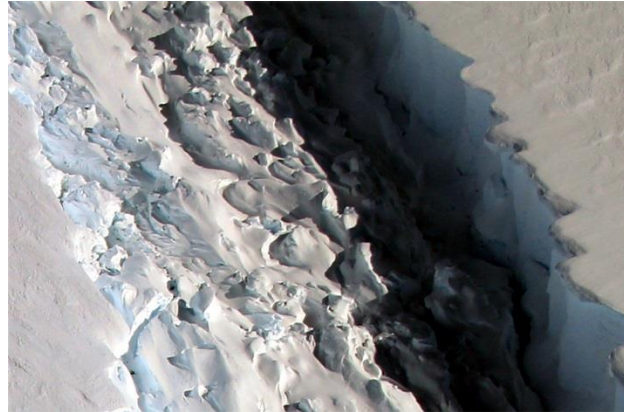




# SCIENCE



## Earth Observations for Sustainable Development and Disaster Risk Reduction

**Francisco Delgado Olivares**  
Geospatial IT Lead, NASA/SERVIR Program  
MSFC, Huntsville

NOVEMBER 2018

# Presentation Outline

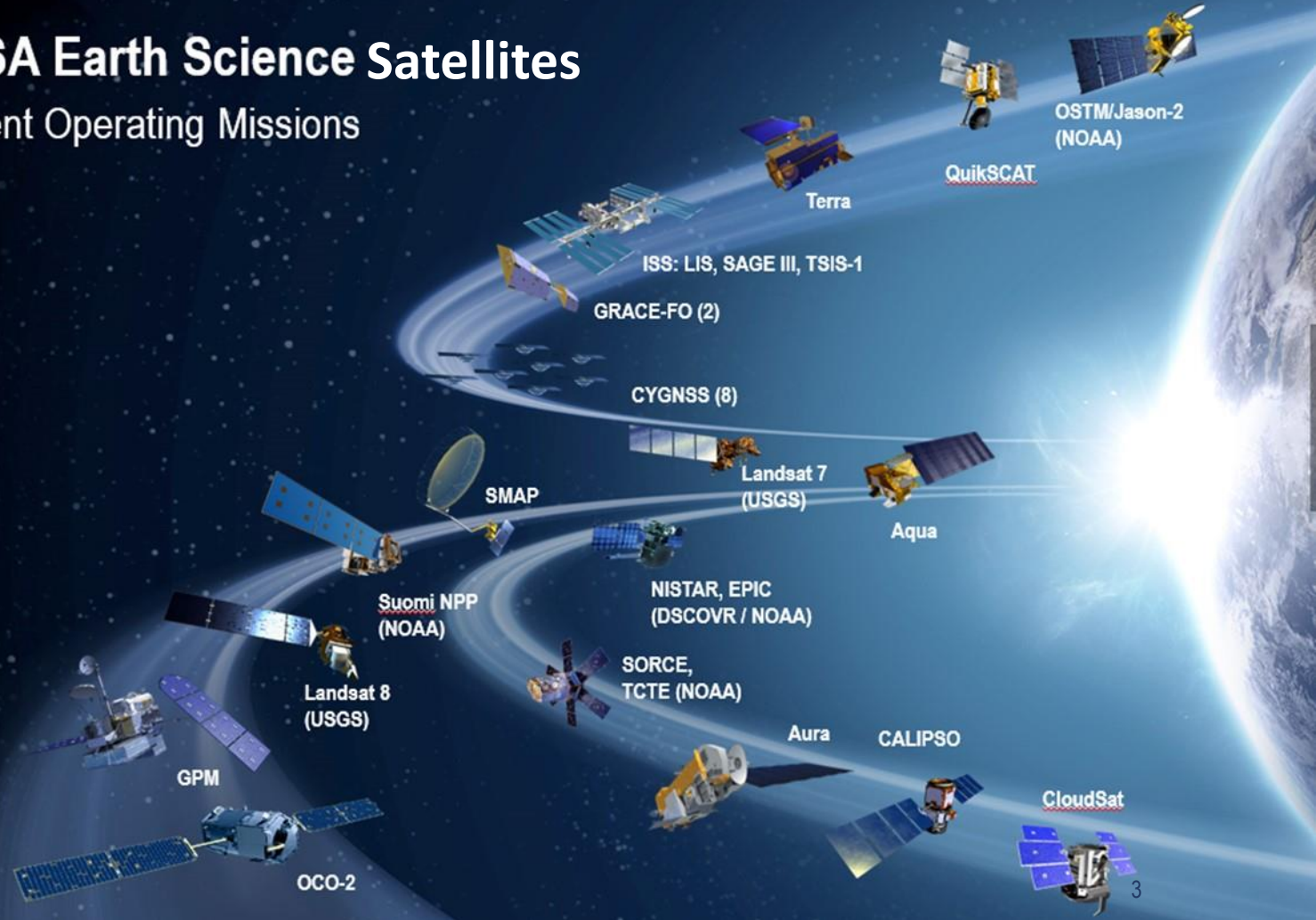
- **NASA Earth Observation Data**
- Applications for Sustainable Development
- Applications for Disaster Risk Reduction
- Capacity Building

# Observing the Earth from the Perspective of Space



## NASA Earth Science Satellites

### Current Operating Missions



# Maintaining Global Situational Awareness, 365 Days a Year



# *Maintaining Global Situational Awareness, 365 Days a Year*



*by day and by night*

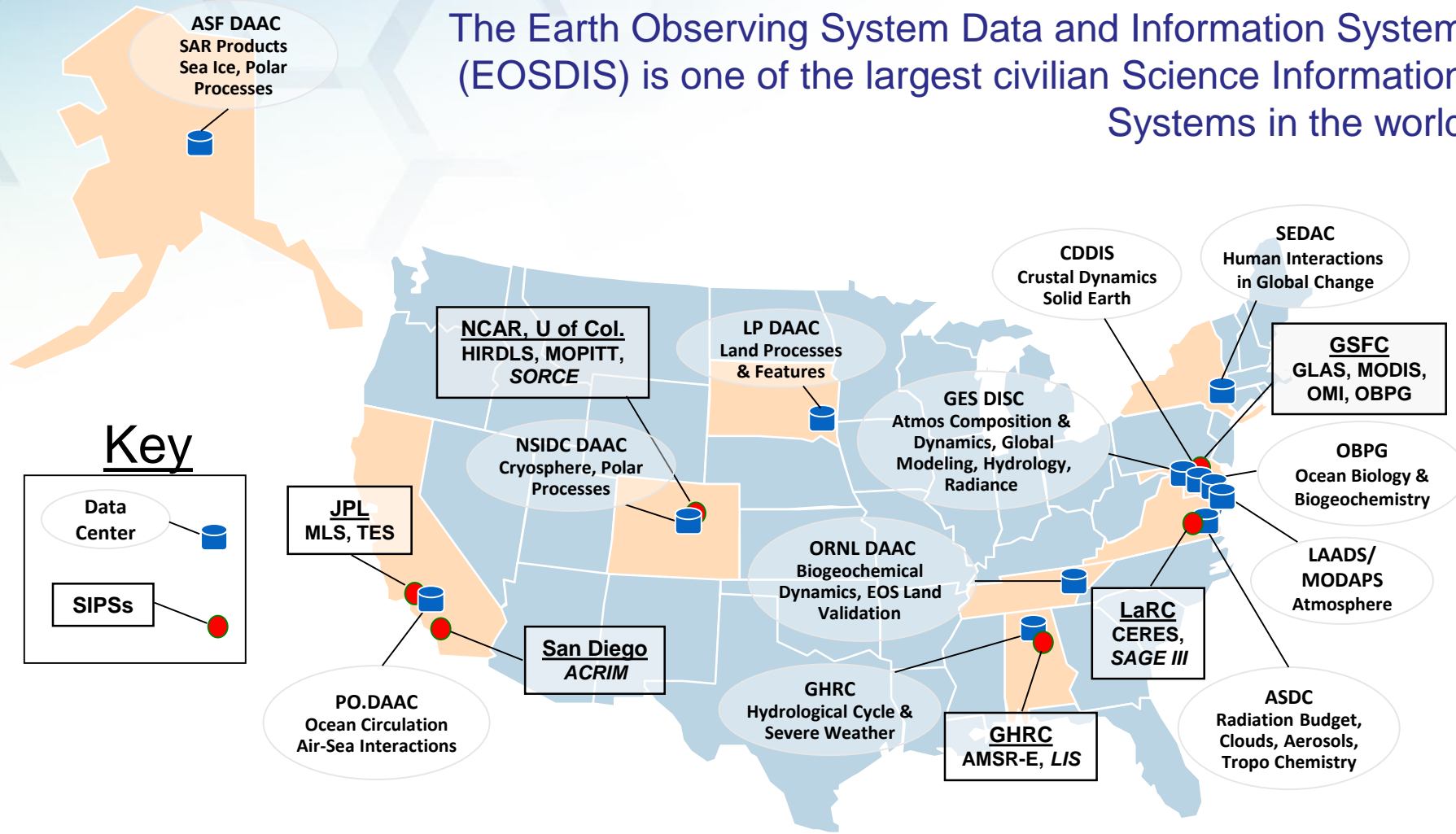
*Visible Infrared Imaging Radiometer Suite (VIIRS)*

