



Supporting the use of Earth observation data for sustainable development

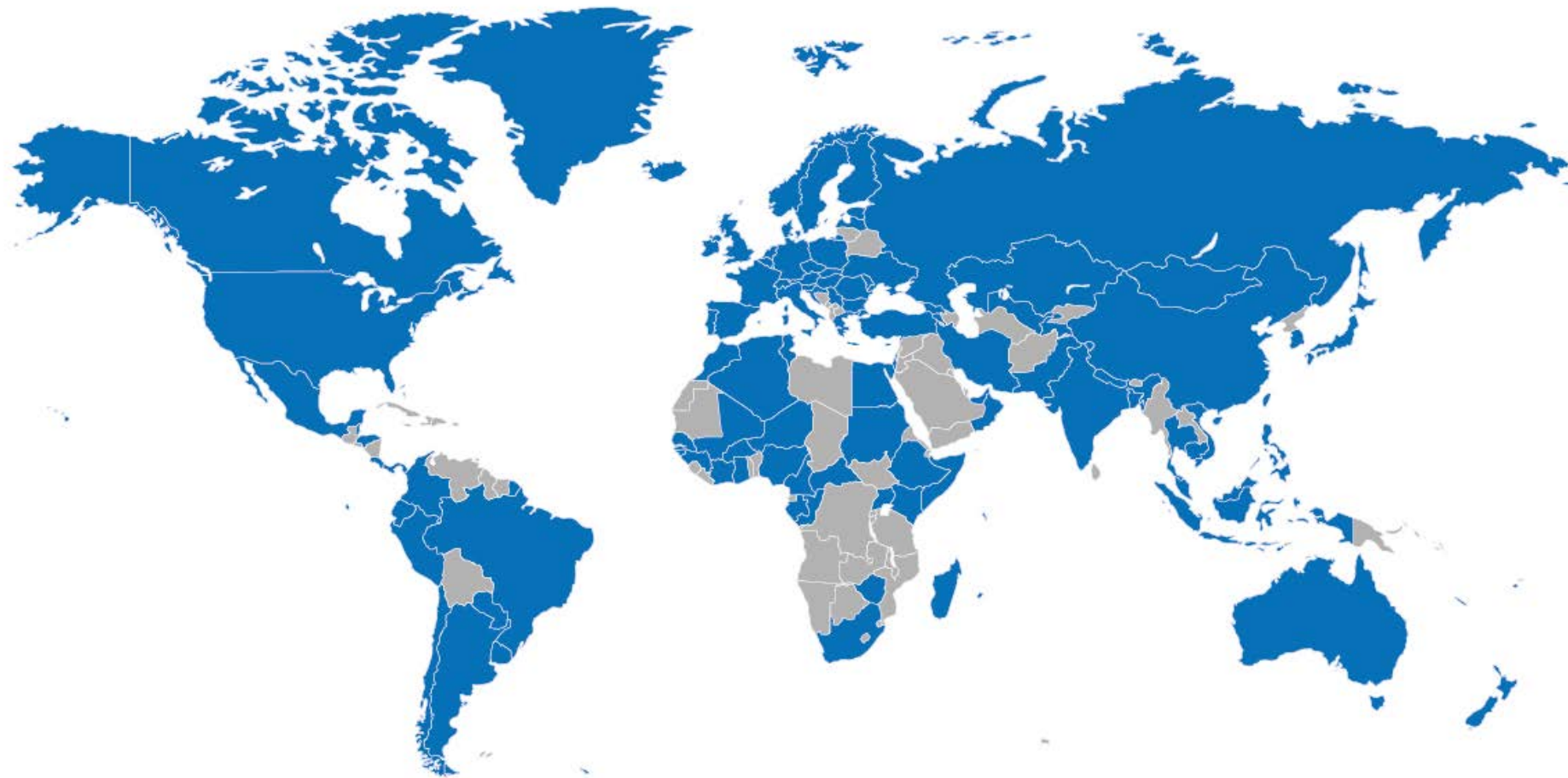
Gilberto Câmara

GEO Secretariat Director

Presented at ESA Living Planet Symposium 2019

www.earthobservations.org
www.geoportal.org

GEO member states



Africa: **27** - Asia/Oceania - **21**, Europe: **34** - C.I.S: **7** - Americas: **16**

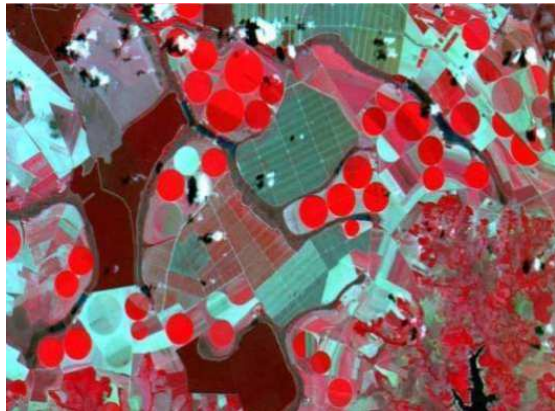
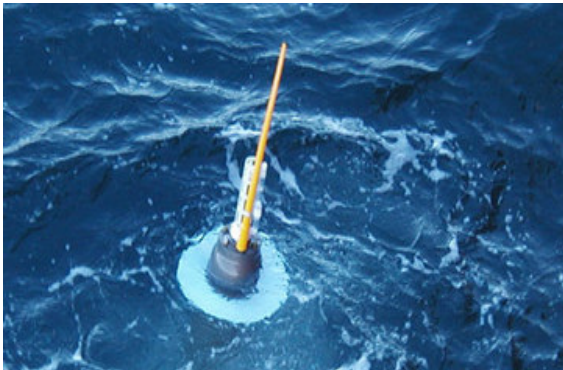
Total: 105

GEO participating organisations (128)



How does GEO work?

