



# Earth observations and Geospatial Information for the Sustainable Development Goals

*Lawrence Friedl, NASA & EO4SDG Initiative*

*Argyro Kavvada, NASA/BAH & EO4SDG Initiative*

*Workshop for Members of the Caribbean Project and the Americas*

*UN-GGIM 8 • UN Headquarters • 30-31 July, 2018*





***Earth Observations  
and the SDGs***



**GEO & SDGs**



**Examples of EO  
applications for SDGs**



**NASA Earth Science -  
ARSET Program**



## Group on Earth Observations

Intergovernmental organization working to improve the availability, access, and use of Earth obs. to benefit society.

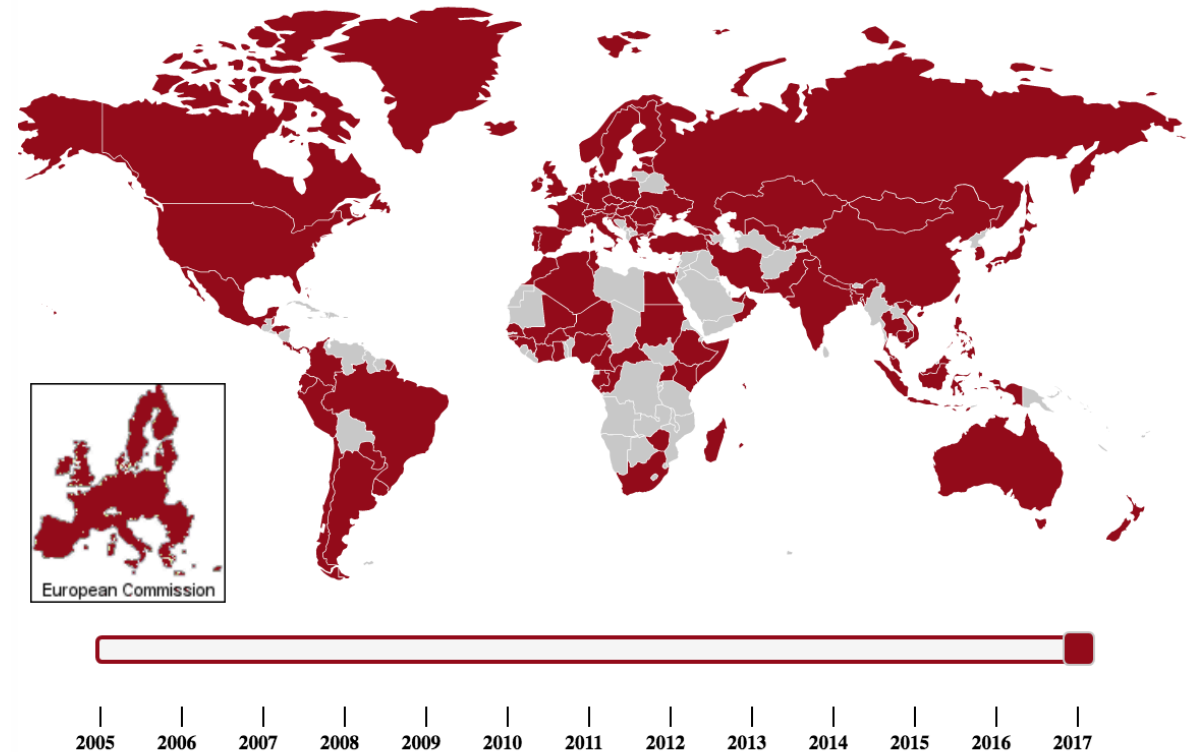
105 Member Countries: A forum for ministerial-level consultation

GEO has convening power and elevates awareness of Earth observations issues from a technical level to a policy level

Maintains a multi-year “Work Programme” as a compendium of projects

GEO Member Map for the year 2017

*(Use slider under the map to change the year)*



Africa: 27 – Americas: 16 – Asia/ Oceania: 21 - C.I.S.: 7 - Europe: 34 Total: 105



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## Engagement Priorities

GEO’s global priorities include supporting the UN 2030 Agenda for Sustainable Development, the Paris Agreement on Climate Change, and the Sendai Framework on Disaster Risk Reduction.



UN World Conference on  
Disaster Risk Reduction  
2015 Sendai Japan

*What questions do you and your organization have?*

## Discover

**How do I find  
Earth  
observations  
data and  
information?**

## Access

**How do I access  
Earth  
observations  
data and  
information?**

## Use

**How do I use  
Earth  
observations  
data and  
information?**



# Alignment of Earth Observations to the SDGs

*SDGs with most opportunities*



# EO4SDG



EARTH OBSERVATIONS FOR THE  
SUSTAINABLE DEVELOPMENT GOALS

## INITIATIVE CO-CHAIRS

Mexico/INEGI



Japan/JAXA



USA/NASA



## EXECUTIVE SECRETARY

USA/NASA





# EO4SDG Initiative

## Earth Observations in Service of the 2030 Agenda

### Purpose:

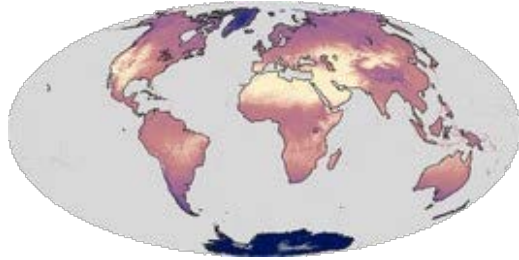
Organize and enable the potential of Earth observations and geospatial information within GEO to advance the 2030 Agenda and enable societal benefits through achievement of the SDGs.

### Key Emphasis:

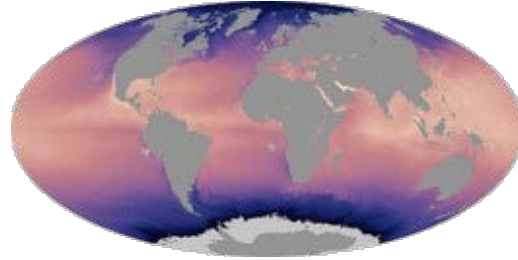
Collaborations with global statistical community, NSOs, line ministries, custodian agencies. Also, communication role in a federated approach to GEO community.

- » **Projects**  
*Develop, validate and deploy uses of Earth observations to support SDG tracking and reporting*
- » **Capacity Building**  
*Build skills for accessing and applying Earth observations data*
- » **Data and Information Products**  
*Advance discoverability and accessibility of products*
- » **Outreach and Engagement**  
*Promote the consideration and adoption of Earth obs. for the SDGs*

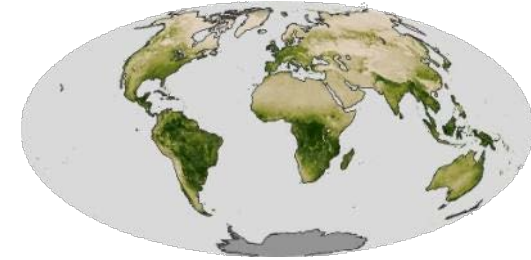
# Earth Observations, an essential source of information for the SDGs



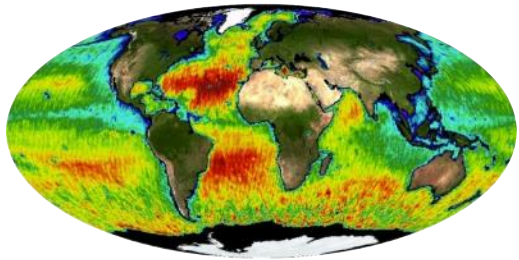
**Land Temperature**



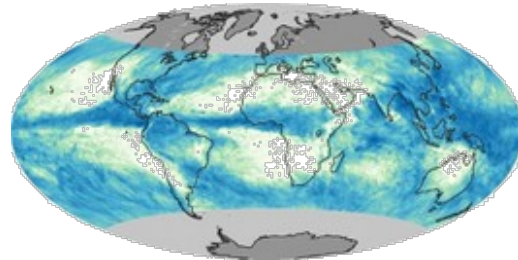
**Sea Surface Temperature**



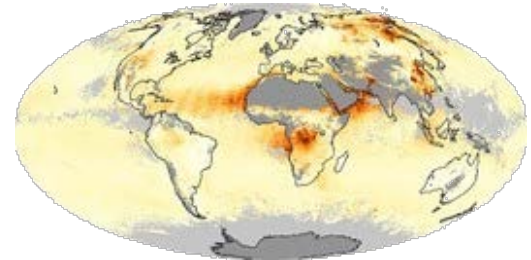
**Vegetation**



**Sea Surface Salinity**



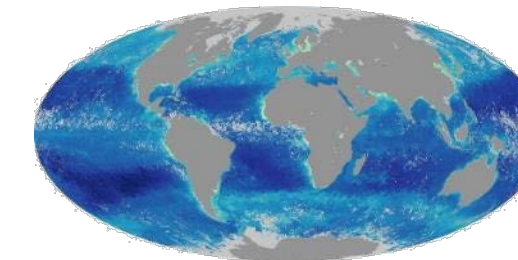
**Total Rainfall**



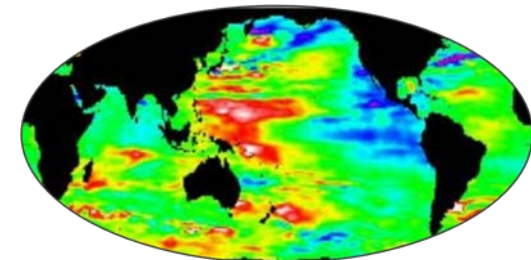
**Aerosols**



**Fires & Thermal Anomalies**



**Chlorophyll**



**Sea Surface Height**





Argo floats are used to observe the ocean [image from Commonwealth Scientific and Industrial Research Organization]



The GOES-R Series—a collaborative program between NASA and NOAA.