*<http://viirsland.gsfc.nasa.gov/index.html>*

# NASA Earth Science Data Centers

<http://earthdata.nasa.gov>

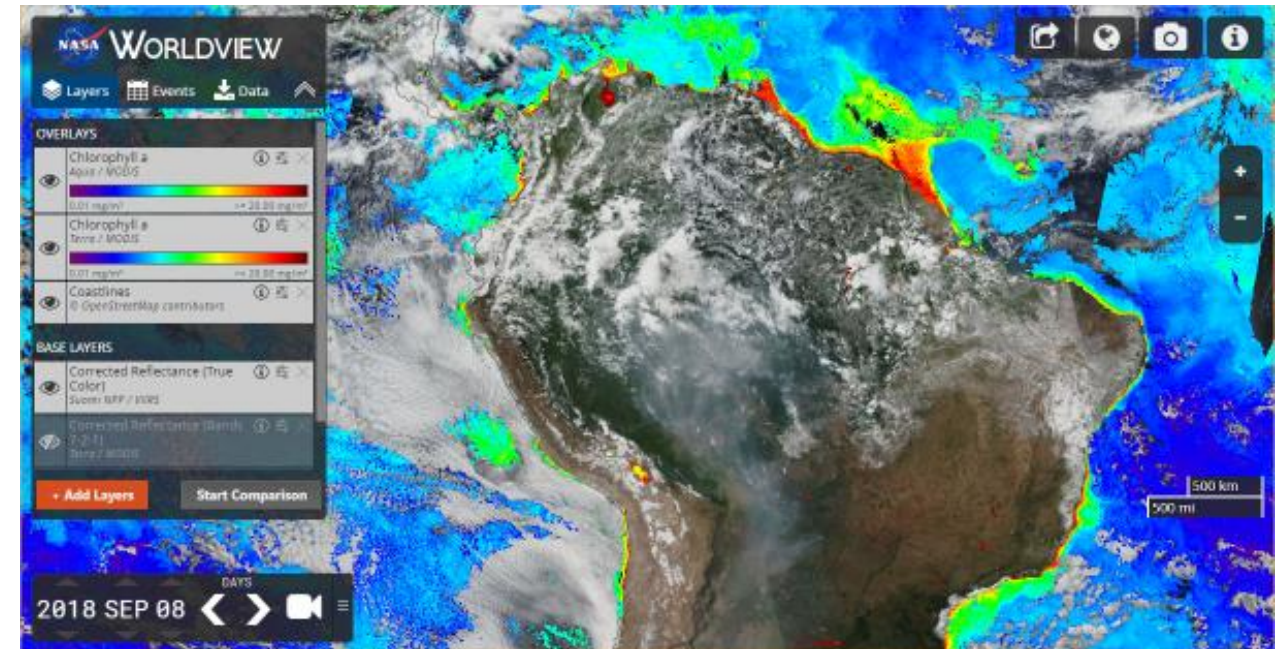
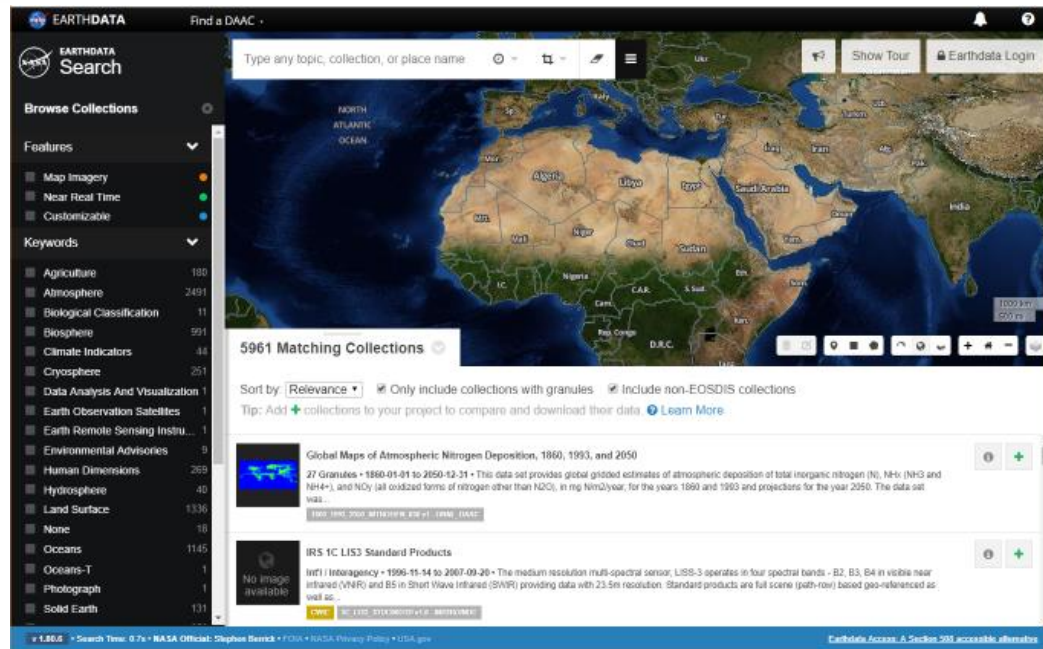
The Earth Observing System Data and Information System (EOSDIS) is one of the largest civilian Science Information Systems in the world



Data centers, collocated with centers of science discipline expertise, archive and distribute standard data

# Accessing EOSDIS NASA data

- Contextual data (stories, images, discoveries): [Earth Observatory](#)
- Visualization:
  - Web Based Visualization: [Worldview](#)
  - Standards-based Map Services: [Global Imagery Browse Services \(GIBS\)](#)
- Interactive search: [Earthdata Search](#)
- Near Real Time Data: [LANCE: Land, Atmosphere Near Real-Time Capability for EOS](#)
- Code-based metadata search: [Common Metadata Repository \(CMR\)](#)



# Worldview Categories

Search

Hazards And Disasters Science Disciplines

<b>All</b> Absolute Dynamic Topography Aerosol Index Aerosol Optical Depth Aerosol Albedo Amphibian Richness Areas of No Data (mask) ...	<b>Air Quality</b> Aerosol Index Aerosol Optical Depth Carbon Monoxide Corrected Reflectance Dust Fires and Thermal Anomalies ...	<b>Ash Plumes</b> Aerosol Optical Depth Corrected Reflectance Fires and Thermal Anomalies Land Surface Reflectance Sulfur Dioxide Volcano Hazard ...
<b>Drought</b> Corrected Reflectance Dams Drought Hazard Land Surface Reflectance Land Surface Temperature Precipitation Estimate ...	<b>Dust Storms</b> Aerosol Optical Depth Dust Corrected Reflectance Land Surface Reflectance ...	<b>Fires</b> Aerosol Index Aerosol Optical Depth Fires and Thermal Anomalies Carbon Monoxide Corrected Reflectance Earth at Night ...
<b>Floods</b> Corrected Reflectance Cloud Fraction Cloud Multi Layer Flag Cloud Phase Cloud Pressure Cloud Effective Radius ...	<b>Severe Storms</b> Corrected Reflectance Cloud Fraction Cloud Multi Layer Flag Cloud Phase Cloud Pressure Cloud Effective Radius ...	<b>Shipping</b> Corrected Reflectance Brightness Temperature Land Surface Reflectance Sea Ice Sea Surface Temperature ...
<b>Smoke Plumes</b> Aerosol Optical Depth Carbon Monoxide Corrected Reflectance Fires and Thermal Anomalies Land Surface Reflectance ...	<b>Vegetation</b> Corrected Reflectance Forests, Mangrove Freeze/Thaw Gross Primary Productivity Heterotrophic Respiration ...	<b>Other</b> Areas of No Data (mask) Blue Marble Brightness Temperature Chlorophyll a Dams ...

Search

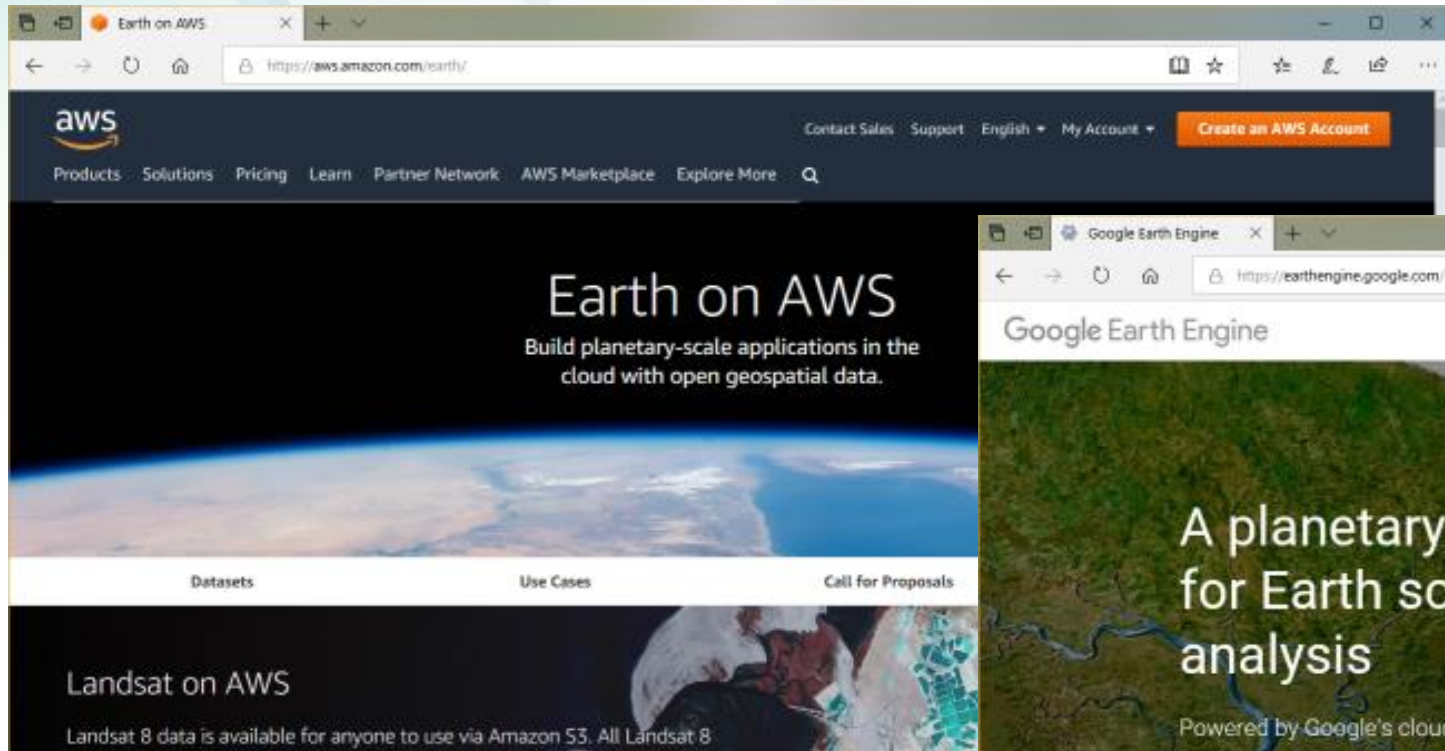
Hazards And Disasters Science Disciplines

<b>All</b> Absolute Dynamic Topography Aerosol Index Aerosol Optical Depth Aerosol Albedo Amphibian Richness Areas of No Data (mask) ...	<b>Atmosphere</b> Aerosol Albedo Aerosol Index Aerosol Optical Depth Cloud Albedo Carbon Dioxide Carbon Monoxide ...	<b>Biosphere</b> Amphibian Richness Forests, Mangrove Gross Primary Productivity Heterotrophic Respiration Human Footprint Land Cover ...
<b>Cryosphere</b> Freeze/Thaw Frozen Area Ice Surface Temperature Sea Ice Sea Ice Brightness Temperature Sea Surface Temperature ...	<b>Human Dimensions</b> Cyclone Hazard Dams Drought Hazard Earth at Night Fires and Thermal Anomalies Flood Hazard ...	<b>Land Surface</b> Blue Marble Corrected Reflectance DHR Reflectance Evaporation Fires and Thermal Anomalies Global Digital Elevation Map ...
<b>Oceans</b> Absolute Dynamic Topography Chlorophyll a Liquid Water Equivalent Cloud Liquid Water Open Water Latent Energy Flux Precipitation Rate ...	<b>Spectral/Engineering</b> Brightness Temperature Sigma0 Faraday Rotation Angle Outgoing Radiation Radiation Surface Flux ...	<b>Terrestrial Hydrosphere</b> Flood Hazard Freeze/Thaw Frozen Area Reservoirs Sea Ice Snow Cover ...
<b>Other</b> Areas of No Data (mask) Blue Marble Global 250m Water Map Global Digital Elevation Map Latitude Longitude Lines ...		