data



community



analysis

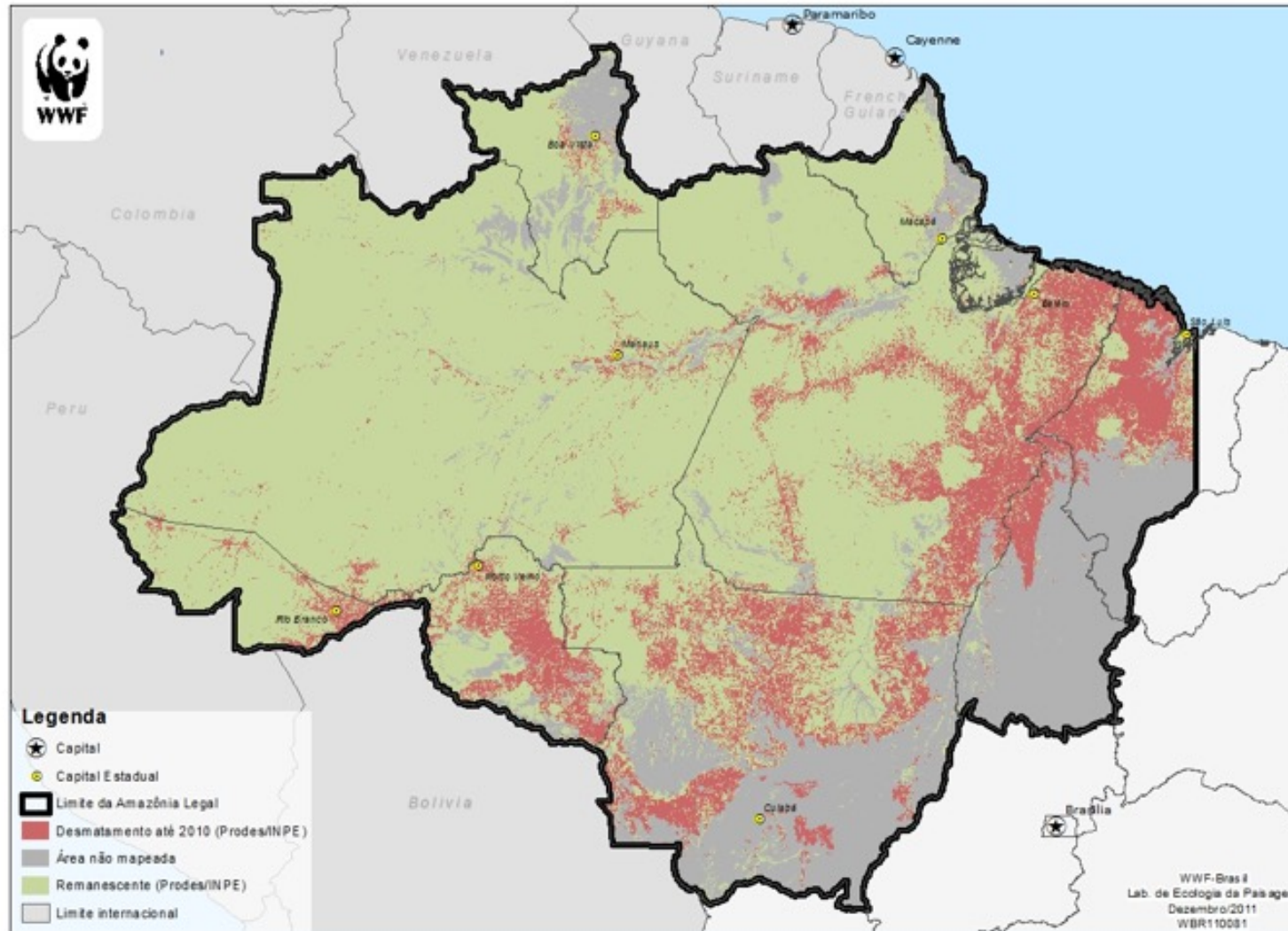
agreements



UN World Conference on
Disaster Risk Reduction
2015 Sendai Japan



The value of Earth observation: How much? Where? When? Who?



What is missing?

How many operational EO applications are supporting GEO member countries to...

Comply with their NDCs to the Paris Agreement?

Develop disaster preparedness?

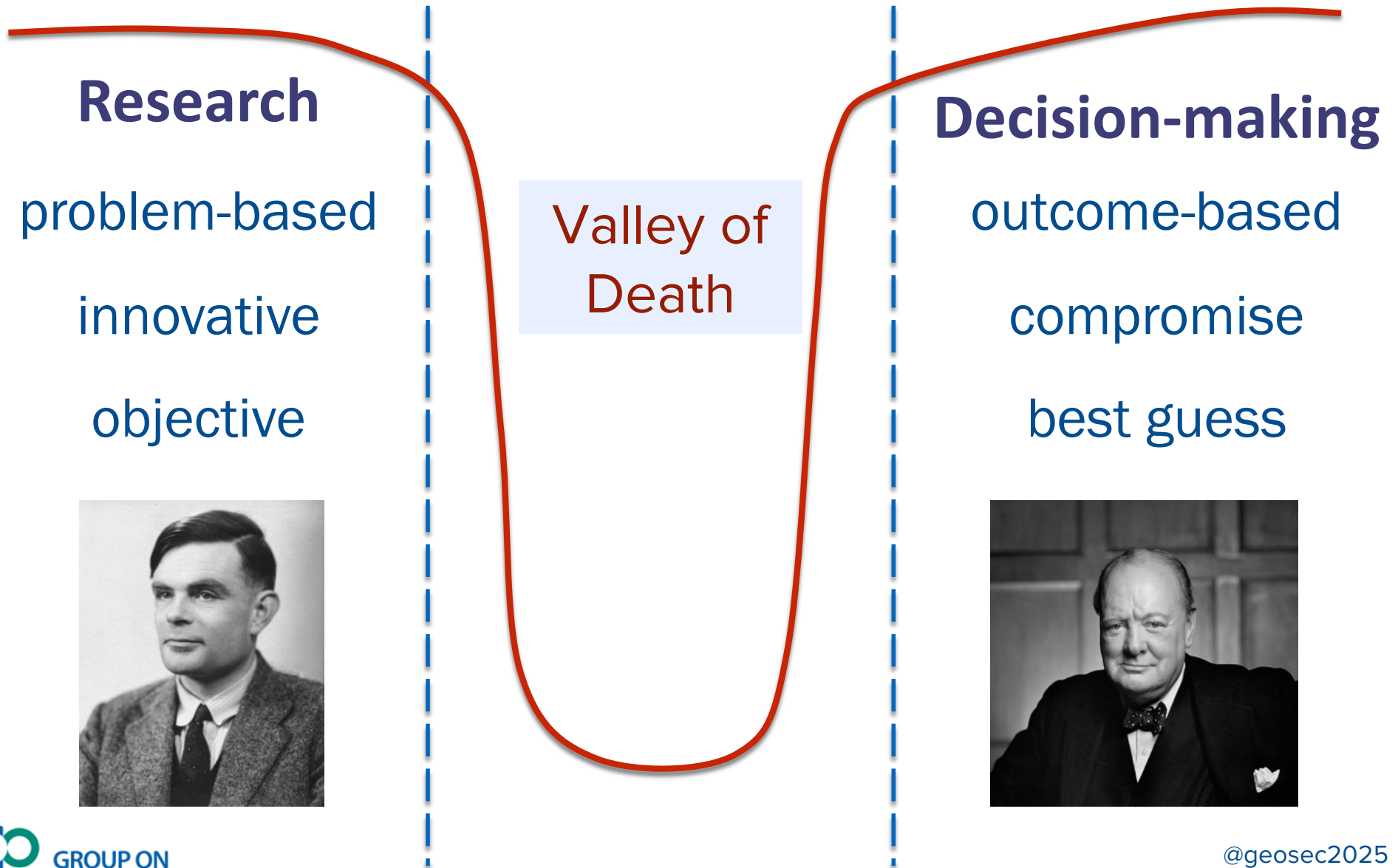
Produce SDGs and transition to a green economy?