Ground-based instruments used to observe precipitation include rain gauge tipping buckets, cylinders, and disdrometers & radar systems [top]



A sensor pod from NASA – Jet Propulsion Laboratory



Researchers with the University of Alaska-Fairbanks (UAF) use small aircraft such as the Havilland DHC-3 Otter. Credit: UAF

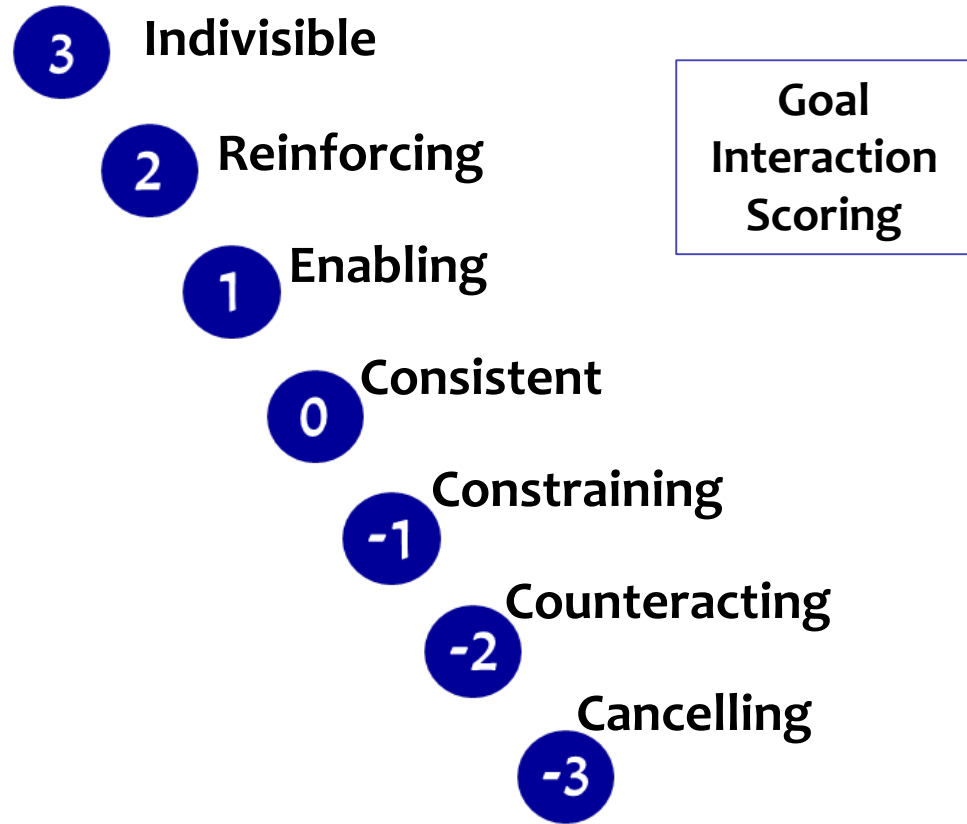
**Space-based  
Satellites**  
**Airborne**  
**Ground-based**  
**In Situ**





# IUCN Framework on SDG

A Spectrum of Goal Interactions:  
From Synergy to Conflict



## Health & Cities +2, +3

Sustainable urban planning, and decent and affordable housing support mental health and access to health services, reduce non-communicable diseases and limit environmental impacts.

**Directionality:** Unidirectional



## Food Security & Life on Land +2, +1, -2

Sustainable agricultural systems and practices contribute to ecosystem health. However, increased agricultural production and productivity, if not sustainable, can result in deforestation and land degradation.

**Directionality:** Mostly bidirectional

# What is the EO community's role in the SDG landscape?

Country Support (NSO, line ministries)

Custodian Agencies Support

Scaling of EO Methods

Global to National Datasets

Monitoring and Reporting

EO Toolboxes and Platforms

Capacity Building

Best Practices & Lessons Learned

Effective Partnerships

***Earth Observations  
and the SDGs***



*GEO & SDGs*



***Examples of EO  
applications for SDGs***



*NASA Earth Science -  
ARSET Program*



In the context of DANE's Smart Data strategy, which aims to strengthen statistical production and dissemination by using new sources and methods, efforts are focused on using EO and geospatial information for SDGs

# SDG Indicator 11.3.1

Ratio of land  
consumption rate  
and population  
growth rate

- Use of Landsat images to calculate land consumption rate

# SDG Indicator 9.1.1

Proportion of the  
rural population who  
live within 2km of an  
all-season road

- Use of Landsat images to estimate more accurately the influence area of 2 km of the roads in rural areas, considering obstacles (like water bodies).



EARTH OBSERVATIONS FOR THE  
SUSTAINABLE DEVELOPMENT GOALS



GLOBAL PARTNERSHIP  
FOR SUSTAINABLE DEVELOPMENT DATA

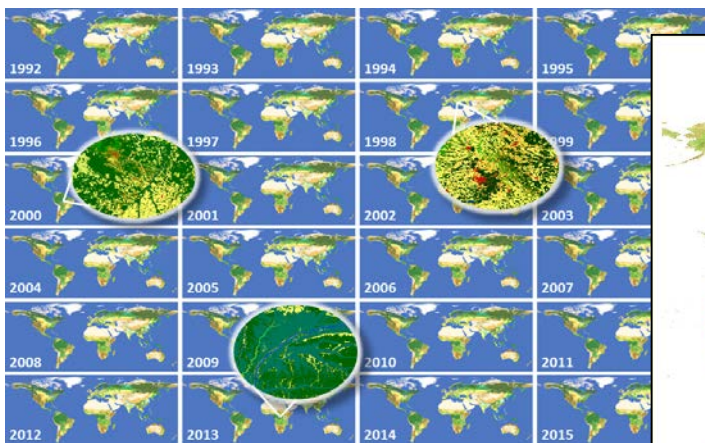
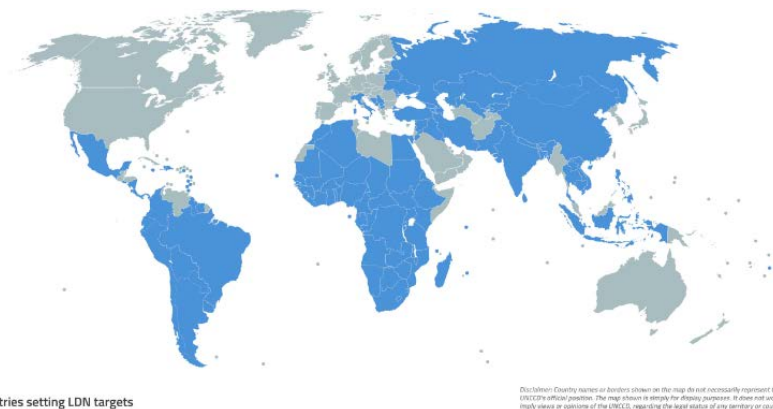


**GEO** GROUP ON  
EARTH OBSERVATIONS

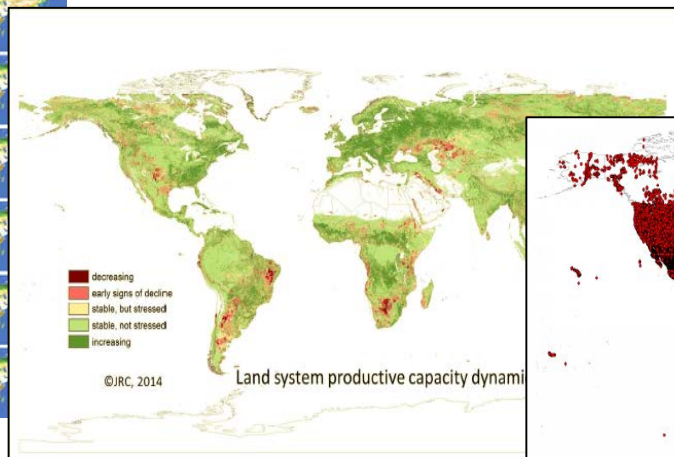


# 15.3.1. Proportion of land that is degraded over total land area

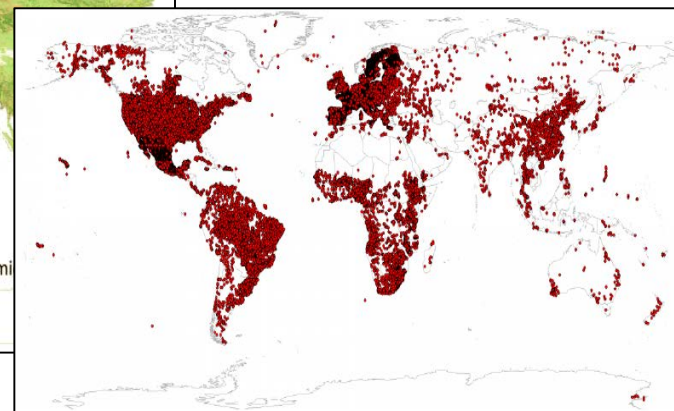
- Good Practice Guidance produced by UNCCD
- National official data sources, complemented by EO.
- EO Data: Land Cover – NASA (Landsat, MODIS), USGS (Landsat), ESA (Land Cover CCI); Land Productivity Dynamics (LPD) – JRC; Soil Organic Carbon (SOC) - International Soil Reference and Information Centre
- UNCCD - GEO LDN Initiative: regional capacity building, federated collaborative platforms, international standards



