ocean, South Pacific Ocean, South Atlantic Ocean, Indian Ocean, and Southern Ocean. At the bottom of the map, there is a Google logo, the word 'ANTARCTICA', and a scale bar indicating 'Map data ©2016 500 km Terms of Use'.

Google Earth Engine

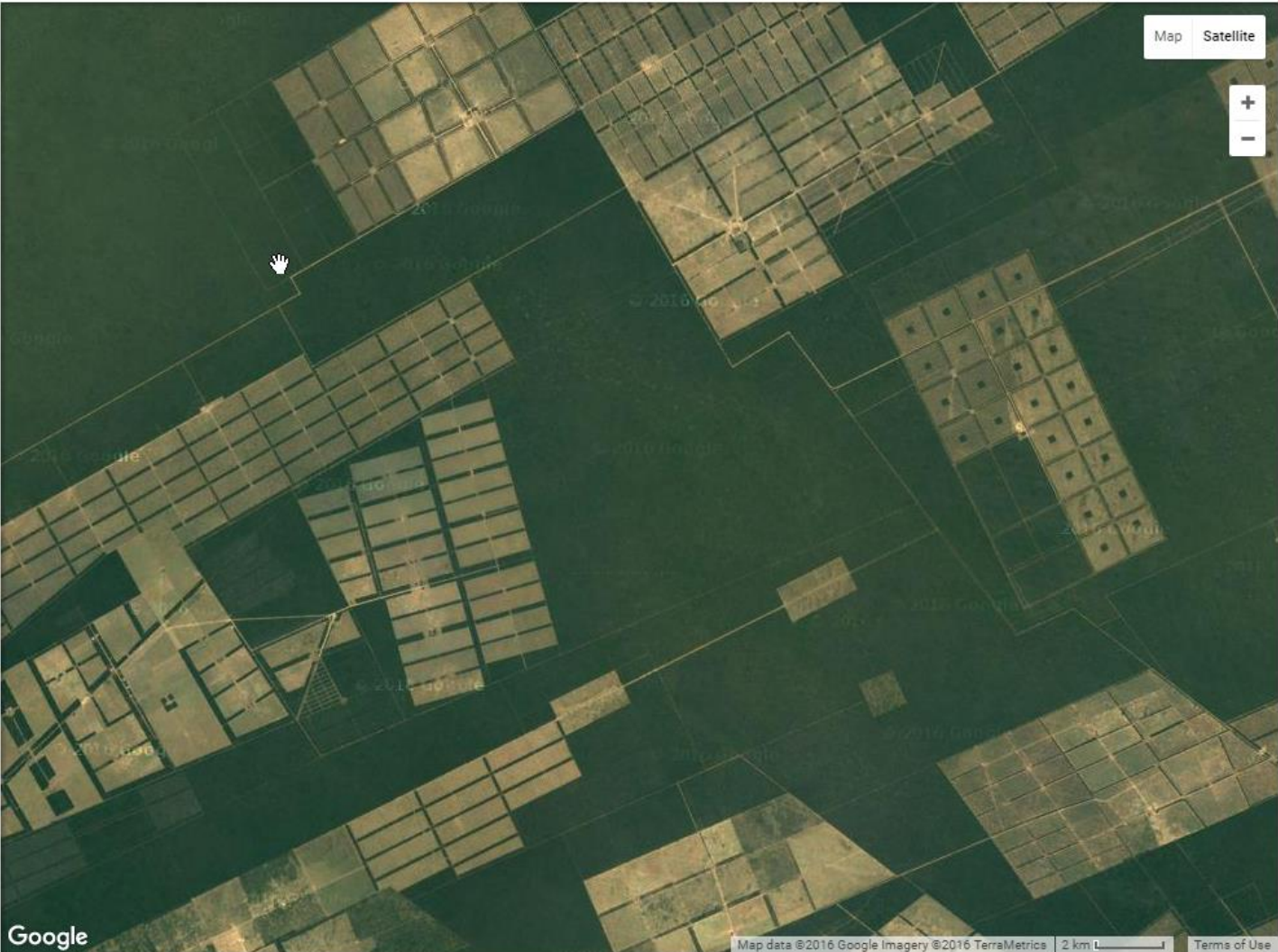
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Explorer Data Catalog Workspace