UN World Conference on
Disaster Risk Reduction
2015 Sendai Japan



From research to decision-making



The challenge we face



Hundreds of presentations on innovative work:
how many are reproducible and reusable?

Building institutions for sustainability



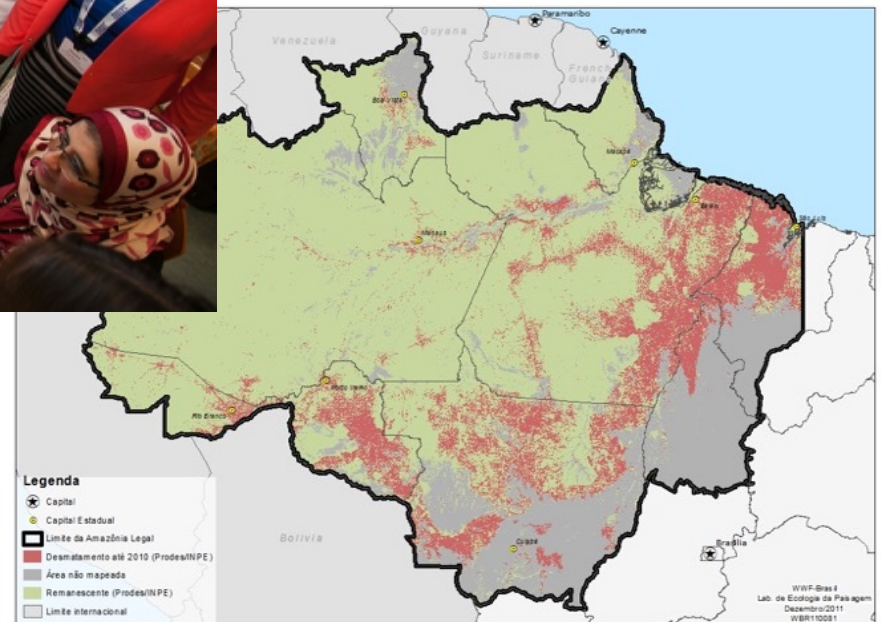
EO data

Trust is the key!