ESA Climate Change Initiative Land Cover



JRC Land Productivity Dynamics

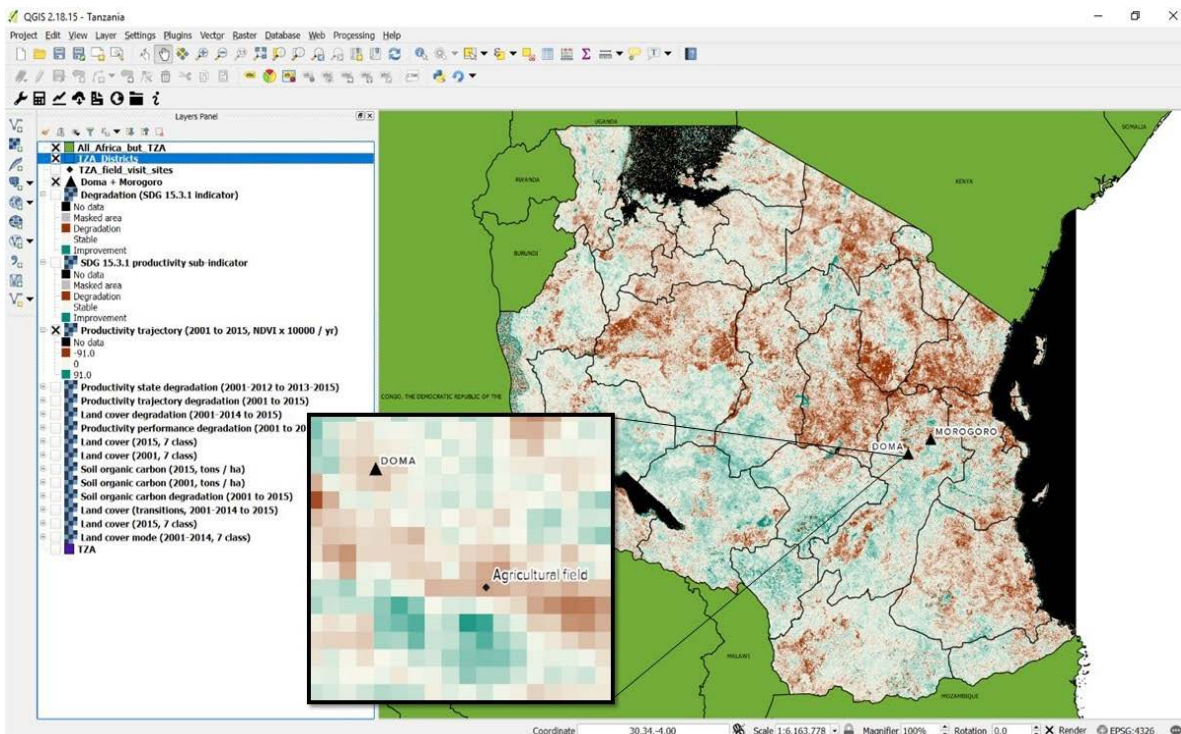


ISRIC SoilGrids250m



Out of the 113 countries that have committed to set LDN targets, 64 countries have already established a baseline

## 15.3.1 – Land Degradation Monitoring Tool



**Above:** A screenshot of the Trends.Earth tool in use. Provided by Tristan Schnader, Vital Signs Senior Project Manager at CI.

- GEF-funded project.
- Initial Focus: Senegal, Tanzania, Uganda, Kenya
- EO Data: AVHRR, MODIS (NDVI), GOME-2 (chlorophyll fluorescence), MERRA-2 (soil moisture), Landsat 8, Sentinel 2A & 2B, 50 cm commercial satellite data
- Open source platform, qGIS, GEE



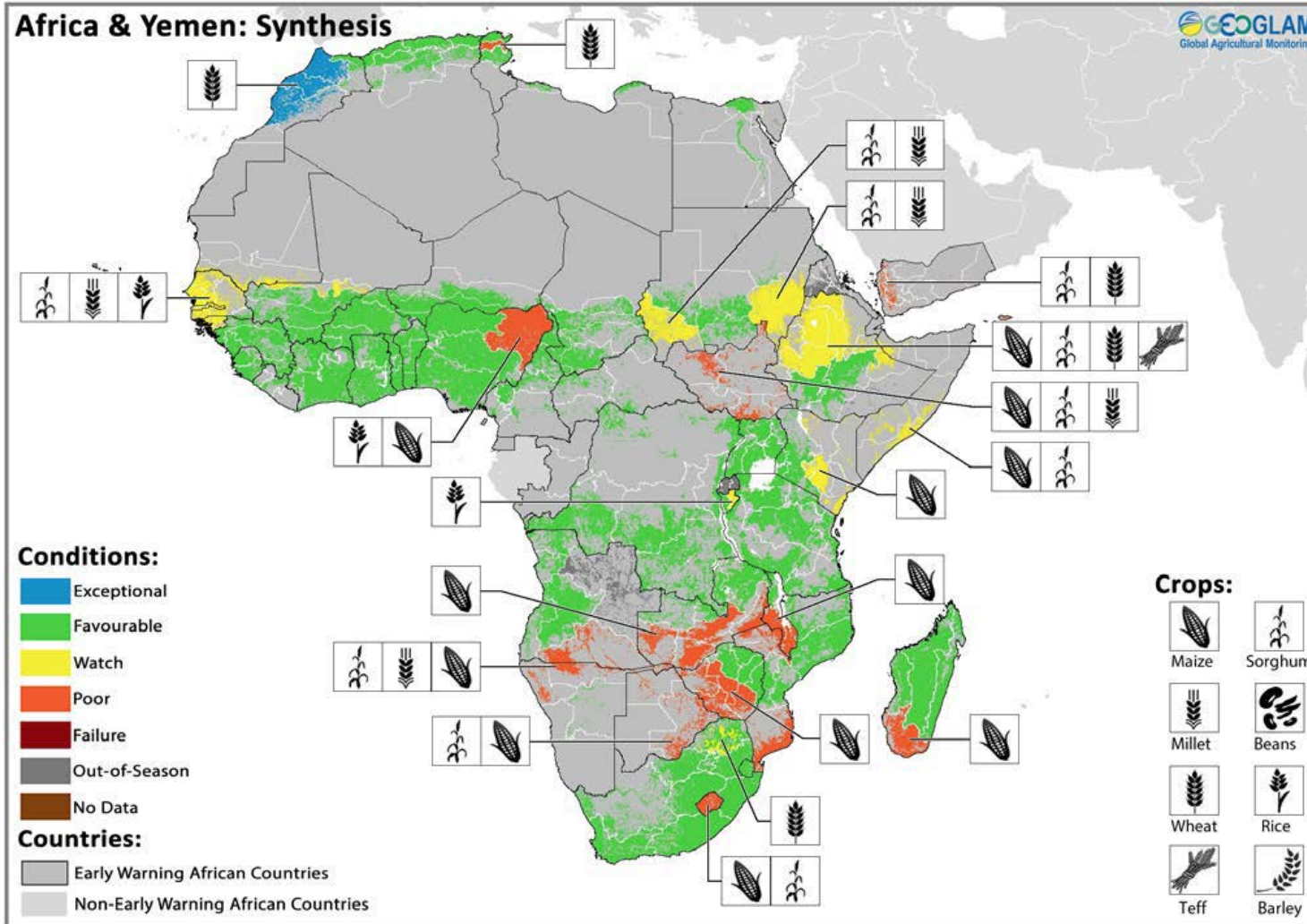
### Pilot Country Workshops & Lessons Learned

Guidelines on dataset standardization to allow for valid comparisons • Request for finer spatial res. EO, preprocessed and ready for analysis • Need for further capacity building around indicators & tools • Internet access could limit usefulness of fully online platforms



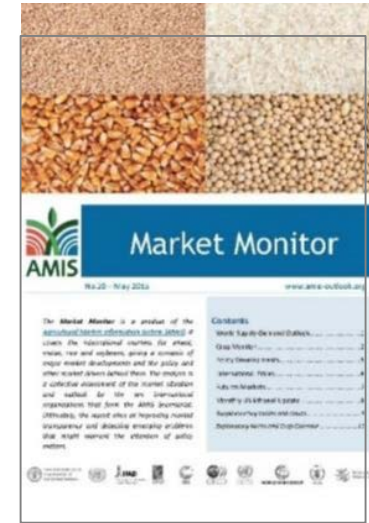


# End hunger, achieve food security and improved nutrition and promote sustainable agriculture



Crop condition map synthesizing information for all Crop Monitor for Early Warning crops as of June 28th.

<https://cropmonitor.org/>



*Market Monitor:*  
Operational monthly bulletin for primary crop types for 49 countries