Data +
Add data

Map Satellite + -



Google

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The image shows a satellite view of a landscape with a grid overlay, likely representing a spatial analysis or data visualization. The grid is composed of rectangular cells, some of which are highlighted in yellow. A hand cursor is visible over the map, indicating an interactive element. The map is framed by a dark border, and the Google Earth Engine logo is visible in the top left corner. The bottom of the image shows a scale bar and copyright information.

Google Earth Engine

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Explorer Manage workspace ▾ The map layer has been deleted. [Undo](#) Data Catalog Workspace

Data +

1975	🔗
1985	🔗
1990	🔗
2000	🔗
2001	🔗
2002	🔗
2004	🔗
2006	🔗
2008	🔗
2010	🔗
2012	🔗
2014	🔗
2015	🔗
2016	🔗

←

Add data Add computation

Analysis: Train a classifier ▾

Classifier Resolution (m)

Random Forests ▾ 30

Train classifier and display results

Map Satellite + -

Google

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For more details



remote sensing



Article

Collect Earth: Land Use and Land Cover Assessment through Augmented Visual Interpretation

Adia Bey ^{1,*}, Alfonso Sánchez-Paus Díaz ¹, Danae Maniatis ^{2,3}, Giulio Marchi ¹, Danilo Mollicone ¹, Stefano Ricci ¹, Jean-François Bastin ^{1,4}, Rebecca Moore ⁵, Sandro Federici ¹, Marcelo Rezende ¹, Chiara Patriarca ¹, Ruth Turia ⁶, Gewa Gamoga ⁶, Hitofumi Abe ¹, Elizabeth Kaidong ⁶ and Gino Miceli ⁵

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Assessing tree cover

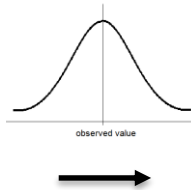


Uncertainty analysis

Step 1 :

Error distribution due to visual interpretation

Obs	AVI
TC_A	TC_1
TC_B	TC_2
...	...
TC_Z	TC_3



Step 2 : propagate error on TC estimation

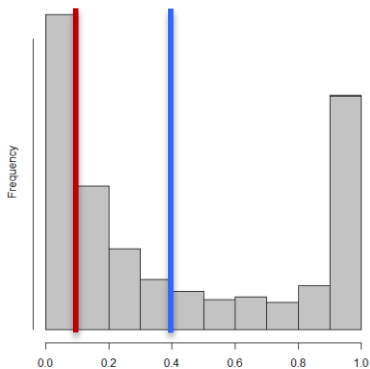
AVI	Obs + Err1	Obs + Err2		Obs + Err100
TC_1	TC_1 + err1	TC_1 + err2		TC_1 + err100
TC_2	TC_2 + err1	TC_2 + err2		TC_2 + err100
...
TC_3	TC_3 + err1	TC_3 + err2		TC_3 + 100