socially robust results

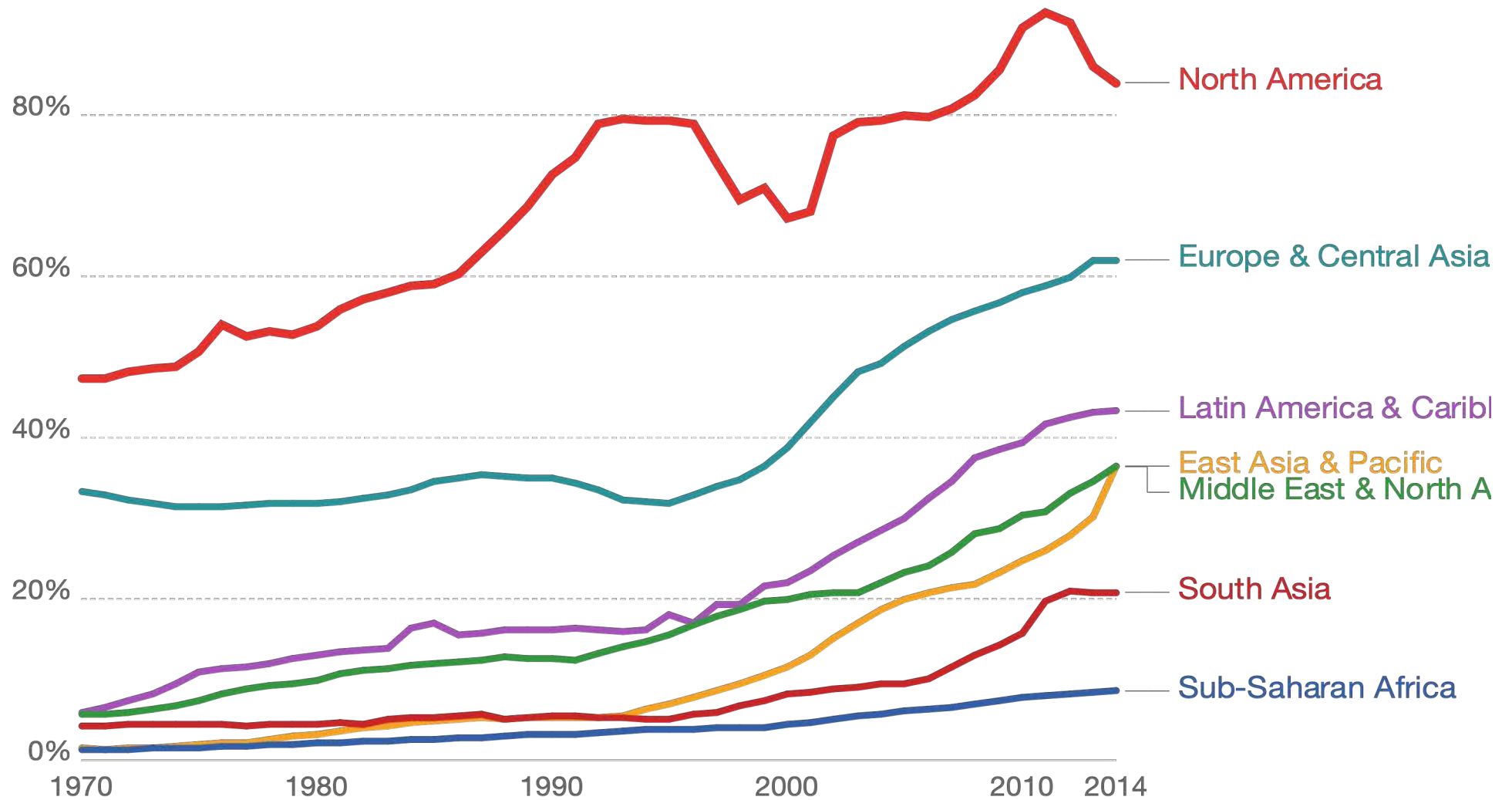
co-design & co-production



Trust matters!



The world is becoming more educated: enrolment rate in tertiary education

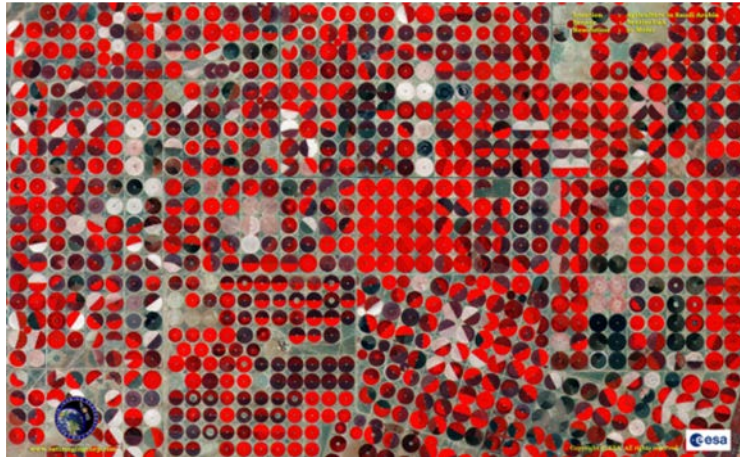


Source: World Bank

OurWorldInData.org/tertiary-education/ • CC BY-SA

source: World Bank

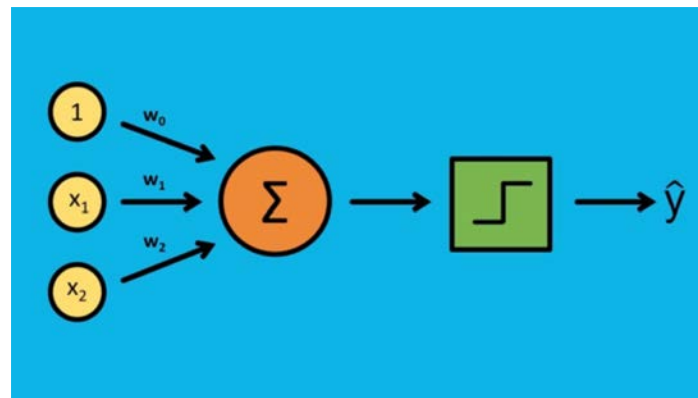
How we work on Earth observation?



Study area and images



In situ data



New method

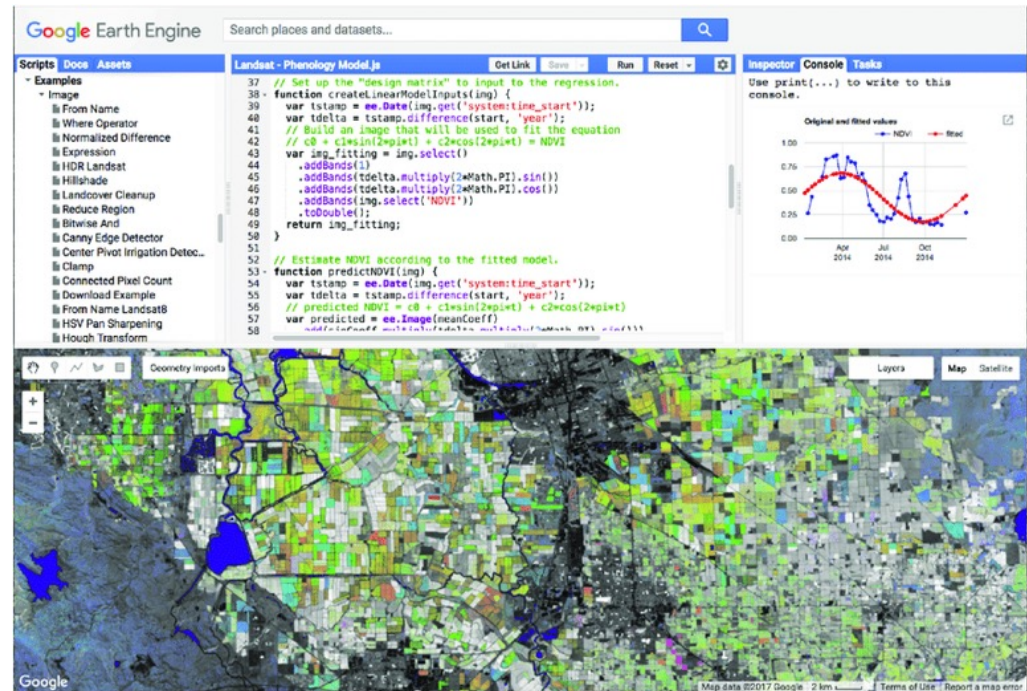
Paper

What is needed?

Easy access to the products and services developed in GEO.