Four main crops:  
Rice, Wheat, Maize, Soybeans

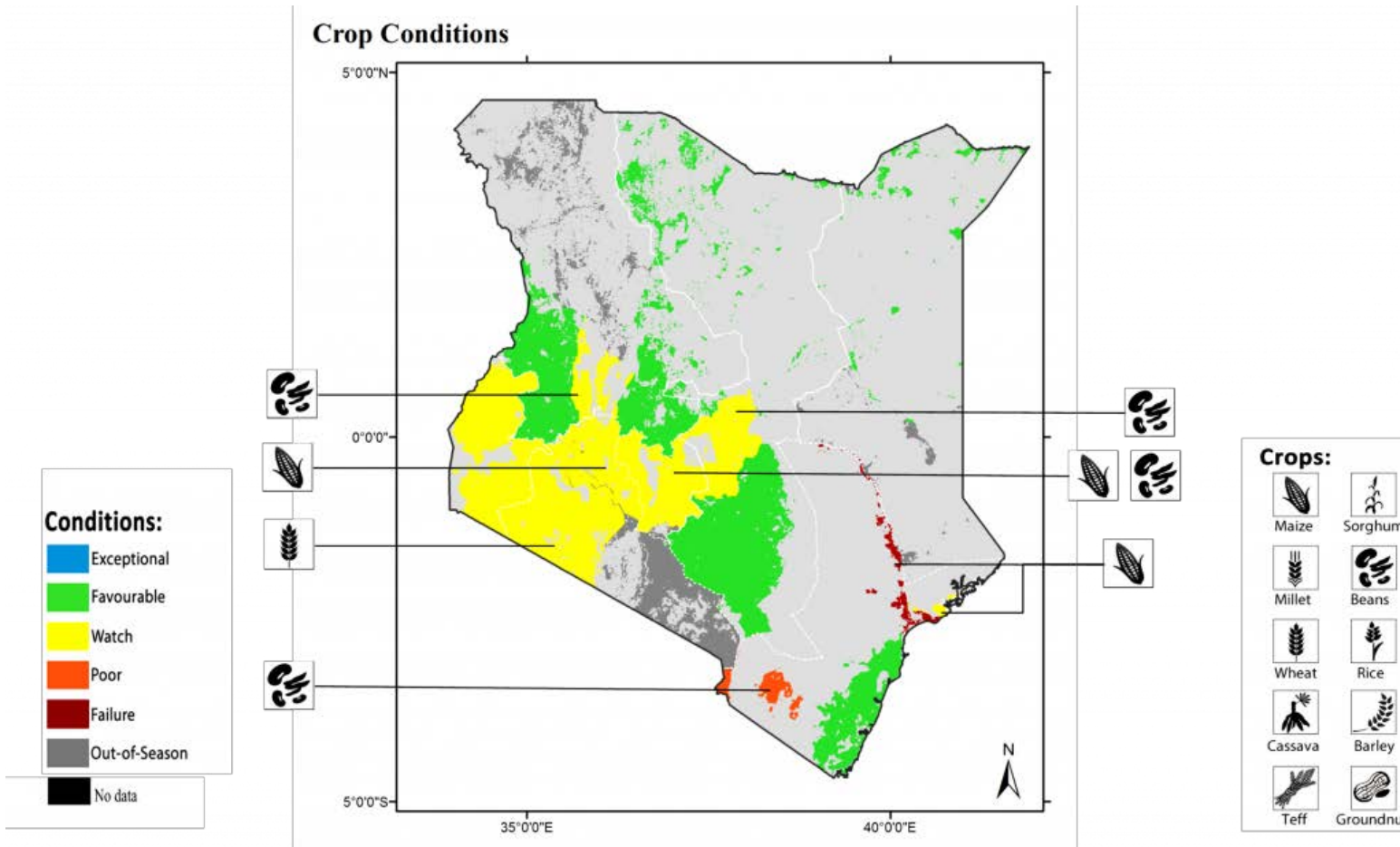
## EO Data Use

- Satellite baseline datasets - GEOGLAM Crop Calendars and Crop Masks
- Satellite observations of land - NASA & USGS (MODIS, Landsat, SMAP), ESA (Sentinel-1, Sentinel-2, Sentinel-3), CSA (Radarsat-2, RCM), JAXA (GCOM-C, ALOS-2), DLR (TerraSAR-X, TanDEM-X), CNES (Pleiades)
- In-situ & agrometeorological data sets
- Novel crowd-sourced information – GEO WIKI





# End hunger, achieve food security and improved nutrition, and promote sustainable agriculture



## Proven value

The Kenyan Crop Monitor will provide early warning of crop failure related to drought and other risks, giving the government time to take preemptive action to protect livelihoods and ensure food security during food crises.

## Global support for national agricultural monitoring

GEGLAM provides national partners with methods and tools to develop and manage national crop monitors, and then transitions the tools to be managed nationally. The information produced by the governments then informs global assessments for food security and markets.

*Kenya National Crop Monitor Crop condition map showing crop conditions information in Kenya regions as of 23rd May 2018*



# Track and Predict the Risk of cholera in Haiti following Hurricane Matthew

Application of Earth observations for connecting large-scale hydro- climatological processes with cholera occurrence in epidemic regions

## Types of Data used

TRMM/GPM: Precipitation

NCEP/ NCAR: Air Temperature

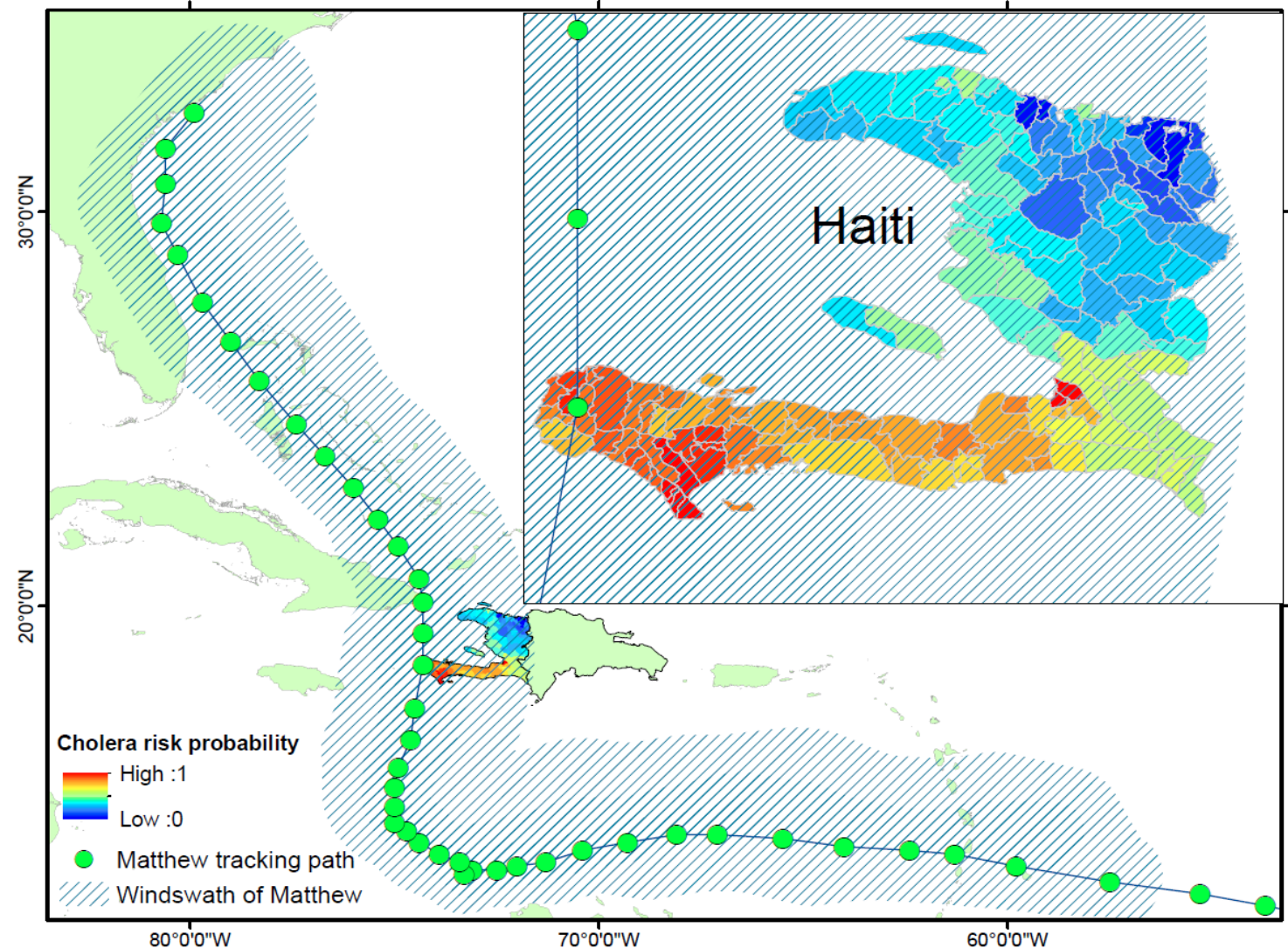
GPM: Precipitation

GPWv4: Population Density

National Hurricane Center: Track points, wind swath

Grand Valley State University Program of Safe and Sustainable Water for Haiti: Administrative Boundaries, roads, river data

*Risk of epidemic cholera is high (red) if heavy precipitation follows persistent warm temperatures in regions with poor or damaged water and sanitation infrastructure. (Credit, Jutla and Colwell)*