Step 3 : define TC threshold

10 %

40 %

Area	Area err1	Area err2		Area err100
Area	Area err1	Area err2		Area err100

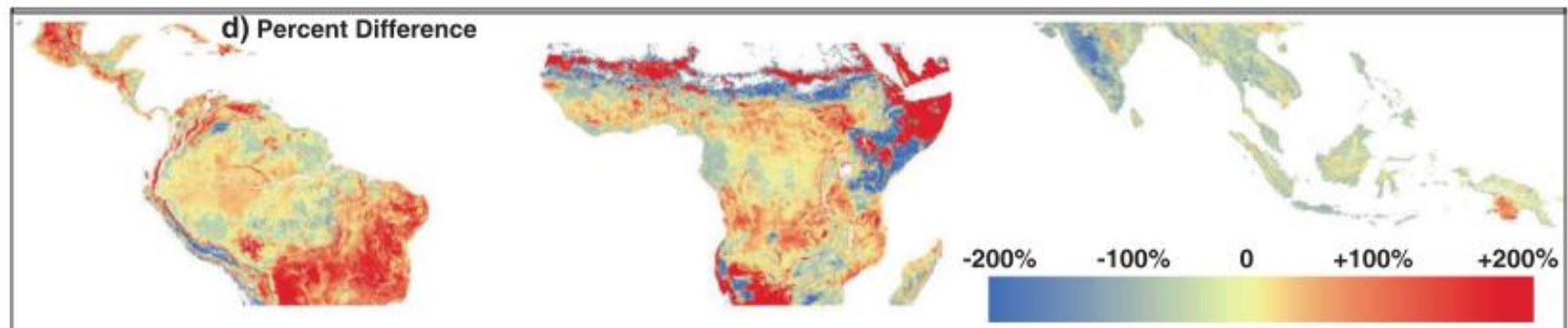


RESEARCH

Open Access

Uncertainty in the spatial distribution of tropical forest biomass: a comparison of pan-tropical maps

Edward TA Mitchard^{1*}, Sassan S Saatchi², Alessandro Baccini³, Gregory P Asner⁴, Scott J Goetz³, Nancy L Harris⁵ and Sandra Brown⁵



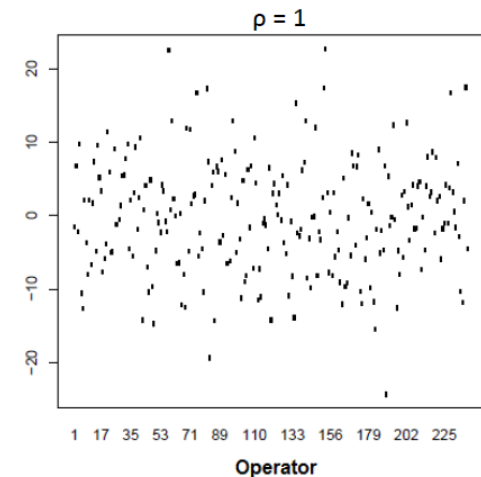
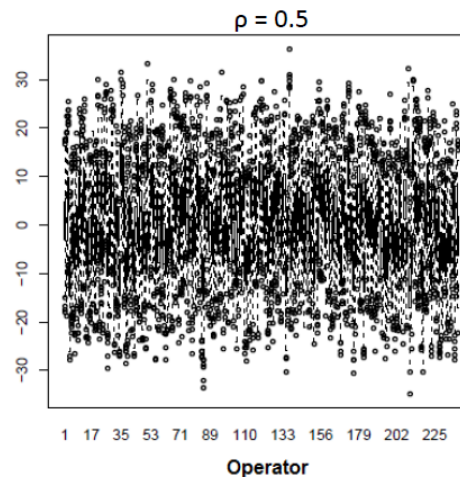
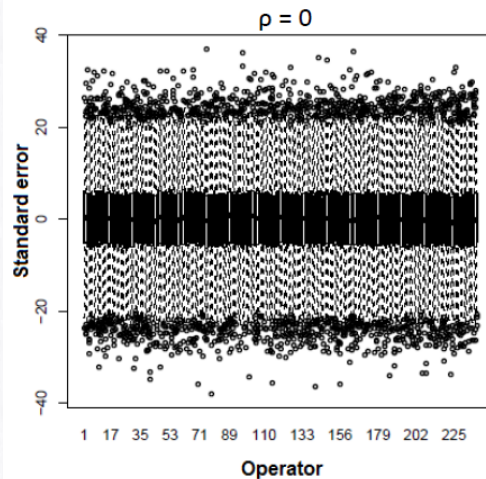
Uncertainties