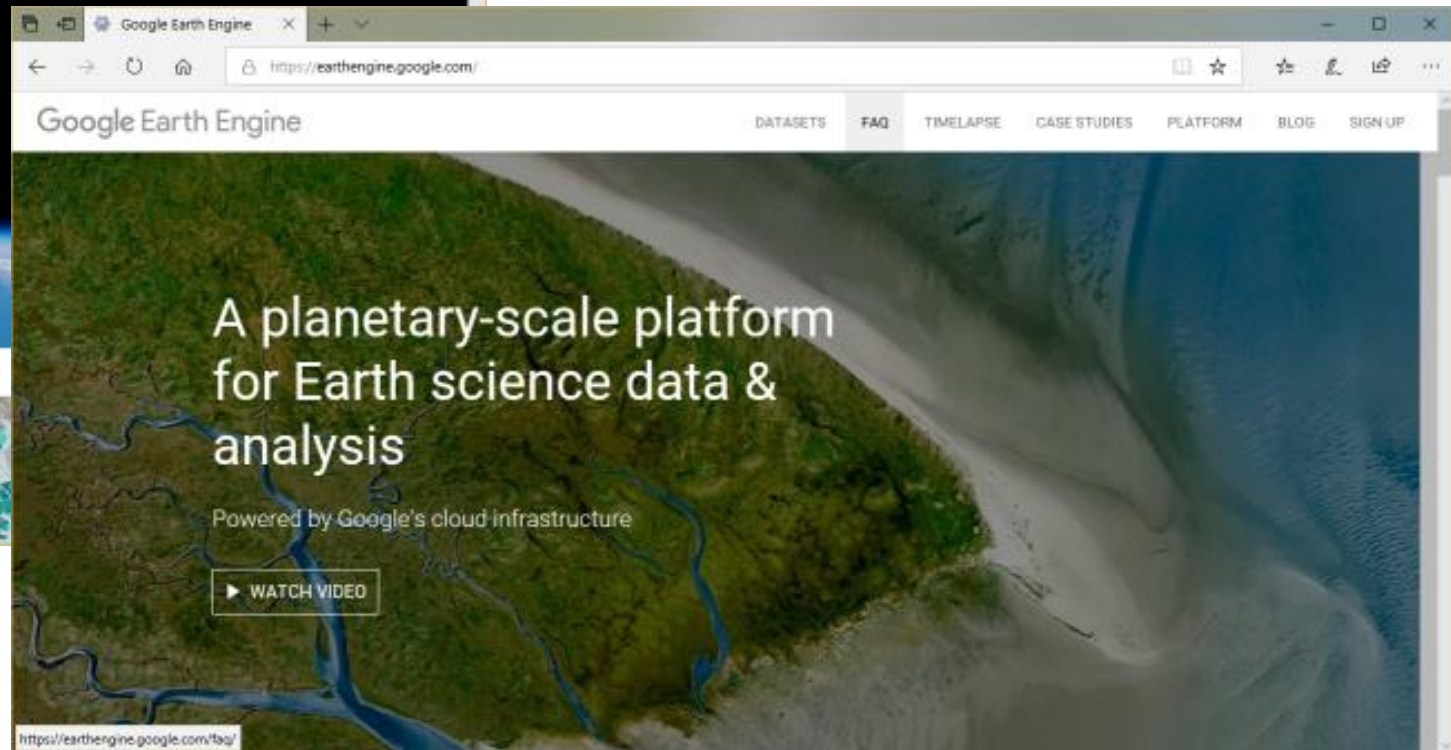
# Key datasets are also available on third-party platforms

Amazon Web Services:

<https://aws.amazon.com/earth/>



Google Earth Engine  
<https://earthengine.google.com/>



# Presentation Outline

- NASA Earth Observation Data
- Applications for Sustainable Development
- Applications for Disaster Risk Reduction
- Capacity Building

# Space Agencies and Governments use EO



Committee on Earth Observation Satellites



**60**  
Agencies



**105**

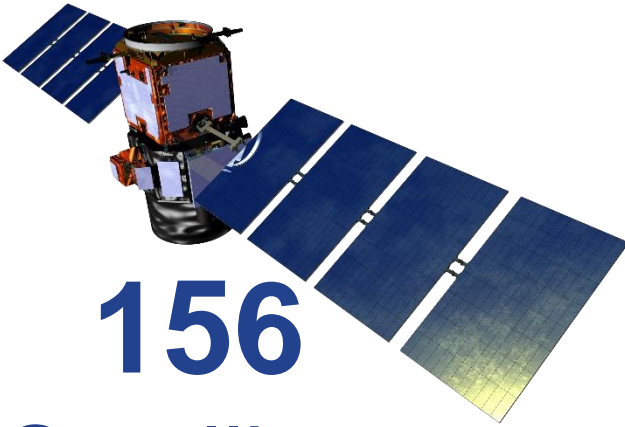


Nations & European  
Commission

**127**



Participating  
Organizations



**156**  
Satellites



Oceans



Ecological  
Forecasting



Disasters



Energy



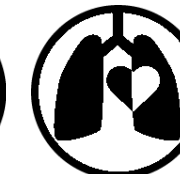
Water  
Resources



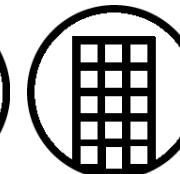
Agriculture &  
Food Security



Transportation  
& Infrastructure



Health & Air  
Quality



Urban  
Development

**9**

Societal  
Benefit  
Areas

# GEOSS / Data Sharing Principles

1. Data, metadata and products will be *shared as Open Data by default*, by making them available as part of the GEOSS Data Collection of Open Resources for Everyone (Data-CORE) without charge or restrictions on reuse, subject to the conditions of registration and attribution when the data are reused;
2. Where international instruments, national policies or legislation preclude the sharing of data as Open Data, data should be made available with *minimal restrictions on use* and at *no more than the cost of reproduction and distribution*;
3. All shared data, products and metadata will be made available with *minimum time delay*

# AmeriGEOSS



The AmeriGEOSS initiative is a framework that seeks to promote collaboration and coordination among the GEO members in the American continent

**AmeriGEOSS Thematic Communities**

 <b>Biodiversity and Ecosystem Sustainability</b> Capacity building for better monitoring, management, and maintenance of ecosystems and biodiversity they support; and to predict future changes.	 <b>Disaster Resilience</b> Disaster risk reduction, particularly for data exchange associated with early warnings and for the generation of regional products.	 <b>Food Security and Sustainable Agriculture</b> Agriculture, associated with climate variability, climate change, and food security.	 <b>Water Resources Management</b> Water, associated with the management approach of water resources and data management.
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GEO members in the American continent

Source: <https://www.amerigeoss.org/>

# SDGs with most opportunities



EARTH OBSERVATIONS FOR THE  
SUSTAINABLE DEVELOPMENT GOALS



GROUP ON  
EARTH OBSERVATIONS

## Initiative Purpose:

Organize and realize the potential of Earth observations and geospatial information to advance the *Sustainable Development Agenda* and enable societal benefits through achievement of the SDGs.

## Key Emphasis:

Collaboration with national statistical offices, line ministries, UN custodian agencies

<http://eo4sdg.org/>

## SDGs with most opportunities

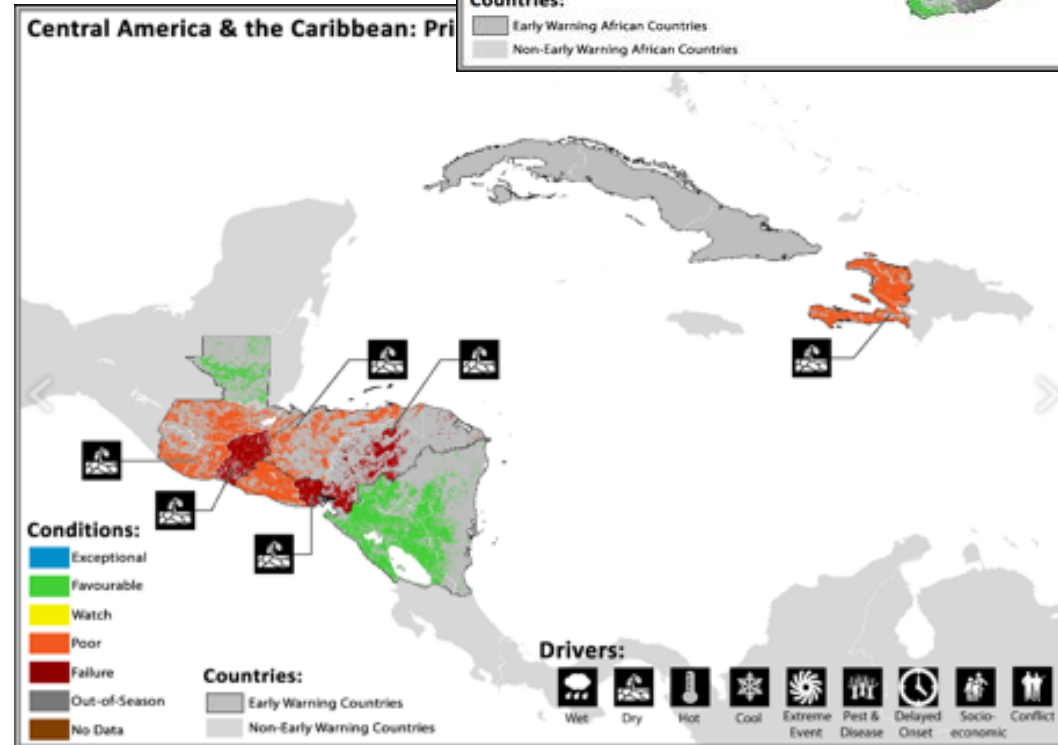
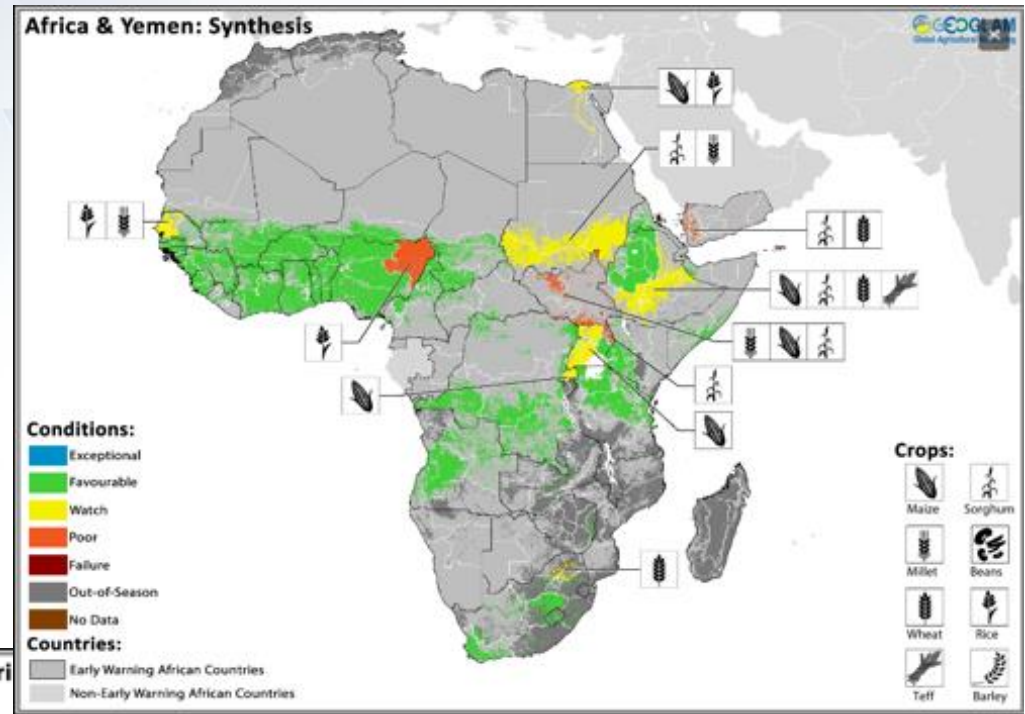