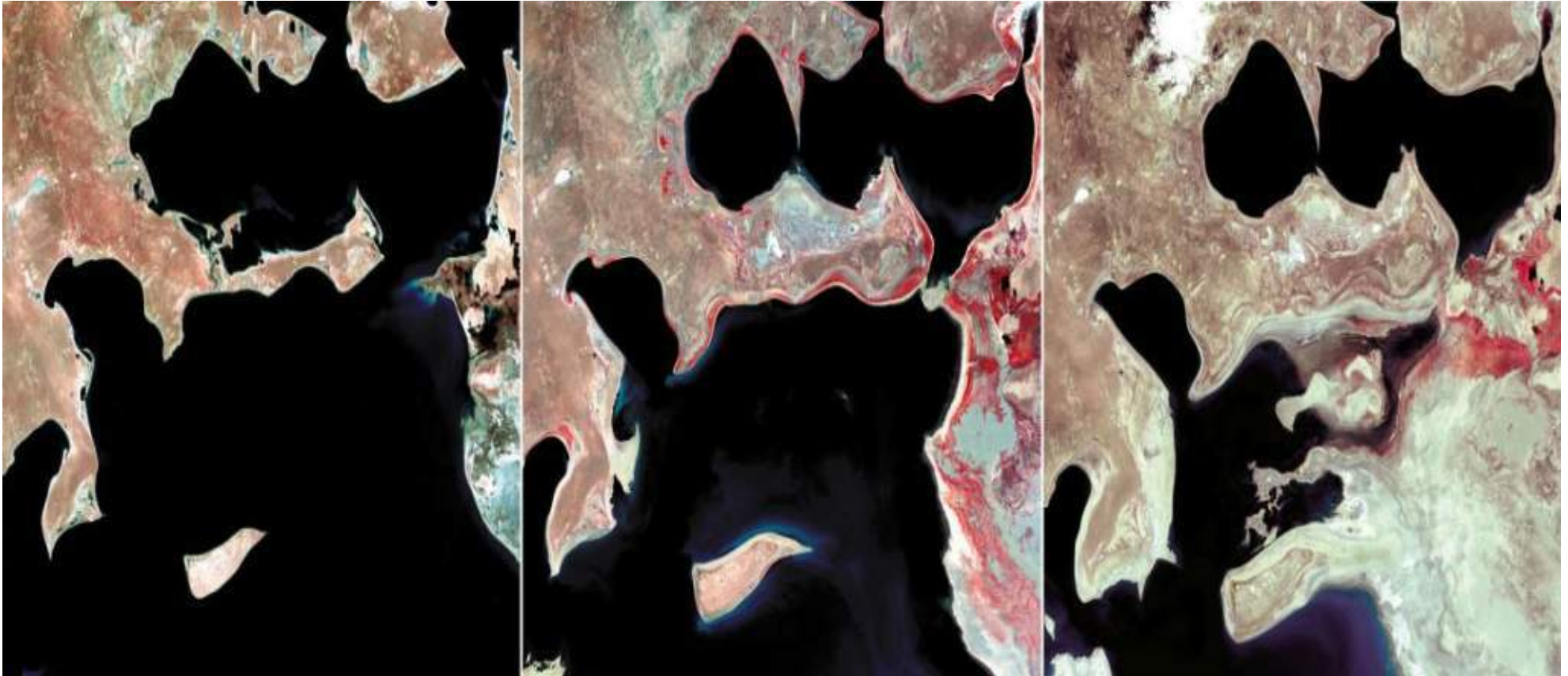
Access to methods, code, models, source data, etc.

Enable others to reuse the results in their country, based on local circumstances.



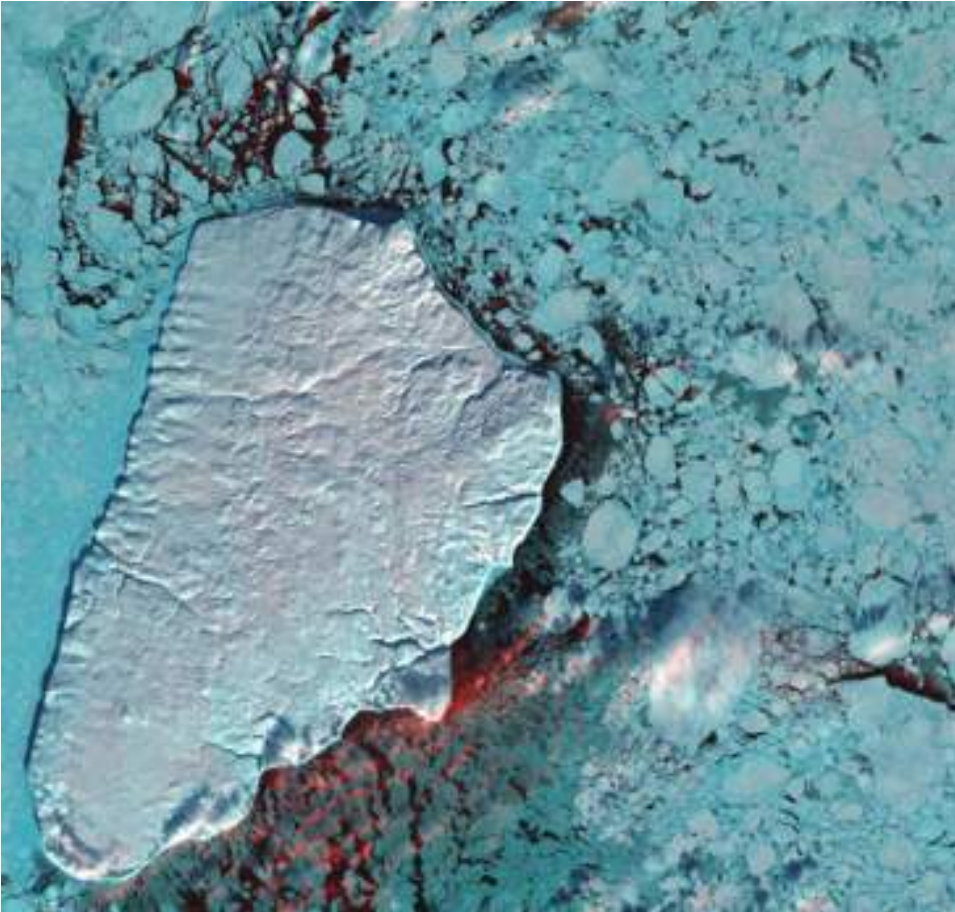
Create a broad global network of EO practitioners who are in control of the tools they use

Sustainable development: present vs future



Who gets to decide? How are decisions made?