- Uncertainties calculated here for the total forest area calculated from (1) forest land-use assessment and from (2) the tree cover assessment.
- Uncertainties are calculated combining “sampling error” and “measurement error”

$$\sigma^2 = \underbrace{\sum_{i=1}^I A_i^2 f_i \frac{\pi_i(1 - \pi_i)}{n_i - 1}}_{\text{Sampling error}} + \underbrace{\sum_{i=1}^I A_i^2 \left(\frac{n_i - 1 - f_i}{n_i - 1} \right) \tau_i^2}_{\text{Measurement error}}$$

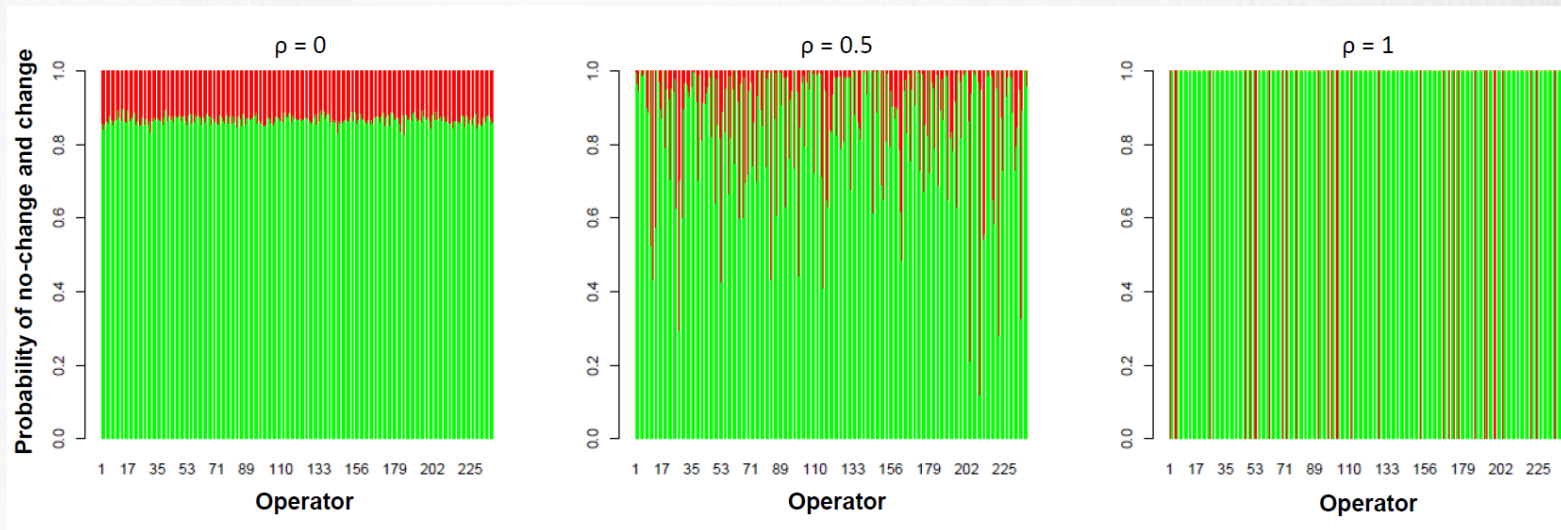
Measurement error – Tree Cover

- Standard deviation of the measurement estimated calculating the Root Mean Square Difference (Montesano et al. 2009) between ground and collect earth (RMSD = 8 %)
- Propagation on forest area estimation : Implementing the SD, following a Gaussian distribution centered on 0, we also account for an operator effect of $\rho=0.5$:



Measurement error – Forest land use

- Based on the percentage of agreement/disagreement comparing ground with Collect Earth (Agreement = 87%)
- Propagation on forest area estimation : Selecting 13 % of land-use to switch from forest/non-forest and non-forest/forest, accounting for an operator effect of $\rho=0.5$:



Results on uncertainties

- On forest estimation based on Tree Cover threshold of 10% :

1,326 ± 98 Mha (± 7.4%)

- On forest estimation based on Tree Cover threshold of 10% :

1,079 ± 38 Mha (± 3.5%)