# Early Warning for Food Security

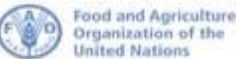
Beyond the major commodity crops, GEOGLAM monitors regionally important food crops monthly to provide early warning in regions susceptible to food insecurity

*Target 2.1 by 2030 end hunger and ensure access by all people*

cropmonitor.org



User Community



October 2018



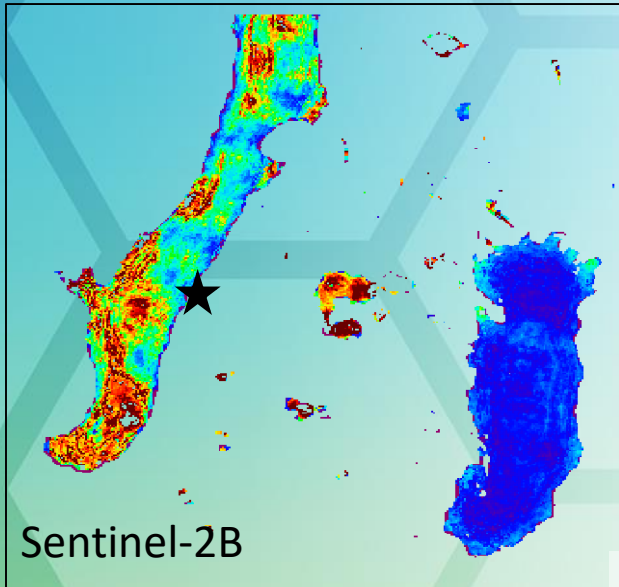
@G20\_GEOGLAM  
www.geoglam.org



Example: El Pañe Reservoir in Perú: water supply for Arequipa city

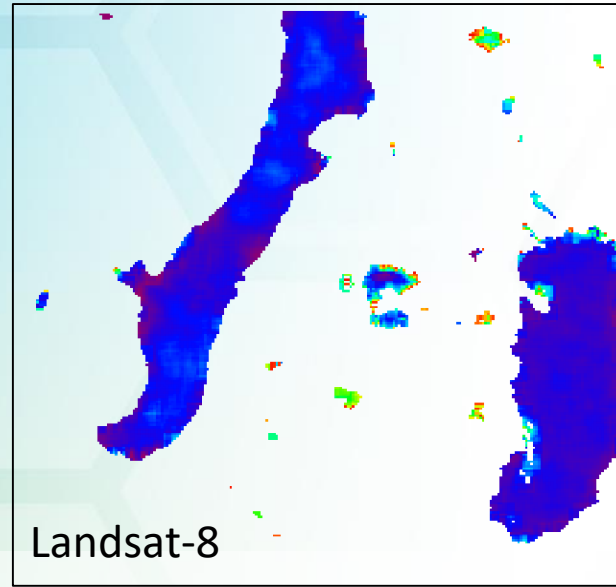
Current monitoring: Monthly at 2 locations

29<sup>th</sup> June 2017



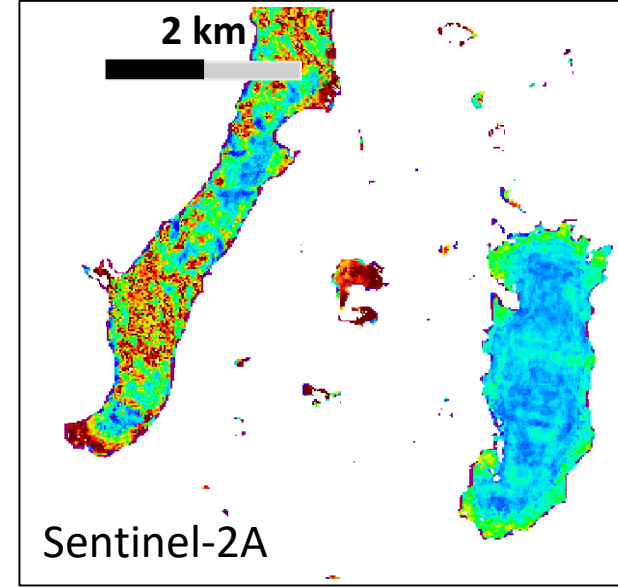
Sentinel-2B

17<sup>th</sup> July 2017



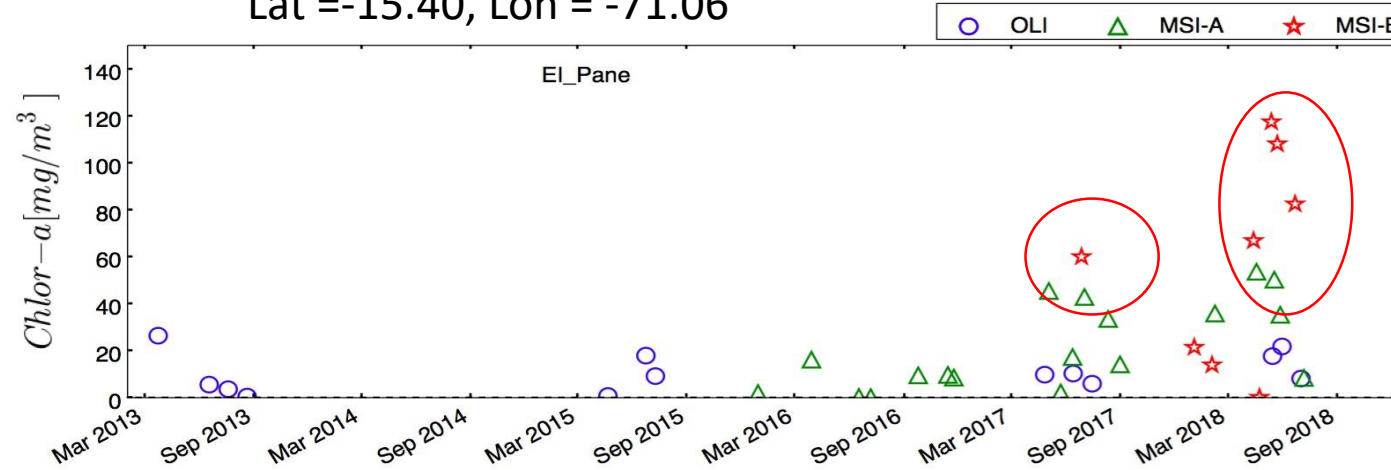
Landsat-8

13<sup>th</sup> August 2017



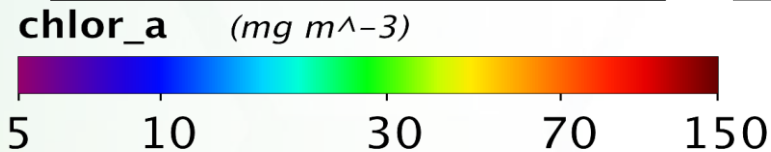
Sentinel-2A

Lat = -15.40, Lon = -71.06



Time-series corresponds to the marked location (star)