Knowledge and action for sustainable development

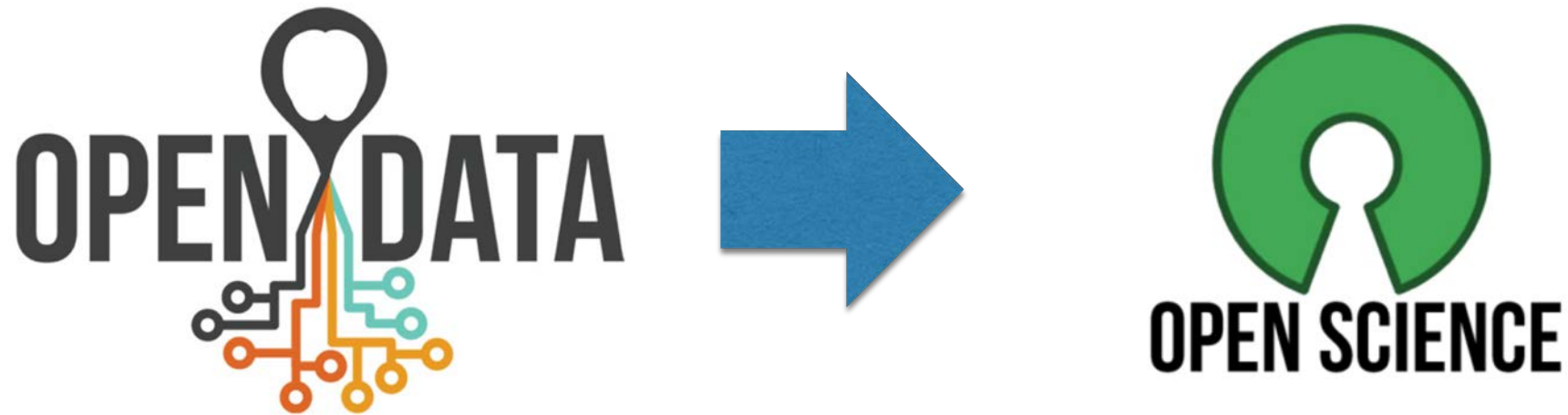


Knowledge: informs us about the **limits of our planet**



Action: societies decide how to **use our planet's resources**

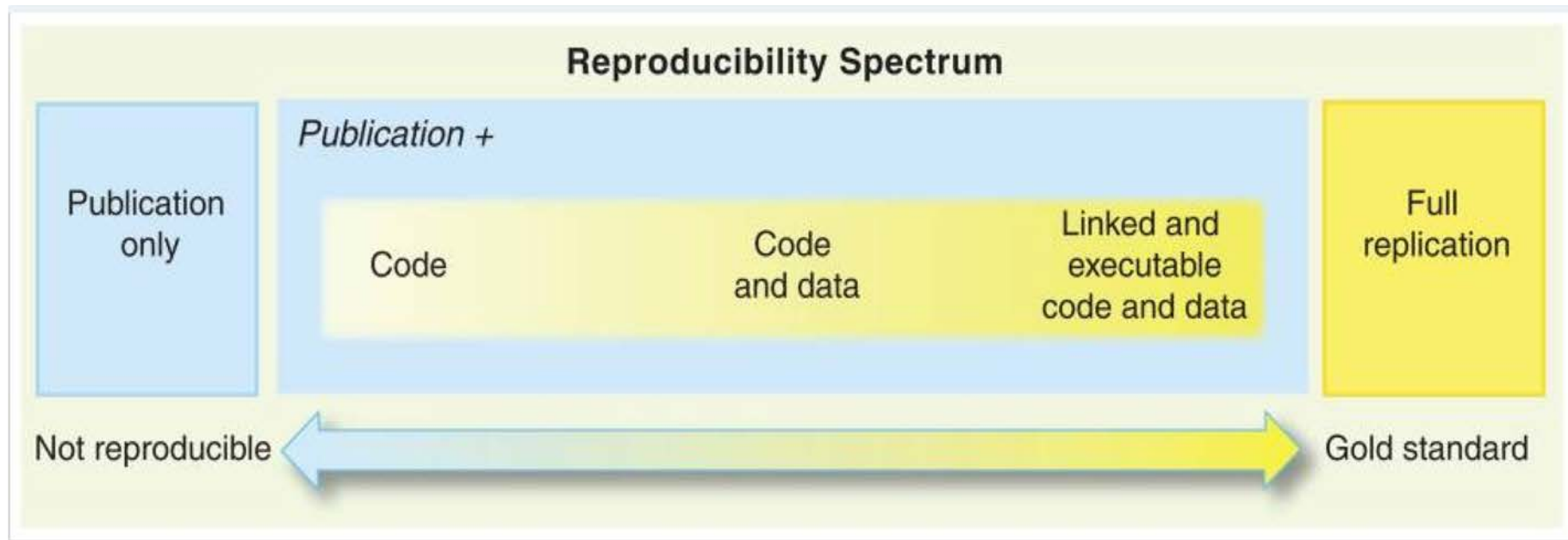
Moving GEO forward



The first 15 years of GEO: focus on provision of **open data**

The future: focus on **results** based on **open Science**

Achieving reproducible knowledge



Exposing all parts of an application

Codified knowledge in EO

(a) Journal paper

ISPRS Journal of Photogrammetry and Remote Sensing

journal homepage: www.elsevier.com/locate/isprsjprs

Big earth observation time series analysis for monitoring Brazilian agriculture

Michelle Cristina Araujo Picoli^{a,*}, Gilberto Camara^a, Ieda Sanches^a, Rolf Simões^a, Alexandre Carvalho^b, Adeline Maciel^c, Alexandre Coutinho^c, Julio Esquerdo^c, Joao Antunes^c, Rodrigo Anzolin Begotti^d, Damien Arvor^d, Claudio Almeida^e

^a National Institute for Space Research (INPE), São José dos Campos, Brazil
^b Institute of Applied Economic Research (IPEA), Brasília, Brazil
^c Empresa Agrícola Informática, Brazilian Agricultural Research Corporation (Embrapa), Campinas, Brazil
^d Université de Rennes, CNRS, IRTV - EMR 6104, F-35000 Rennes, France

(c) R code in github

Branch: master | [sits / demo / classify_deeplearning.R](#)

2 contributors

```
1 library(sits)
2 library(keras)
3 # install_keras()
4
5 message("Processing of a mixed landsat 8 - MODIS data set")
6 message("Please ensure that you have enough memory available")
```

(b) In-situ data

PANGAEA
Data Publisher for Earth & Environmental Science

Câmara, Gilberto; Picoli, Michelle; Simoes, Rolf; Maciel, Adeline; Carvalho, Alexandre X Y; Coutinho, Alexandre; Esquerdo, Julio; Antunes, Joao; Begotti, Rodrigo; Arvor, Damien (2017): Land cover change maps for Mato Grosso State in Brazil: 2001-2016, links to files. PANGAEA, <https://doi.org/10.1594/PANGAEA.881291>.