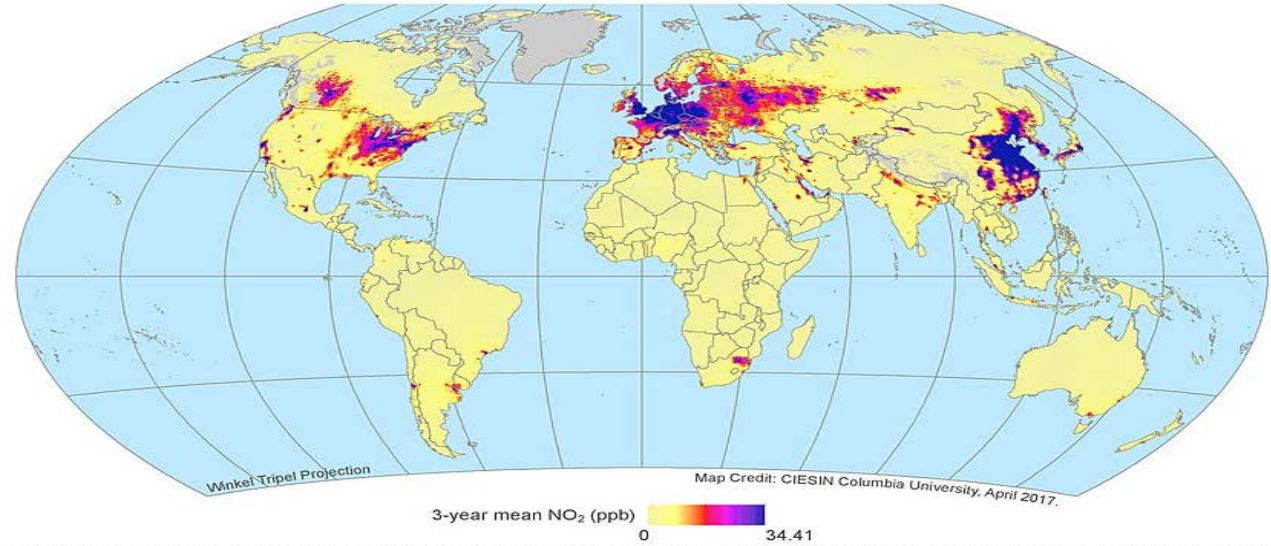




# Population Exposure to Air Pollution: NO<sub>2</sub> and PM<sub>2.5</sub>



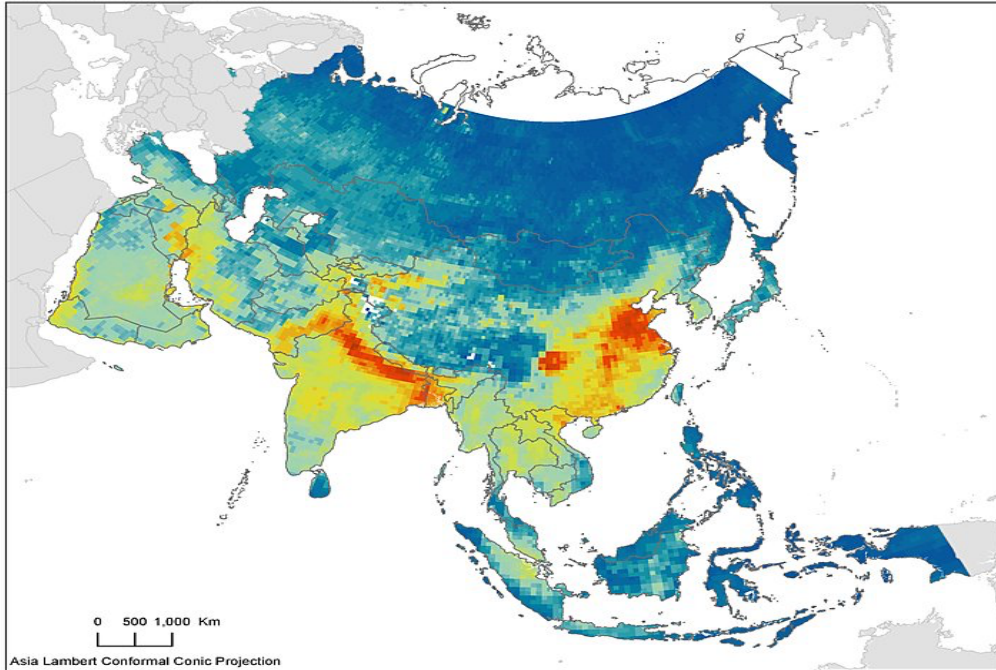
**Global 3-Year Running Mean Ground-Level Nitrogen Dioxide (NO<sub>2</sub>) Grids from GOME, SCIAMACHY and GOME-2, 2010–2012**  
Satellite-Derived Environmental Indicators



The Global 3-Year Running Mean Ground-Level Nitrogen Dioxide (NO<sub>2</sub>) Grids from GOME, SCIAMACHY and GOME-2 are part of the Satellite-Derived Environmental Indicators collection. This data set represents a series of three-year running mean grids (1996–2012) of ground level Nitrogen Dioxide that are derived from Global Ozone Monitoring Experiment (GOME), Scanning Imaging Absorption SpectroMeter for Atmospheric CHartography (SCIAMACHY) and Global Ozone Monitoring Experiment-2 (GOME-2) satellite retrievals. This map displays 3-year mean satellite-derived NO<sub>2</sub> concentrations measured in parts per billion (ppb) at a spatial resolution of 6 arc-minutes (0.1 degree or approximately 10 km at the equator) for the years 2010 to 2012.

<http://sedac.ciesin.columbia.edu/data/collection/sdei>

**Global Annual Average PM<sub>2.5</sub> Grids from MODIS and MISR Aerosol Optical Depth (AOD), 2010: Asia**  
Satellite-Derived Environmental Indicators



Global Annual PM<sub>2.5</sub> Grids from MODIS and MISR Aerosol Optical Depth (AOD) data sets provide annual "snap shots" of particulate matter 2.5 micrometers or smaller in diameter from 2001–2010. Exposure to fine particles is associated with premature death as well as increased morbidity from respiratory and cardiovascular disease, especially in the elderly, young children, and those already suffering from these illnesses. The grids were derived from Moderate Resolution Imaging Spectroradiometer (MODIS) and Multi-angle Imaging SpectroRadiometer (MISR) Aerosol Optical Depth (AOD) data. The raster grid cell size is approximately 50 sq. km at the equator, and the extent is from 70°N to 60°S latitude.





**Briefing Puerto Rico**

The Economist April 14th 2018

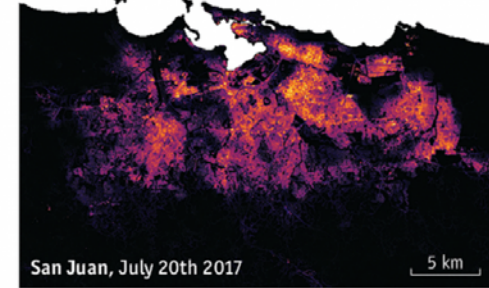


**The Economist**

**Illuminating**

Night-light intensity in San Juan

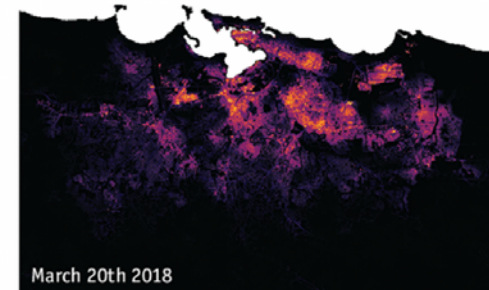
Before Hurricane Maria makes landfall



Immediate aftermath of Hurricane Maria



Six months after Hurricane Maria



Source: Suomi NPP VIIRS data from Miguel Román, NASA Disasters Programme

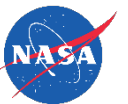
Economist.com

**Earth observations, models & technology applied:**

- NASA's Black Marble product suite (VNP46) | Source: NASA-GSFC
- Gridded Population of the World (GPW), v4 | Source: NASA-SEDAC
- NASA Airborne Assets: Multi Angle Imaging Bidirectional Reflectance Distribution Function sUAS (MALIBU) | Source: NASA-GSFC
- Global Urban Footprint Data | Source: DLR
- Landsat 8/OLI and Sentinel 2-MSI Data | Source: USGS/ESA
- In-situ data collected during field experiments | Source: UFS/Puerto Rico
- Open Street Map GIS Layers | Source: OSM

<https://bit.ly/2IXJmfs>

Courtesy: Miguel Roman, NASA







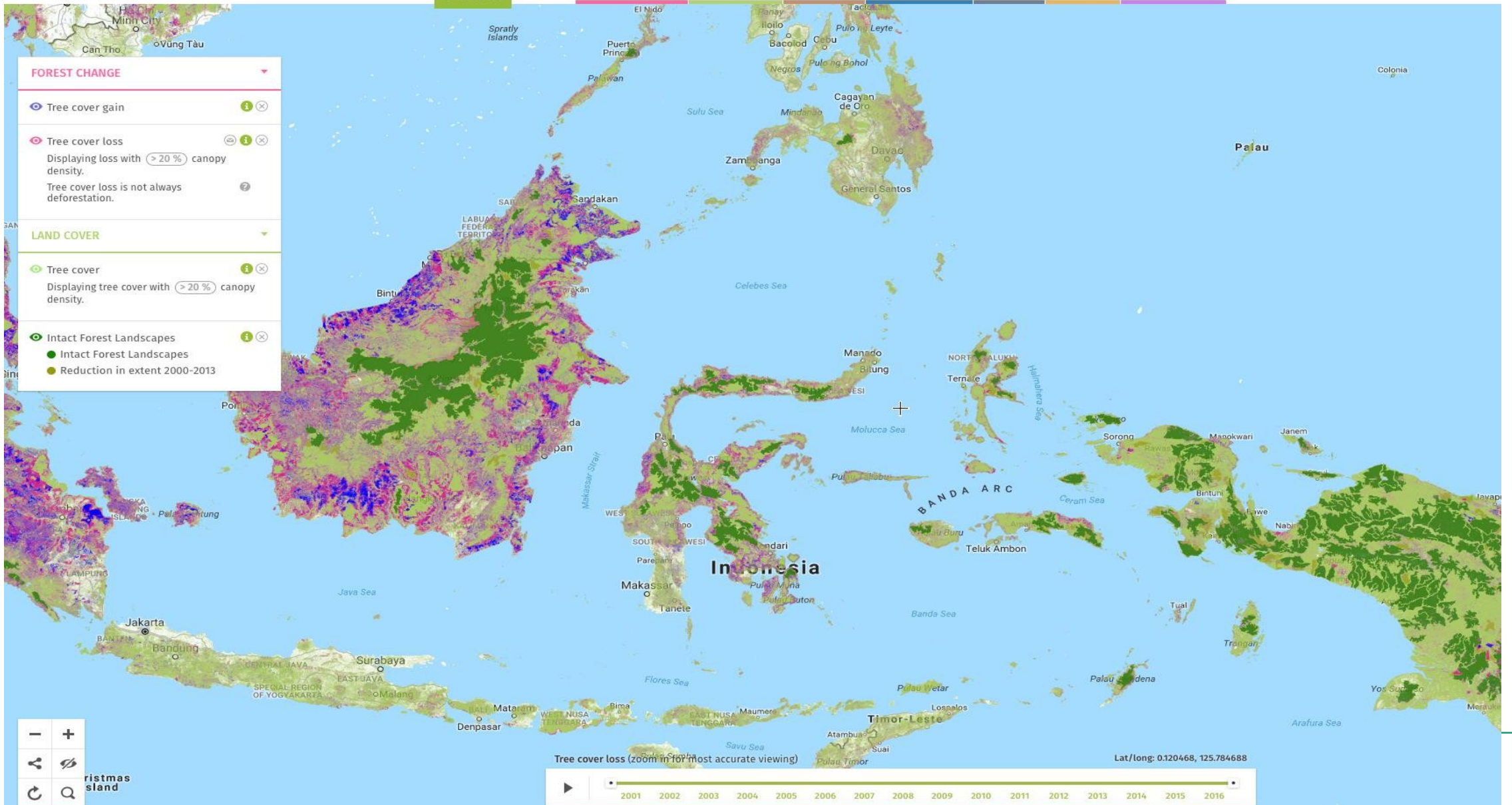
# High quality Global Data Sets at high resolution (10-30m)