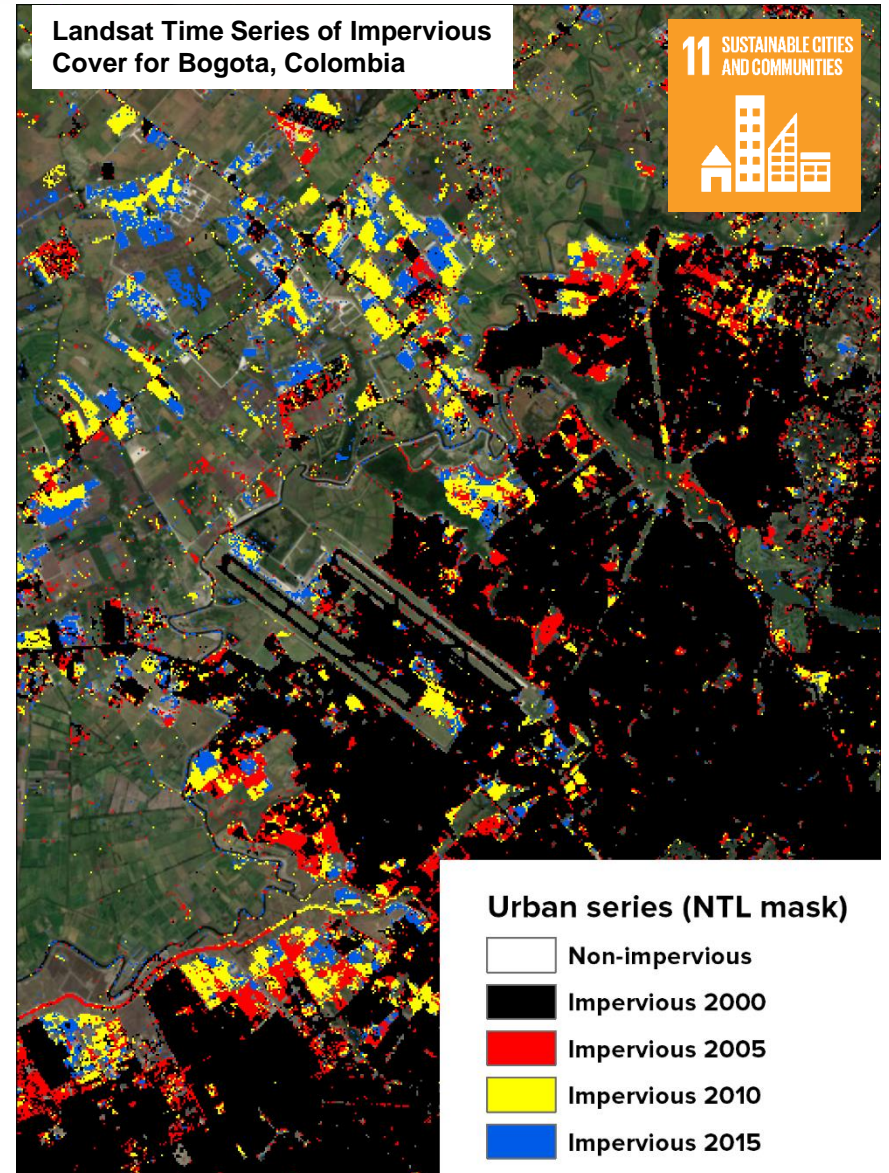
Chlorophyll-a



- ✓ EO contributes to many SDG 11 targets, i.e., 11.1 (slums), 11.3. (planning), 11.6 (air quality/waste management) and 11.7 (urban green/public places)
- ✓ The value of global urban extent data sets or global sampling of cities (Atlas of Urban expansion from NYU/Lincoln Institute of Land Policy) are key for global & national level monitoring & reporting
- ✓ There is a need for method comparability, standardization of datasets for indicator production, capacity development at national level, tools and collaborative platforms.

### Example of NASA/ CI sponsored training

Pre-conference workshop at the Regional Centre for Mapping of Resources for Development (RCMRD) International Conference (RIC) in Nairobi, Kenya in August 2018 [~28 participants] on indicator 11.3.1 & Trends.Earth tool





<http://eo4sdg.org>

@EO4SDG

- ✓ SDGs provide a unique opportunity to define roles of EO for sustainable development. Through SDGs, EO can monitor, assess and enable evidence-based decision making on sustainable development, and help project its impacts towards a more resilient, sustainable and secure society.
- ✓ It is necessary to strengthen governance frameworks at the national level to link the Earth observation community with the geospatial and statistical communities, in order to enrich the data ecosystems in countries; co-design user friendly data platforms and tools; and develop reliable, open and scalable knowledge.

# Presentation Outline

- NASA Earth Observation Data
- Applications for Sustainable Development
- Applications for Disaster Risk Reduction
- Capacity Building

# NASA Disasters Program

Applies NASA Earth observations to disaster risk reduction and building resilience – before, during and after events.

- Contributes to improved situational awareness and decision support with geospatial data, tools and analytics
- Supports risk and resilience assessment within a cultural context globally, regionally and locally
- Creates and leverages partners in EO science and technology, civil society, emergency management, policy and planning, humanitarian development, information and geospatial services
- Integrates EOs including satellite in situ, airborne and ocean; modeling and mapping, virtual reality, artificial intelligence;
- Promotes outreach and education

▶ <https://disasters.nasa.gov/home>

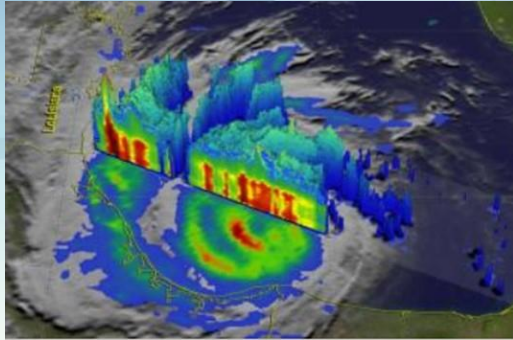
▶ <https://maps.disasters.nasa.gov/arcgis/home/>

The screenshot displays the NASA Disasters Program website interface. At the top, the NASA Earth Science logo and 'DISASTERS PROGRAM' are visible, along with the NASA Applied Sciences Program logo and the NASA logo. A search bar is located in the top right corner. The main navigation menu includes 'ORGANIZATION', 'DISASTERS', 'RESILIENCE', and 'RESOURCES'. The content area features several key sections:

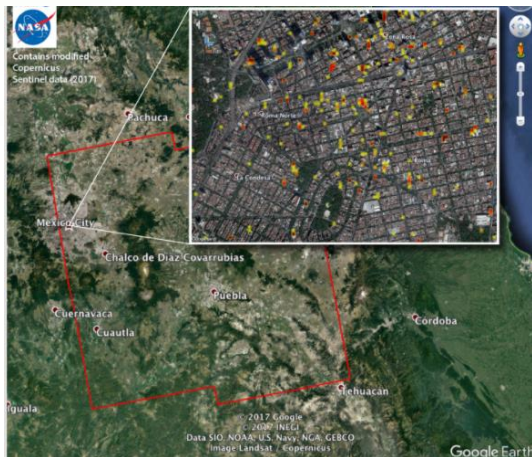
- Recent Responses:** A list of recent disaster events including Super Typhoon Yutu 2018, Hurricane Willa 2018, Hurricane Michael 2018, Sulawesi Island, Indonesia Earthquake and Tsunami 2018, Super Typhoon Mangkhut 2018, Hurricane Florence 2018, Hokkaido Japan Earthquake 2018, Manam Island Eruption August 2018, Kerala India Flood 2018, and Hurricane Lane 2018.
- About the NASA Disasters Program:** A text block explaining the program's mission to use Earth observations for disaster prediction, response, and recovery, with a 'Learn More' button and a 'View the NASA Disasters Mapping Portal' button.
- Earth Observatory:** A section titled 'Drought Persists in the Southwest' dated November 8, 2018, featuring a map of the United States showing drought conditions in the Four Corners region.
- Organization:** A section titled 'The Team' listing roles such as Disaster Response Coordination Team, Monthly Status Reports (MSR), nasa.gov Disaster Response Blog, Contact Us, and News. It also lists NASA Organizations: NASA HQ and NASA Applied Sciences.
- Resources:** A section with icons and labels for 'Airborne Science Asset Tracker', 'Meetings', and 'Training'.



# Answering Key Questions



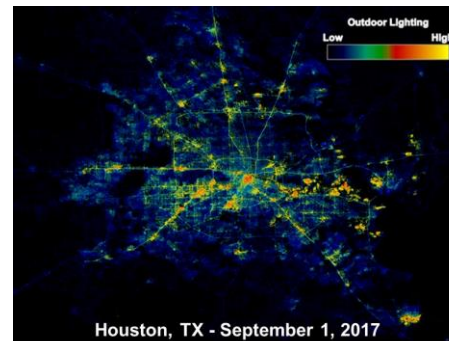
GPM's Radar Measures Intense Rain In Hurricane Harvey



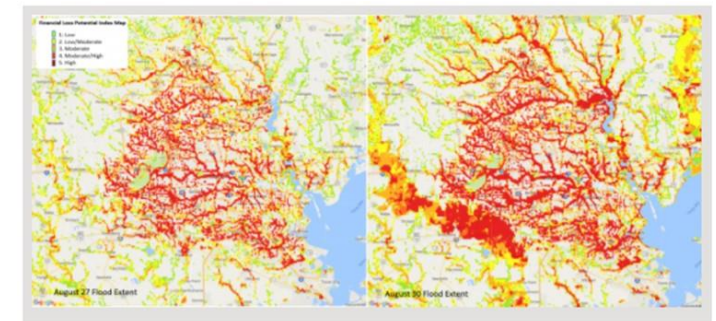
Damage Proxy Map of the M7.1 Raboso, Mexico, earthquake was created from the Copernicus Sentinel-1 satellite SAR

*What is the extent, severity and impact from hurricane, fire, quake ..!*

- Awareness of pre-existing conditions
- Monitoring evolving weather and water impacts;
  - Tropical winds and water extremes, soil moisture...
  - Flood and inundation extent
  - Socio-economic exposure and vulnerability
- Transport, supply chain and power disruptions
- Ecosystem, big city and community impacts
- Damage mapping and loss estimation
- Humanitarian and development assistance