Supplement to: Picoli, Michelle; Câmara, Gilberto; Sanches, Ieda; Simoes, Rolf; Carvalho, Alexandre X Y; Maciel, Adeline; Coutinho, Alexandre; Esquerdo, Julio; Antunes, Joao; Begotti, Rodrigo; Arvor, Damien; Almeida, Claudio (2018): Big earth observation time series analysis for monitoring Brazilian agriculture. ISPRS Journal of Photogrammetry and Remote Sensing, 145, 328-339, <https://doi.org/10.1016/j.isprsjprs.2018.08.007>

(d) Cloud data in AWS

Amazon S3 > landsat-modis

Name	TS	Last modified	TS	Size	TS
<input type="checkbox"/>	LO8MOD_222068_2015-08-29_evl.tif	Apr 8, 2018 1:40:49 PM GMT+0200		2.3 GB	
<input type="checkbox"/>	LO8MOD_222068_2015-08-29_mdv.tif	Apr 8, 2018 1:49:12 PM GMT+0200		2.4 GB	
<input type="checkbox"/>	LO8MOD_222068_2015-08-29_akk.tif	Apr 8, 2018 1:56:01 PM GMT+0200		2.1 GB	

(e) Results

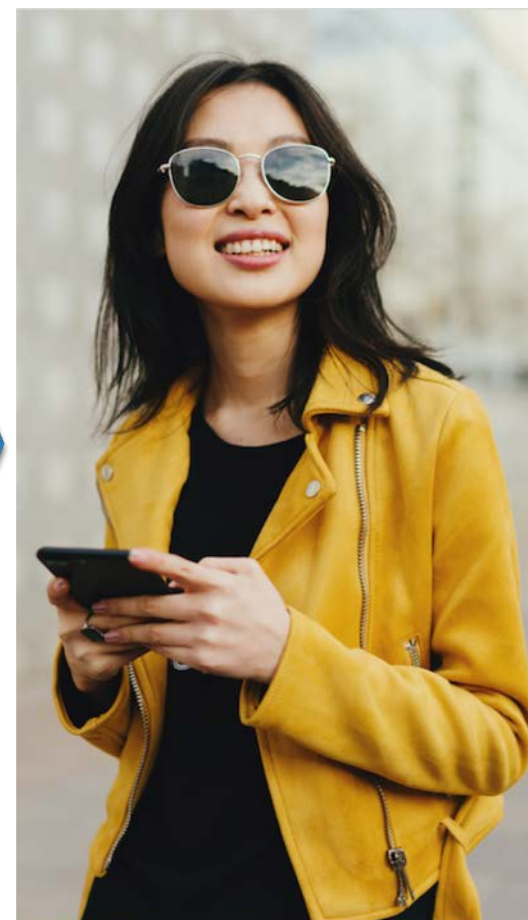
The new digital economy



big data



Low access
cost



massive use

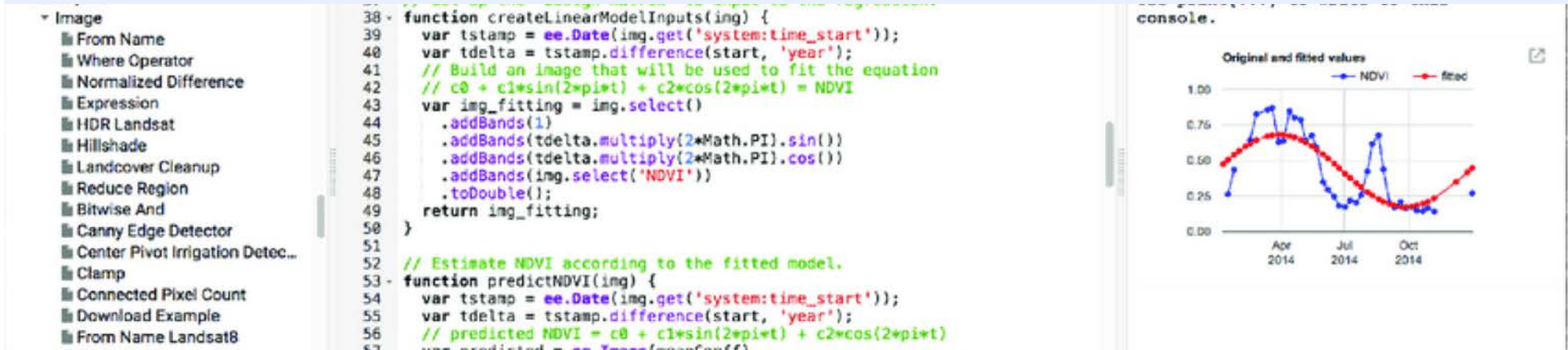
Google, Twitter, Facebook, Spotify, Netflix,...

Knowledge is becoming easier to share



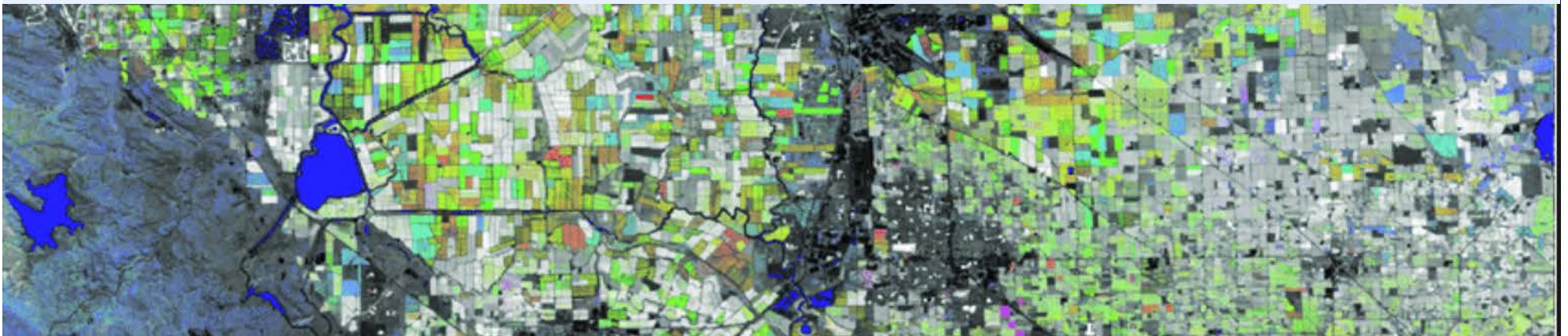
Using the cloud: focus on **mindware**, not hardware