GLOBAL FOREST WATCH

MAP COUNTRIES BLOG ABOUT

ENGLISH MY GFW MORE

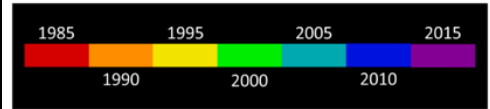
FOREST CHANGE LAND COVER LAND USE CONSERVATION PEOPLE STORIES COUNTRY DATA







## Monitoring urban development



*WSF evolution*





# CEOS EO Handbook on SDGs

<http://eohandbook.com>

## Part I

role of EO data in support to the SDGs



## Part II

### Stakeholders' perspectives on EO for the SDGs

#### Part II: Perspectives on EO for the SDGs

##### The UN System

1. UN-GGIM: The Role of Geospatial Information and Earth Observations in the SDGs: A Policy Perspective
2. UNSD: Earth Observation for Ecosystem Accounting

##### National Statistical Organisations and Their Use of EO

3. Australia: Forging Close Collaboration Between EO Scientists and Official Statisticians – An Australian Case Study
4. Mexico: Monitoring the 2030 Agenda in Mexico: Institutional Coordination and the Integration of Information

##### Custodian Agencies and Their Use of EO

5. FAO: Perspectives from a Custodian Agency for Agriculture, Forestry and Fisheries
6. UN-Habitat: The 'Urban' SDG and the Role for Satellite Earth Observations

##### EO Data Providers and Coordination Bodies

7. GEO: EO4SDG: Earth Observations in Service of the 2030 Agenda for Sustainable Development
8. Pan-European Space Data Providers and Industry Working in Support of the SDGs

##### Non-Governmental Organisations

9. Radiant Earth: The Rise of Data Philanthropy and Open Data in Support of the 2030 Agenda
10. GPSDD: Building a Demand-Driven Approach to the Data Revolution for Sustainable Development

##### International Financing Institutions

11. Environmental Information from Satellites in Support of Development Aid

## Part III

### Examples of EO contribution to SDG Targets and Indicators





# EO4SDG



EARTH OBSERVATIONS FOR THE  
SUSTAINABLE DEVELOPMENT GOALS

<http://eo4sdg.org>

Twitter: @EO4SDG

The screenshot shows the EO4SDG website homepage. At the top, there is a navigation bar with links for Home, About Us, What We Do, Users, Get More Information, and Contact. A search bar is also present. The main header features the EO4SDG logo and the text "EARTH OBSERVATIONS FOR THE SUSTAINABLE DEVELOPMENT GOALS" on the left, and the "GEO GROUP ON EARTH OBSERVATIONS" logo on the right. Below the navigation bar is a large banner image of a sunlit forest. A text box in the center of the banner reads: "EO4SDG organizes and realizes the potential of Earth observations and geospatial information to advance the United Nations 2030 Agenda and enable societal benefits through achievement of the Sustainable Development Goals." Below the banner, the page is divided into two columns. The left column is titled "Upcoming Events" and features a section for "SDG Training Workshop at UN-GGIM 8" with a description of the workshop and a "VIEW ALL EVENTS" button. The right column is titled "Featured Projects" and features a section for "Integration of Earth Observations and National Statistics for the SDGs in Colombia" with a map of Colombia and a description of the project. Below these sections, there is a "Latest News" section with a link to "CEOS Earth Observation Handbook" and a section for "Using satellite-based Earth observations to monitor SDG 6 indicators" with a small map and a description of the project.

***Earth Observations  
and the SDGs***



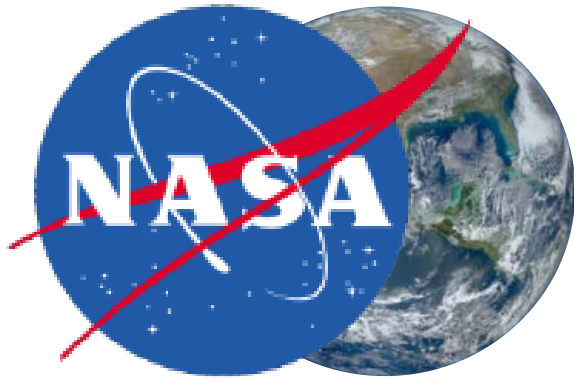
***GEO & SDGs***



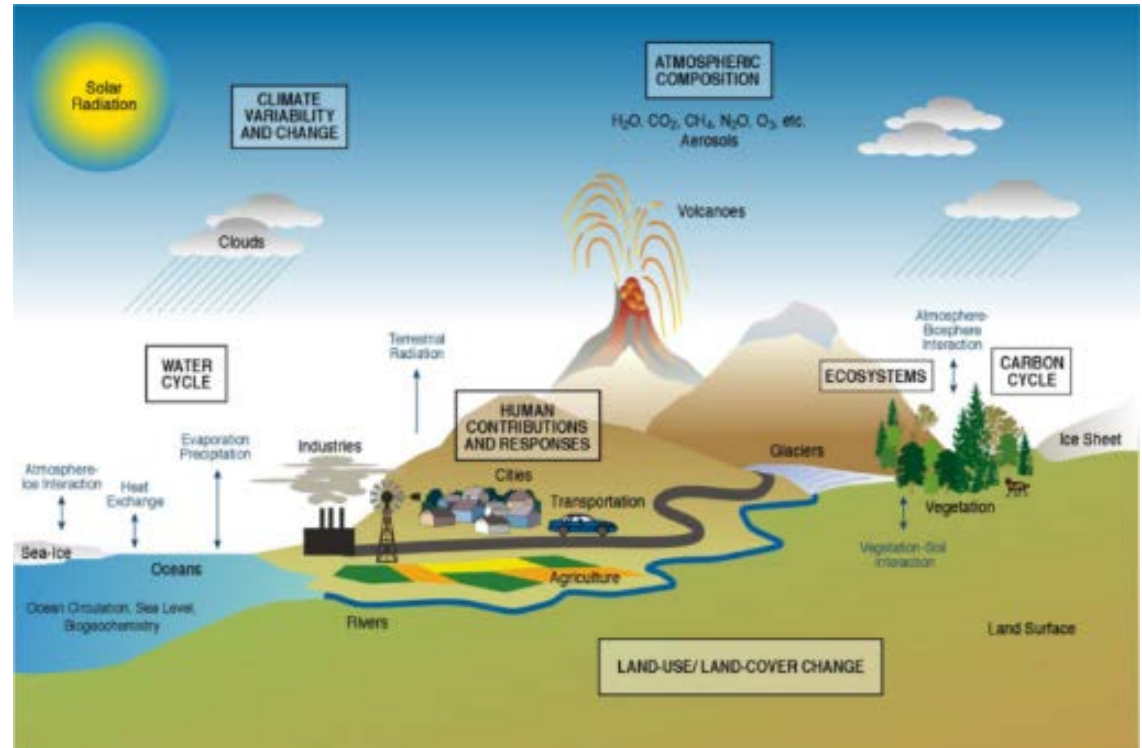
***Examples of EO  
applications for SDGs***



***NASA Earth Science -  
ARSET Program***



# NASA Earth Science



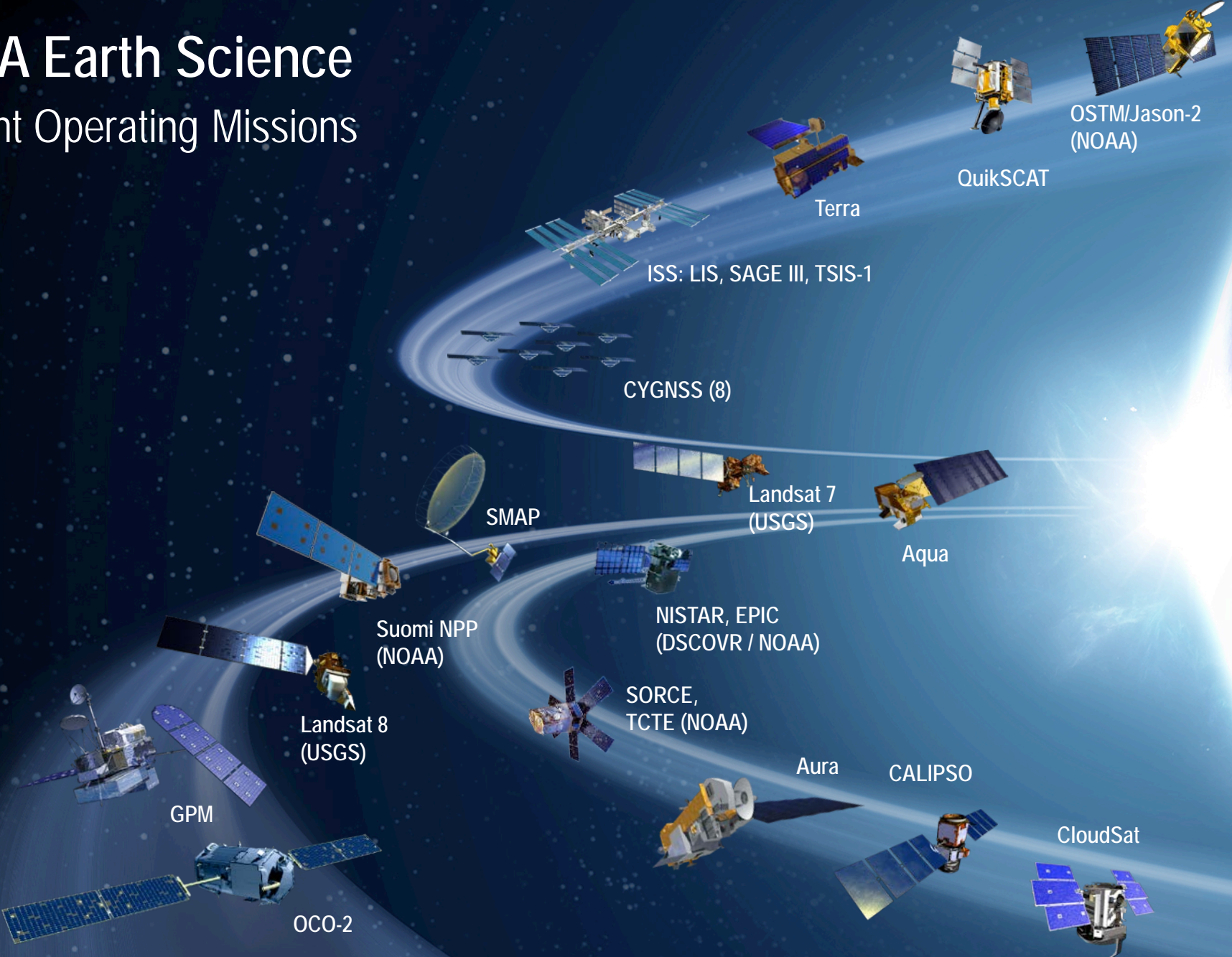
Basic and applied research to advance knowledge about the Earth system