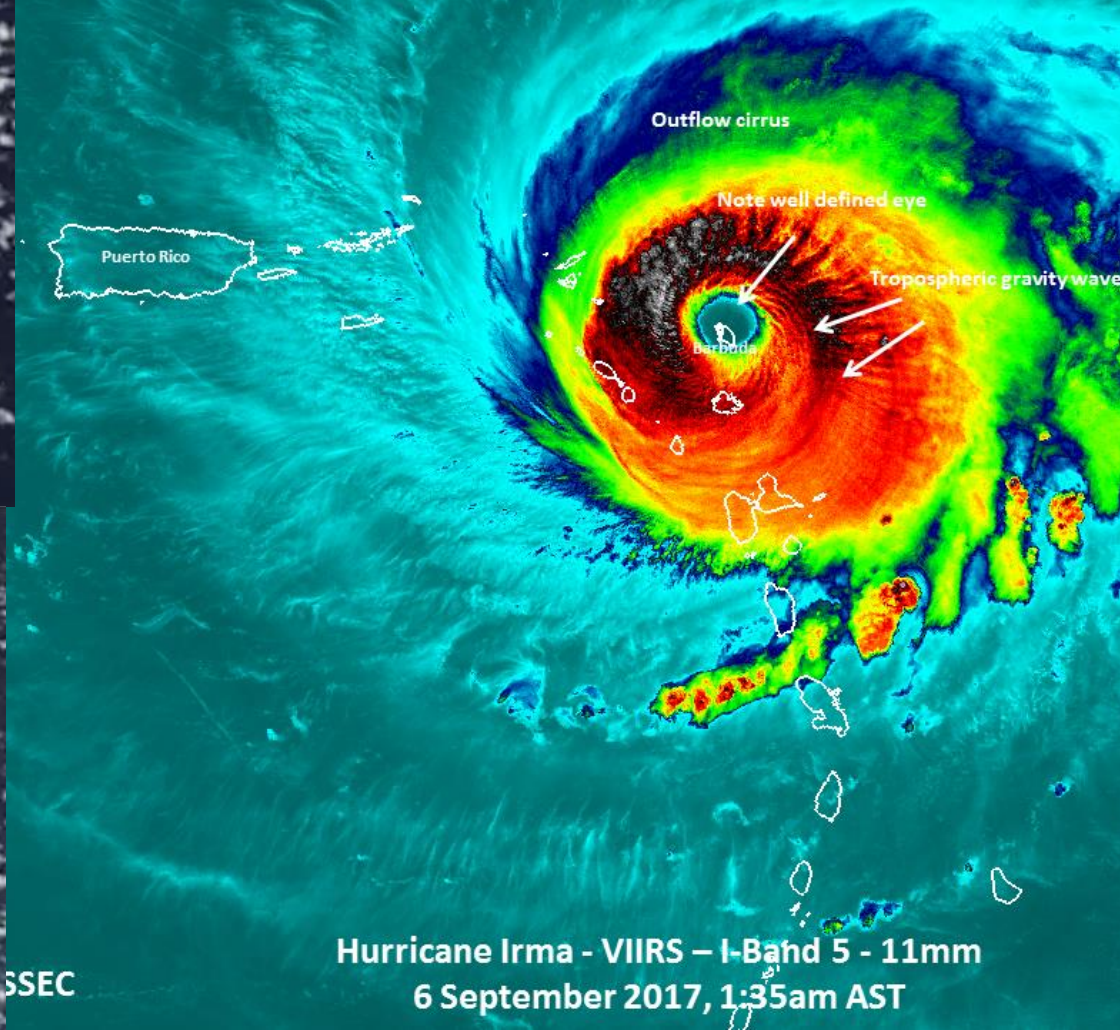


High resolution nighttime maps combined data from six satellites (Suomi-NPP, Landsat-8, Sentinel 2A & 2B, TerraSAR-X/TanDEM-X)

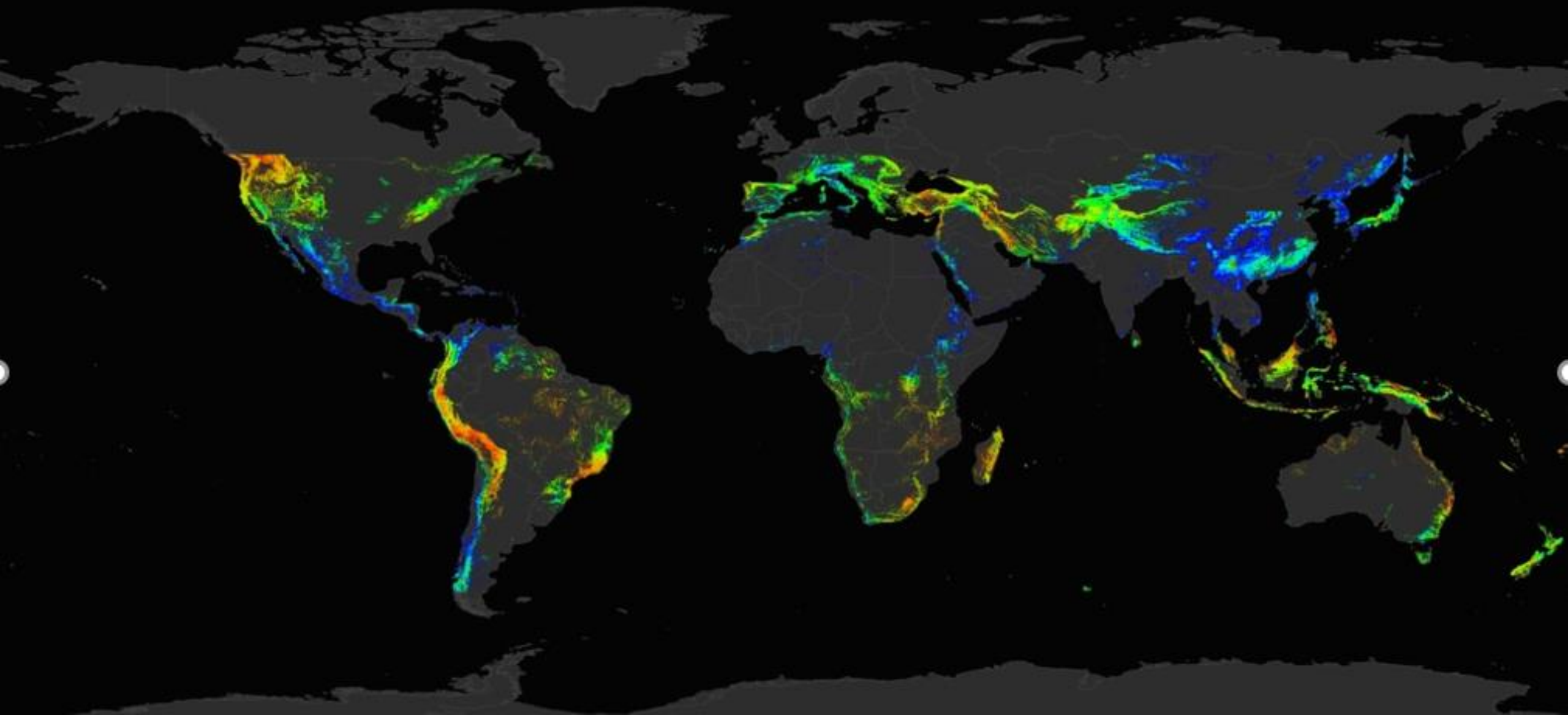


Financial Loss Potential Index for Hurricane Harvey

# Informing Preparedness, Response, Relief



# Global Landslides in June

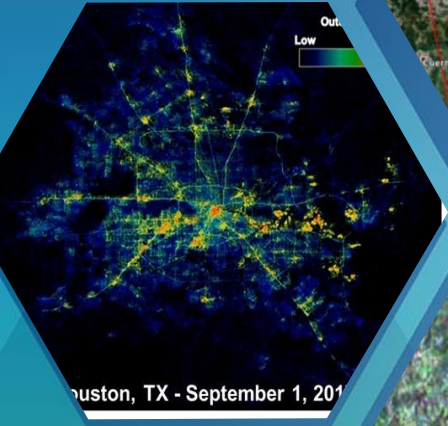


# Perils at City Scale

Earthquake  
Damage



*Radar  
and Night  
Imagery*



Power grid



Infrastructure and Flood



Mapping  
Flood and  
NOT Flood

# Disasters Program Geospatial Resources

- Disasters Mapping Portal
  - [maps.disasters.nasa.gov](https://maps.disasters.nasa.gov)
  - Aggregation across NASA of relevant data and/or derived products
  - Curation in a single space to add value to technical users & inform the general public



NASA Disasters Mapping Portal

## Featured Maps and Apps



Recent NASA Products for  
Hurricane Florence



Recent NASA Products for  
the California Wildfires of



Recent NASA Products for  
the 2018 Kilauea Eruption



Recent NASA Products for  
the June 2018 Fuego

# Hurricane Michael Story Map consolidates relevant resources



## NASA Products for Hurricane Michael 2018

Home

VIIRS Nighttime Imagery

Landsat Imagery

Sentinel-1 RGB Imagery

Sentinel-1 Water Extent

GFMS Inundation Estimate

Global Precipitation Measurement

### Dates of Images:

October 9 at 00 UTC - October 11 at 03 UTC (10/8 at 19 EDT to 10/10 at 22 EDT)

### Next Estimated Update:

10/11/2018

### Refresh Interval:

24 Hours

### Purpose/Summary:

Inundation Estimate from Global Flood Monitoring System (GFMS) based on surface and river routing models using NASA Global Precipitation Measurement (GPM) Integrated Multi-Satellite Retrievals for GPM (IMERG) precipitation information. GFMS covers the globe from 50N-50S. This product shows the near real time flooding every 3 hours at 1 km resolution.

### Suggested Usage:

This product can be used to estimate flood extent (and depth) and for comparison with other estimates from satellite and ground observations.

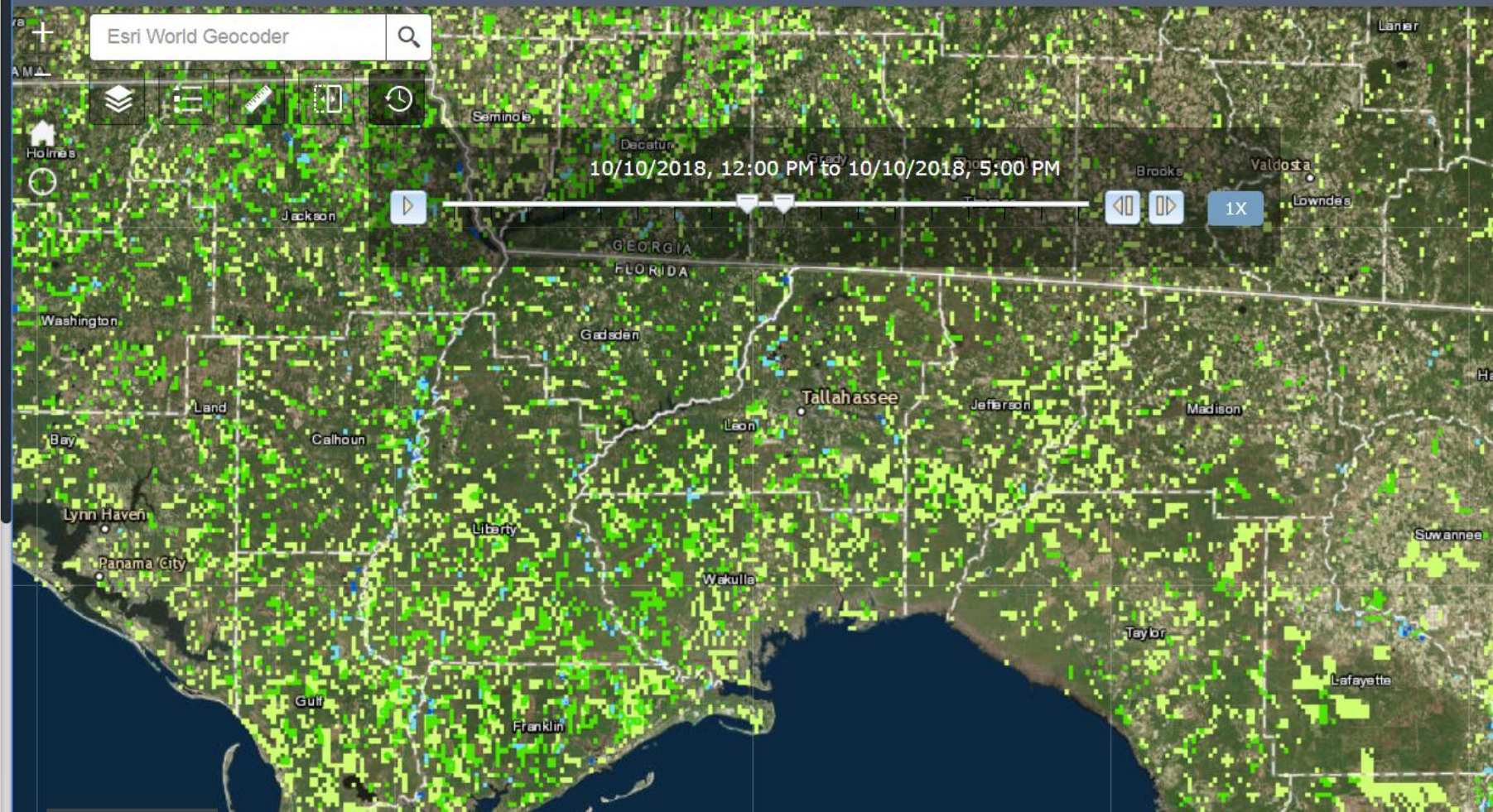
### Satellite/Sensor:

Model calculations are at 1km resolution and 3-hours; satellite precipitation (GPM IMERG) is input to models at ~12 km and 3-hrs.