Google Earth Engine: Silicon Valley comes to Earth observations



The screenshot displays the Google Earth Engine interface. On the left, a list of image sources is visible, including 'From Name', 'Where Operator', 'Normalized Difference', 'Expression', 'HDR Landsat', 'Hillshade', 'Landcover Cleanup', 'Reduce Region', 'Bitwise And', 'Canny Edge Detector', 'Center Pivot Irrigation Detec...', 'Clamp', 'Connected Pixel Count', 'Download Example', and 'From Name Landsat8'. The central code editor shows a JavaScript function named 'createLinearModelInputs' and another named 'predictNDVI'. The 'predictNDVI' function uses the 'createLinearModelInputs' function to estimate NDVI values. The console on the right shows a line graph titled 'Original and fitted values' with 'NDVI' (blue line with dots) and 'fitted' (red line with dots) values plotted against time from April to October 2014. The y-axis ranges from 0.00 to 1.00.

Global enabler (2.000+ papers): low entry cost to big Earth observation data analysis



but...no public decision on data, no long term guarantee

The zero download model



Users

Software

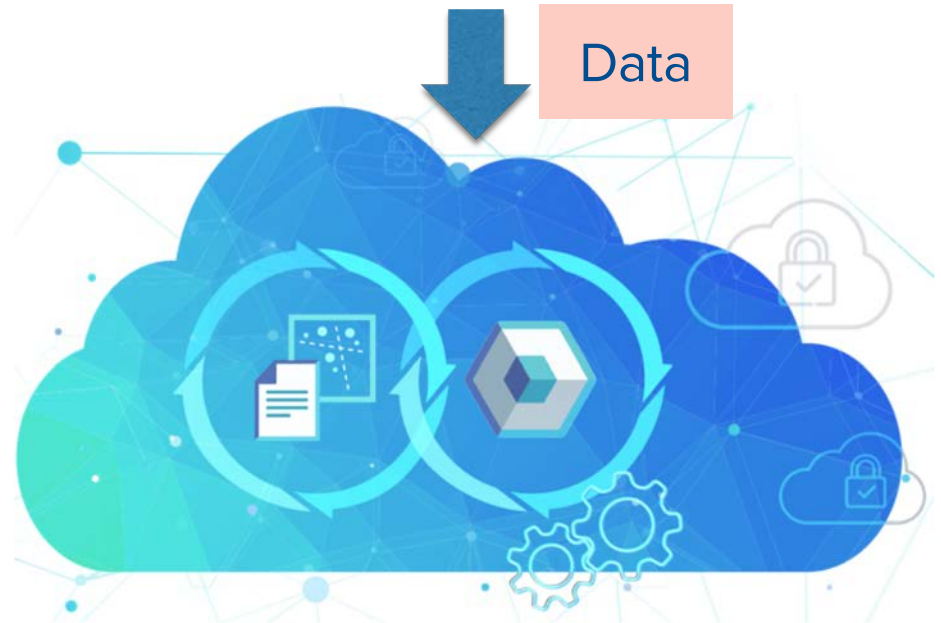


Results



Space agencies

Data



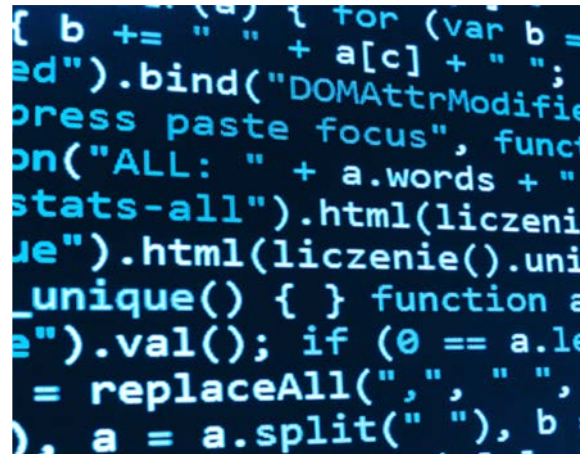
Cloud platforms

What the global EO community needs

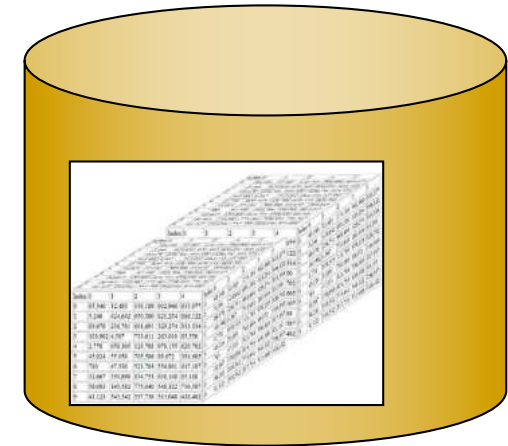
Empowered
global experts



Reusable, shared
knowledge

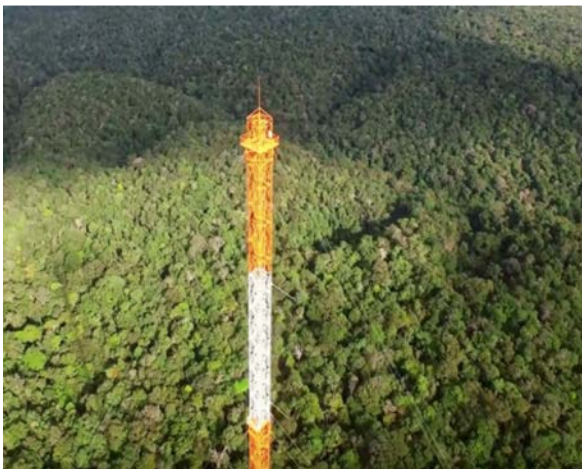


Cloud
platforms



APIs

APIs



In-situ
observations

Multi-
satellite data