Innovative and practical uses of Earth science data to inform decisions and benefit society



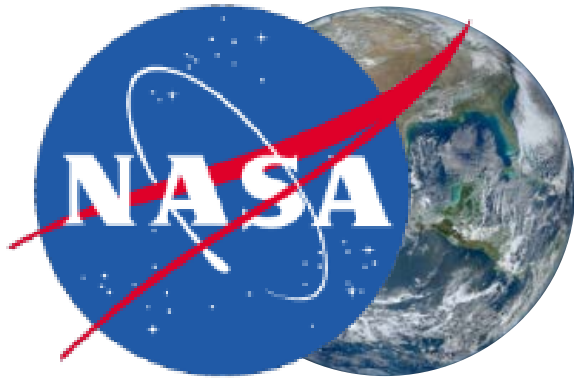


# NASA Earth Science Current Operating Missions



InVEST/CubeSats  
RAVAN  
IceCube  
MiRaTA





# NASA Earth Science



**Health &  
Air Quality**



**Water  
Resources**



**Ecological  
Forecasting**



**Disasters**



**Food Security**



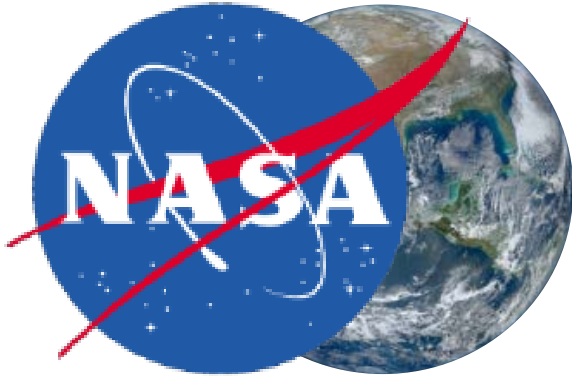
**Energy**



**Transportation /  
Infrastructure**



**Urban  
Development**



**NASA**  
**Earth Science**

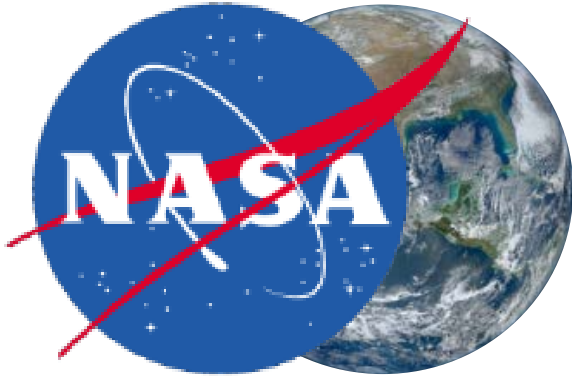
# **ARSET**

## ***Applied Remote Sensing Training***

<http://arset.gsfc.nasa.gov>

- » **Professional-level trainings**
- » **Online webinars and In-person events**
- » **Hands-on, guided computer exercises**
- » **~18 trainings throughout the year**





# **NASA Earth Science**

## **ARSET**

### ***Applied Remote Sensing Training***

<http://arset.gsfc.nasa.gov>

- » **International audiences**
- » **Basic and Advance level courses**
- » **No prior remote-sensing or Earth observations knowledge needed**
- » **Past trainings archived**

# ***ARSET: 2018 Training***

**NASA**  
**Earth Science**



## **PAST**

**Tools for High Resolution Air Quality Datasets, January**

**Accuracy Assessments, February**

**Introduction to Hydrological Modeling Using Remote Sensing, February**

**Advances in Remote Sensing for Scenario-Based Ecological Forecasting, March**

**NASA Remote Sensing for Air Quality Applications, March**

**Monitoring Tropical Storms for Emergency Preparedness, May**

**Satellite Remote Sensing of Dust, Fires, Smoke, and Air Quality, July**

**Techniques for Wildfire Monitoring & Detection, July**

## **UPCOMING**

**Applications of Synthetic Aperture Management, August**

**NASA Remote Sensing for Urban Flooding, August**

**Air Quality Measurements for Geostationary Platforms, August**

**Advanced Change Detection with Google Earth Engine, September**

**Water Quality Monitoring Using Remote Sensing Observations, September**

# International: Trainings on Earth Observations & SDGs



EARTH OBSERVATIONS FOR THE SUSTAINABLE DEVELOPMENT GOALS



## WEBINAR TRAINING



### Satellite Derived PM2.5 Data Sets in Support of SDGs 3 & 11



March 2017; English, Spanish

Three-session training:

Satellite observations of air quality associated with SDG Indicators 3.9.1 and 11.6.2; WHO PM2.5 data set; case study and mapping exercise.

Satellites & sensors: Aqua, CALIPSO, MISR, MODIS, Terra

## WEBINAR TRAINING



### Remote Sensing of Land Indicators for SDG 15: 15.1.1 & 15.3.1

June 20-22, 2017; English

Three-session training:

Satellite observations of land cover; image classification, change detection, and techniques for developing accuracy assessments.

Satellites & sensors: Landsat, MODIS, Sentinel 3, Suomi NPP/VIIRS



# International: Trainings on Earth Observations & SDGs



EARTH OBSERVATIONS FOR THE SUSTAINABLE DEVELOPMENT GOALS



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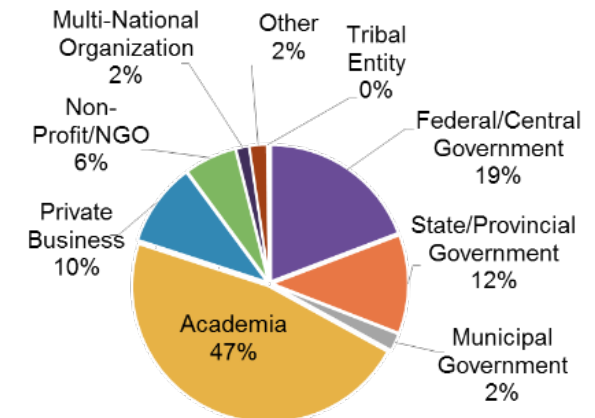
Satellites & sensors: Aqua, CALIPSO, MISR, MODIS, Terra

391 attendees; 298 organizations; 61 countries

“I work in the science division at an NGO, identifying natural habitats that will help communities and countries meet their SDGs. My interest in these datasets are to look at any potential linkages between habitat degradation and air quality. One of our areas of interest is Singapore, whose air quality has been affected by deforestation in Indonesia.”

“[I] assist in coordination of SDG 11 related events: Workshops, review of metadata, development of training toolkits (SDG 11 indicators). **The webinar is important in terms of development of training toolkits, alternative methods of data collection.**”

### Attendee Sectors



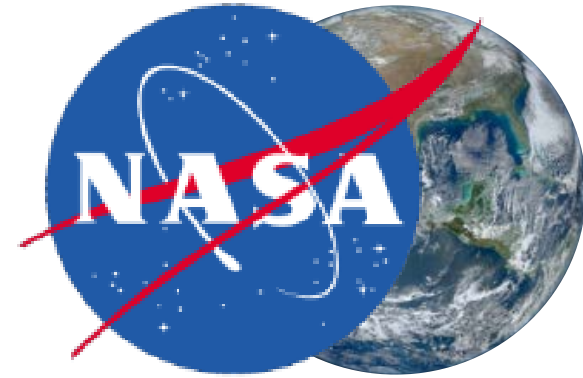
<https://arset.gsfc.nasa.gov/>



EARTH OBSERVATIONS FOR THE  
SUSTAINABLE DEVELOPMENT GOALS

@ EO4SDaaG

<http://eo4sdg.org>



ARSET

*Applied Remote  
Sensing Training*

<http://arset.gsfc.nasa.gov>





# Thank you!

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Target Contribute to progress on the Target, not necessarily the Indicator								Goal	Indicator Direct measure or indirect support to the Indicator					
						1.4	1.5	<b>1 No poverty</b>	1.4.2					
						2.3	2.4	<b>2 Zero hunger</b>	2.4.1					
						3.3	3.4	<b>3 Good health and well-being</b>	3.9.1					
								<b>4 Quality education</b>						
								<b>5 Gender equality</b>	5.a.1					
		6.1	6.3	6.4	6.5	6.6	6.a	<b>6 Clean water and sanitation</b>	6.3.1	6.3.2	6.4.2	6.5.1	6.6.1	
						7.2	7.3	<b>7 Affordable and clean energy</b>	7.1.1					
								<b>8 Decent work and economic growth</b>						
								<b>9 Industry, innovation and infrastructure</b>	9.1.1	9.4.1				
								<b>10 Reduced inequalities</b>						
						10.6	10.7	<b>11 Sustainable cities and communities</b>						
		11.1	11.3	11.4	11.5	11.6	11.7	<b>11 Sustainable cities and communities</b>	11.1.1	11.2.1	11.3.1	11.6.2	11.7.1	
								<b>12 Responsible consumption and production</b>	12.a.1					
								<b>13 Climate action</b>	13.1.1					
						13.1	13.2	<b>13 Climate action</b>						
						13.3	13.b	<b>13 Climate action</b>						
								<b>14 Life below water</b>	14.3.1	14.4.1	14.5.1			
								<b>15 Life on land</b>	15.1.1	15.2.1	15.3.1	15.4.1	15.4.2	
								<b>16 Peace, justice and strong institutions</b>						
								<b>16 Peace, justice and strong institutions</b>						
								<b>17 Partnerships for the goals</b>						
17.2	17.3	17.6	17.7	17.8	17.9	17.16	17.17	<b>17 Partnerships for the goals</b>	17.6.1	17.18.1				