### Credits/Acknowledgements:

Global Flood Monitoring System (GFMS), University of Maryland

## Global Flood Monitoring System (GFMS) Inundation Estimates



# Disasters Program Response: Florence



## Recent NASA Products for Hurricane Florence

[Home](#)[Sentinel-1 RGB](#)[Sentinel-1 Flood Map](#)[ARIA Flood Map](#)[ARIA Damage Map](#)[Black Marble Nighttime Imagery](#)[Black Marble HD Nighttime City Imagery](#)[VIIRS Nighttime Imagery](#)[UAVSAR Imagery](#)[Landsat Imagery](#)[GFMS Map](#)[Floodwater Maximum Depth](#)

## NASA Disasters Program: Hurricane Florence

A collection of NASA's products used in response to Hurricane Florence.

Click on the tabs at the top of the page to learn about impacts from the storm that NASA scientists can observe through satellite data.

For stories related to NASA products produced for the Hurricane Florence, click [here](#).

For more information about the NASA Disasters Program, click the following links:

[NASA Disasters Mapping Portal](#)

[NASA Disasters Program Website](#)

Image Source: [International Space Station Program](#)



China Flooding  
Jun-Jul 2017



Indonesia  
Landslide Feb  
2017



Mongolia desertification  
and drought June 2017

How could NASA disasters program information contribute to improving your countries resilience to disasters?

# Presentation Outline

- NASA Earth Observation Data
- Applications for Sustainable Development
- Applications for Disaster Risk Reduction
- **Capacity Building**



# Capacity Building

- ▶ Engages current and future decision makers
- ▶ Improves skills and capabilities to access and apply NASA Earth science
- ▶ Three lines of business: trainings, product co-development, and relationship brokering
- ▶ Works through both program and element activities
- ▶ Identifies partnership opportunities to reach new end users
- ▶ Participates in both domestic and international capacity building groups, such as GEO and CEOS
- ▶ Supports three Elements (ARSET, DEVELOP, and SERVIR) and initiatives focused on indigenous peoples in North America and an interactive mapper

## 2017 Achievements Programmatic Engagement:

6,622  
Individuals



2,369  
Institutions



104  
Trainings



142  
Countries



Impacted



Not Impacted



# ARSET

- ▶ Applied Remote Sensing Training Program
- ▶ Provides online and in-person trainings for:
  - Policy Makers
  - Regulatory Agencies
  - Applied Environmental Professionals
- ▶ Increases the use of NASA Earth Science models and data for environmental applications
- ▶ <http://arset.gsfc.nasa.gov>
- ▶ Thematic areas addressed:



Disasters



Health &  
Air Quality



Ecological  
Forecasting



Water  
Resources

# ARSET Trainings: Meeting Attendees at Their Level

- ▶ ARSET trainings are offered at different levels, both online and in-person, and many training materials are available in English & Spanish

## **Advanced (Level 2)**

Requires level 1 training or equivalent knowledge  
In-depth and highly focused topics

*Advanced Webinar: SAR Image and Data Processing*

## **Basic (Level 1)**

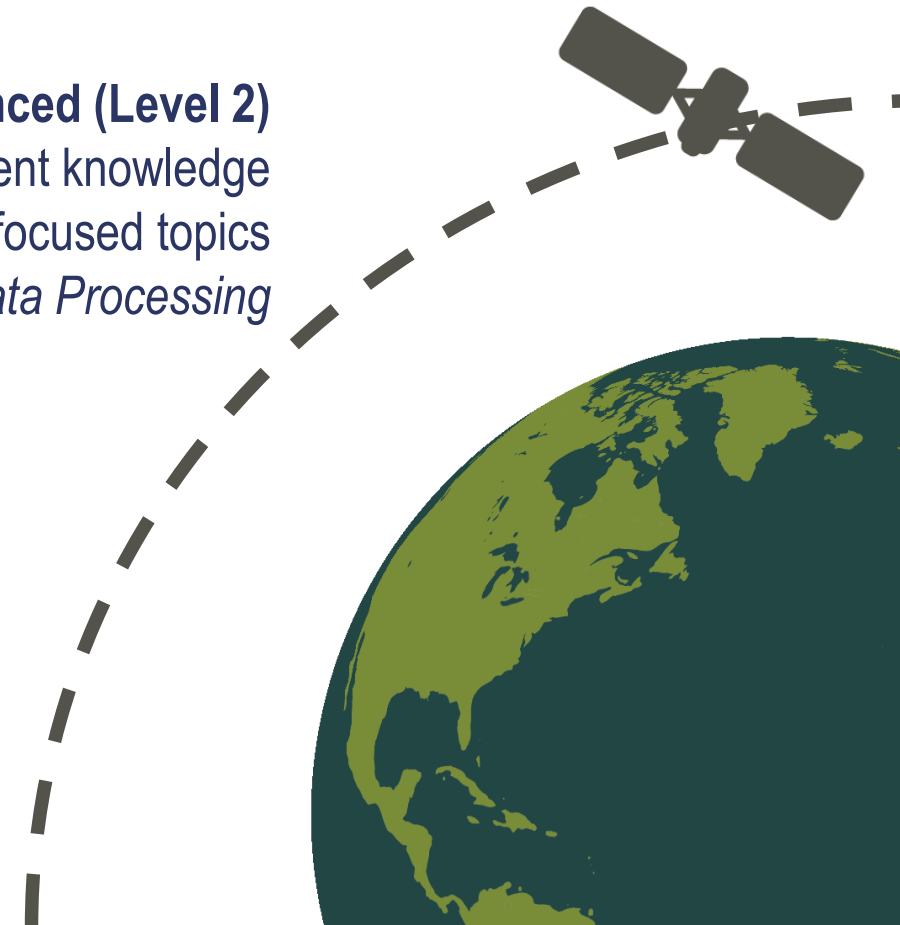
Requires level 0 training or equivalent knowledge  
Covers specific applications

*Introduction to Synthetic Aperture Radar*

## **Fundamentals (Level 0)**

Assumes no prior knowledge of remote sensing

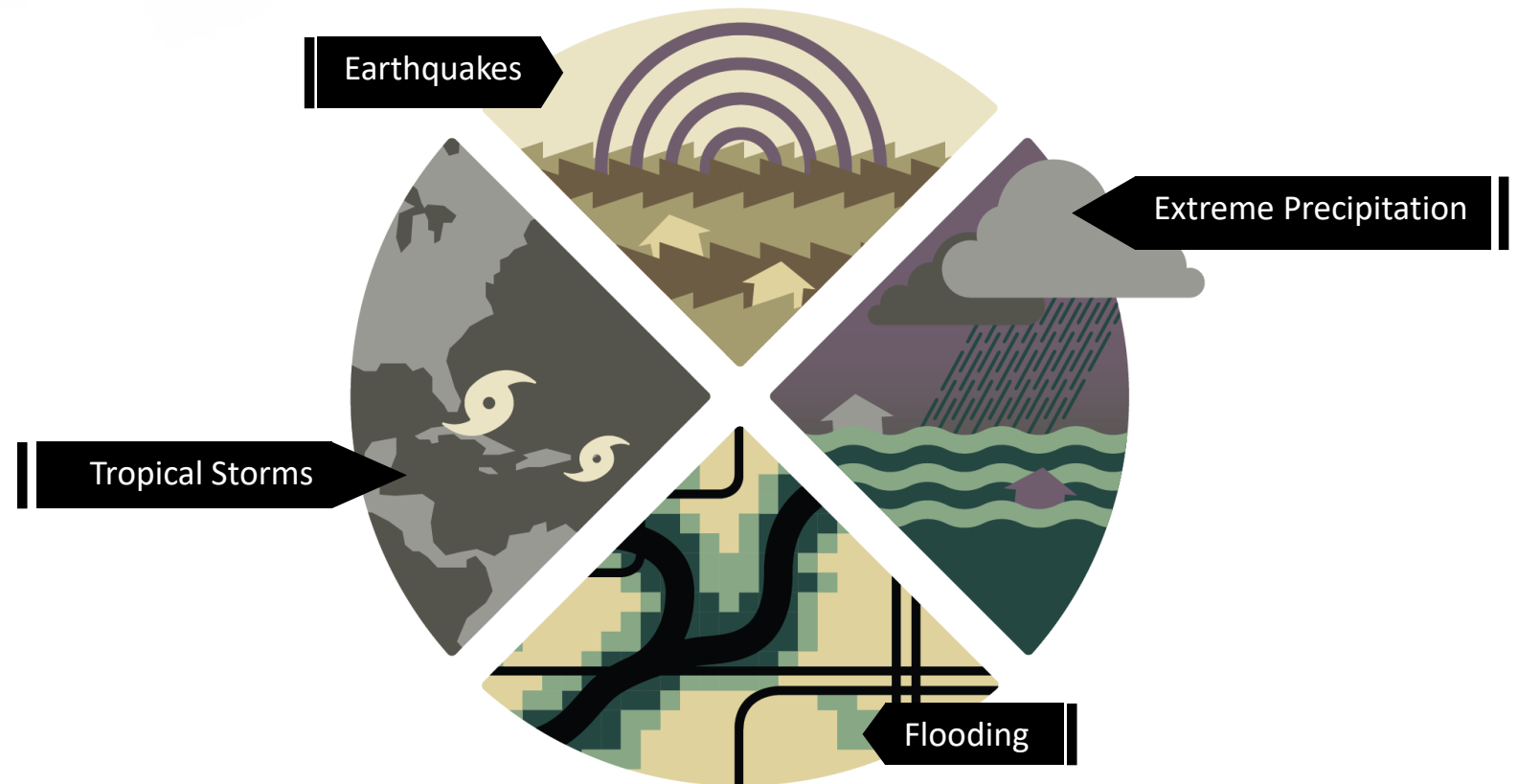
*Fundamentals of Remote Sensing*





# ARSET Disasters Trainings

- ▶ Offered since 2013
- ▶ 13 trainings
- ▶ 3,500+ participants
- ▶ 130+ countries
- ▶ 1,400+ organizations



# DEVELOP



<https://develop.larc.nasa.gov>

- ▶ Bridges the gap between NASA Earth Science and society
- ▶ Addresses environmental and public policy issues around the globe
- ▶ Conducts 10-week long interdisciplinary feasibility studies (3 terms per year)
- ▶ Builds capacity to use Earth observations in both participants (students, recent grads & transitioning career professionals) and partner organizations
- ▶ Works within all 8 thematic areas



Disasters



Health &  
Air Quality



Energy



Agriculture &  
Food Security



Ecological  
Forecasting



Urban  
Development



Water  
Resources



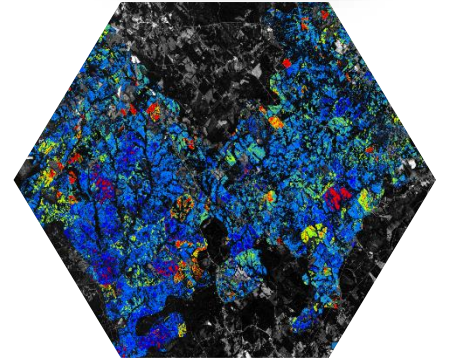
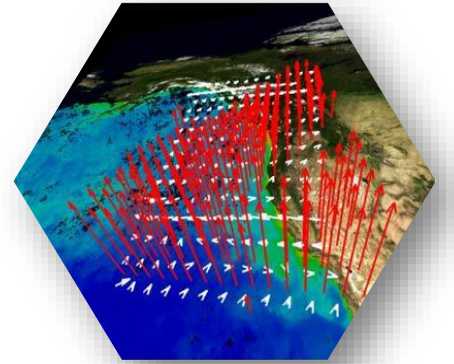
Transportation  
& Infrastructure



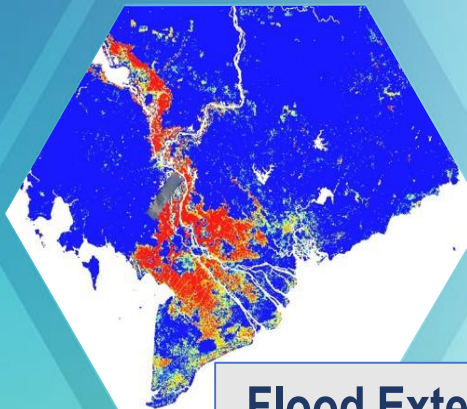
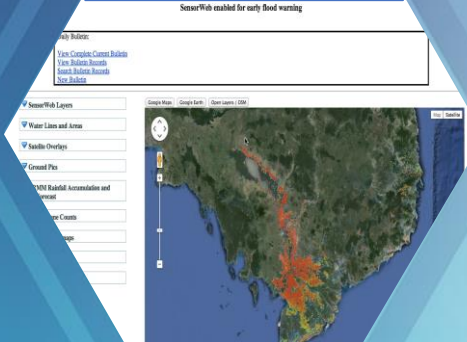
# DEVELOP Feasibility Projects

- ▶ Highlight the applications and capabilities of Earth observations
- ▶ Address actionable real-world environmental issues
- ▶ Partner with decision-making organizations
- ▶ Study areas in the United States and internationally
- ▶ Conducted in 10-week terms (spring, summer, fall)
- ▶ Align with one of the Applied Sciences' thematic areas
- ▶ Address both domestic and international decision making

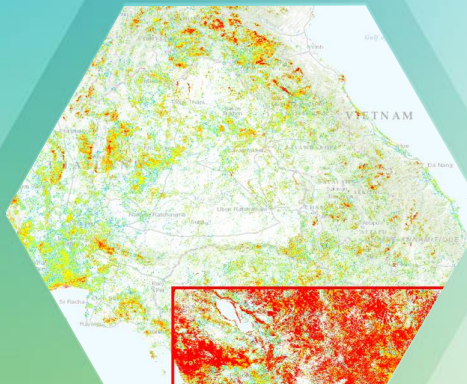
***60-70 Projects each year***



## Dashboard



Flood Extent



Inundation Maps

# Southeast Asia Disasters:

## Near Real-Time Flood Monitoring and Web-based Decision Support Tool for Enhanced Flood Management Along the Mekong River

### Community Concerns:

- ▶ Severe flooding can cause significant loss of life, expansive crop destruction, infrastructure damage, worsened public health, and splintered social and economic continuity
- ▶ Improved water management enhances agriculture and aquaculture productivity, drinking water quality, water-derived transportation highways, and overall quality of life, which can help alleviate poverty
- ▶ Seasonal flows are vital for maintaining habitats for 20,000 plant species, 1,200 bird species, 850 fish species, 800 reptile and amphibian species, and 430 mammal species in one of the most bio-diverse regions in the world

### Project Objectives:

- ▶ Create MODIS-based near real-time flood impact mapping product
- ▶ Develop an online Flood Dashboard that aggregates flood and weather products for enhanced decision making

### Benefits & Outcomes:

- ▶ Flood impact product allows for near real-time visualization of flood extent and degree across the region
- ▶ The web access dashboard provides a single, free, service that aggregates several different flood map and weather products, including near real-time maps and data
- ▶ The tool allows anyone to monitor the extent of floods in the region, which can aid in flood disaster relief, as well as find patterns and vulnerable areas for flood mitigation decisions
- ▶ Case studies provide validation of mapping methods used in flood mapping products



- ▶ Joint development initiative of NASA & USAID
- ▶ Works in partnership with leading regional organizations world-wide
- ▶ Helps developing countries use information provided by Earth observing satellites and geospatial technologies for managing climate risks and land use
- ▶ Empowers decision-makers with tools, products, and services to act locally on climate-sensitive issues
- ▶ Works within thematic topics such as:



Disasters



Agriculture &  
Food Security



Ecological  
Forecasting



Water  
Resources



SERVIR connects space to village by helping developing countries use satellite data to address critical challenges in food security, water resources, weather and climate, land use, and natural disasters. A partnership of NASA, USAID, and leading technical organizations, SERVIR develops innovative solutions to improve livelihoods and foster self-reliance in Asia, Africa, and the Americas.



  
Agriculture & Food Security

  
Water & Water-Related Disasters

  
Land Cover & Ecosystems

  
Weather & Climate

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# Enhancing Flood Early Warning Systems (EWS) in Hindu Kush Himalaya (HKH)



**SERVIR**  
HINDU KUSH  
HIMALAYA

**Concern:** Early warning, as one of the key elements of DRR, is essential to build resilience of vulnerable communities. Longer lead time and provisioning of appropriate information ensures better preparedness for response, and in turn saves more lives and properties.

## Partners:

- Flood Forecasting & Warning Centre (FFWC), Bangladesh
- Department of Hydrology and Meteorology (DHM), Nepal
- Mercy Corps

## Direct Science Support:

- SERVIR AST projects led by Jim Nelson, BYU; Patrick Gatlin, MSFC; Ben Zaitchik, JHU; and Cedric David, JPL)

**Study Area:** Bangladesh, Nepal

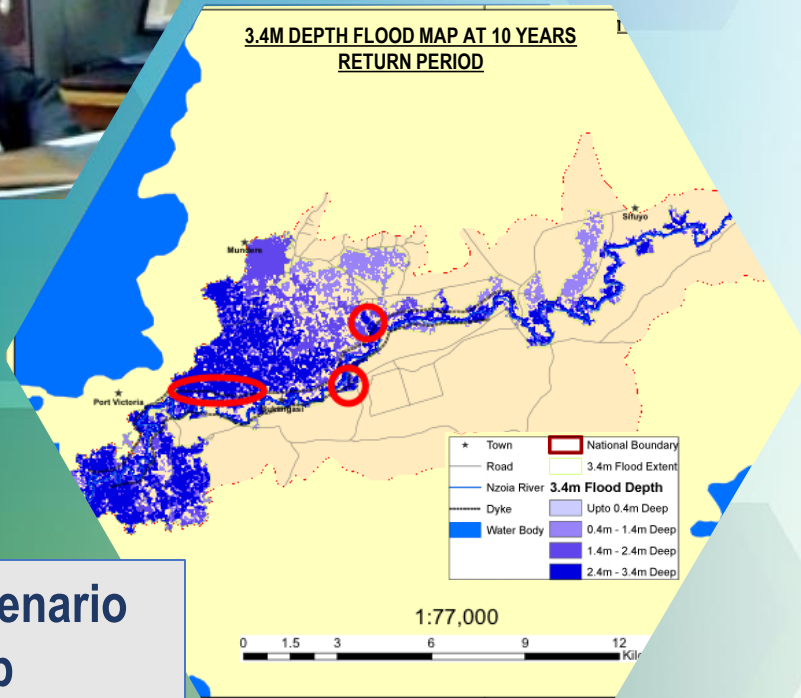
**Impact & Benefit:** FFWC and DHM are actively using the system while issuing their forecasts. An extensive evaluation of the 15-day forecasts are underway, but the initial results are very promising.

**Objective:** Through the service, an operational system has been developed and deployed at FFWC in Bangladesh and DHM in Nepal using downscaled GLOFAS forecast.

## Simintei Kooke

Kenya Ministry of Water & Irrigation

“The biggest problem we have is lack of data. When someone, like SERVIR comes along to help us out it is very good because we have been missing floods.”



Flood Scenario Map

# SERVIR Guides Flood Protection in Kenya

## Community Concerns:

- ▶ Nzoia River in Western Kenya pushes over its banks each year
- ▶ A 2008 flood caused at least 5,000 people to be marooned or evacuated from the banks of the river (UN Office for the Coordination of Humanitarian Affairs)

## Benefits & Outcomes:

- ▶ Provide high-accuracy flood level scenario maps to the World Bank to guide regional flood protection dike repairs
- ▶ SERVIR Floor Map Tool used to identify sections of the dikes in need of repair
- ▶ The World Bank's Water Security and Resilience Project provided financial assistance to design and implement the repairs

# Thanks! Questions?

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