## Earth observations can contribute to progress on many more Targets than Indicators



**11.4:** Strengthen efforts to protect and safeguard the world's cultural and natural heritage

**11.4.1:** Total expenditure per capita spent on the preservation, protection & conservation of all cultural and natural heritage



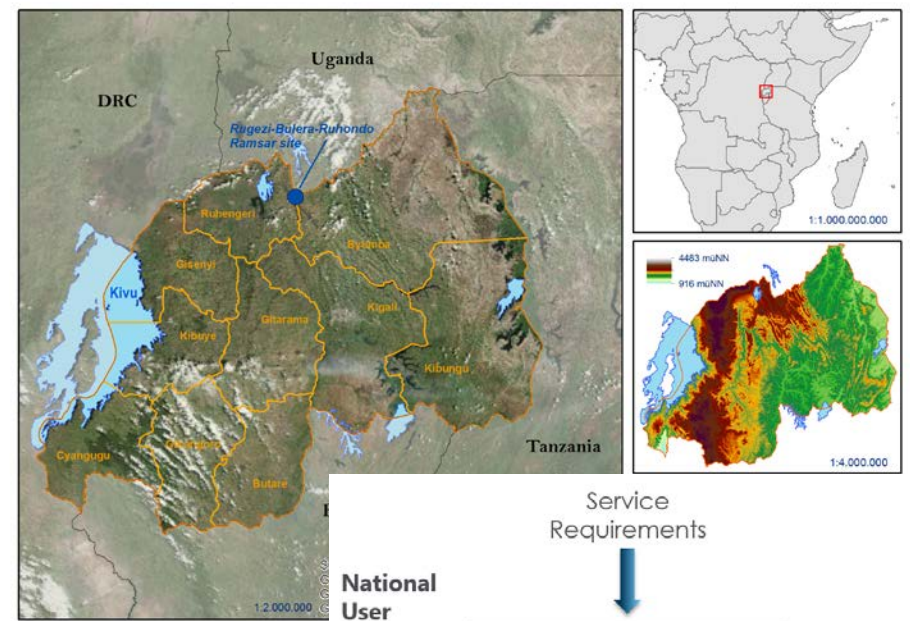
**13.3:** Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning

**13.3.1:** Number of countries that have integrated mitigation, adaptation, impact reduction and early warning into primary, secondary and tertiary curricula

**Project key facts**

- 400.000 EUR budget
- 3 years duration (starting from 1. April 2016)
- 2 partners – cooperation with African partners
- Free and open data policy
- Development of tools and national demonstrator

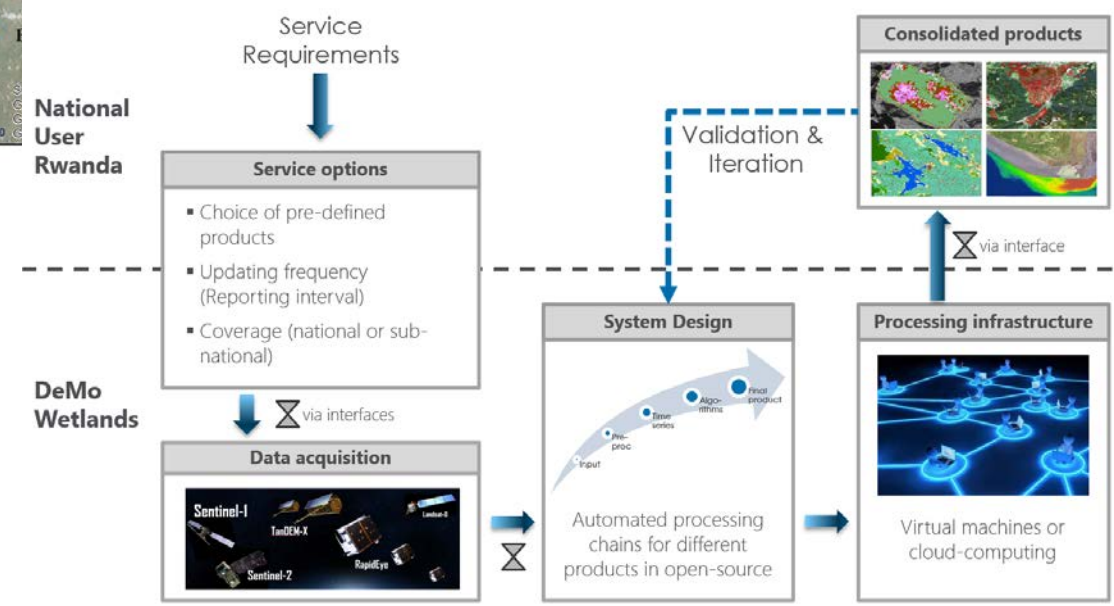
**DeMo Wetlands**  
Copernicus-based Detection and Monitoring of tropical Wetlands



Study area: Rwanda

- Demonstration of satellite-based **wetland monitoring on national level** in Rwanda
- Development of **Wetland EO Tools and Products**
- **Automated wetland EO processing chain**

Automated processing chains



DeMo-Wetlands team:



Contact: Adrian Strauch ([astrauch@uni-bonn.de](mailto:astrauch@uni-bonn.de))



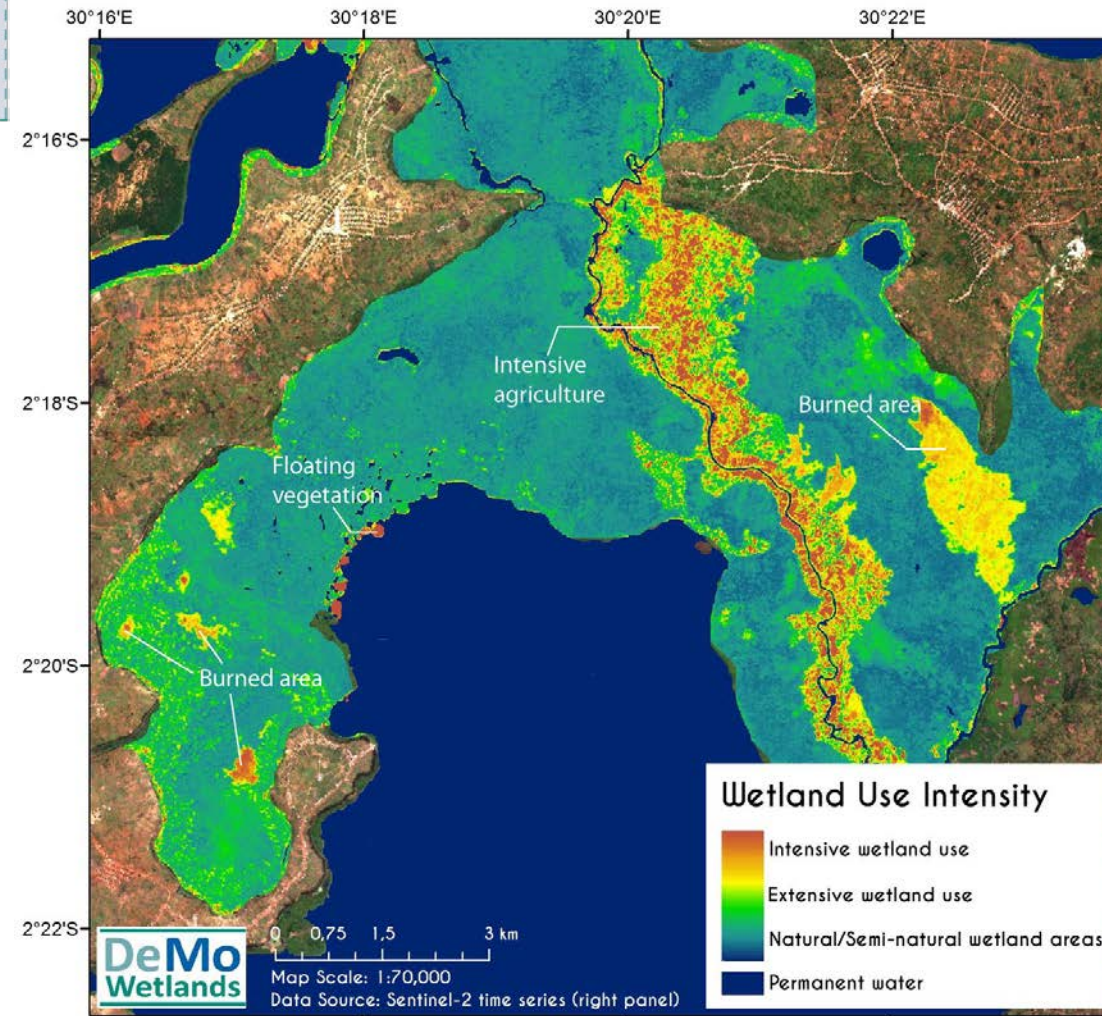
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DeMo-Wetlands team:



## Rweru Wetland

