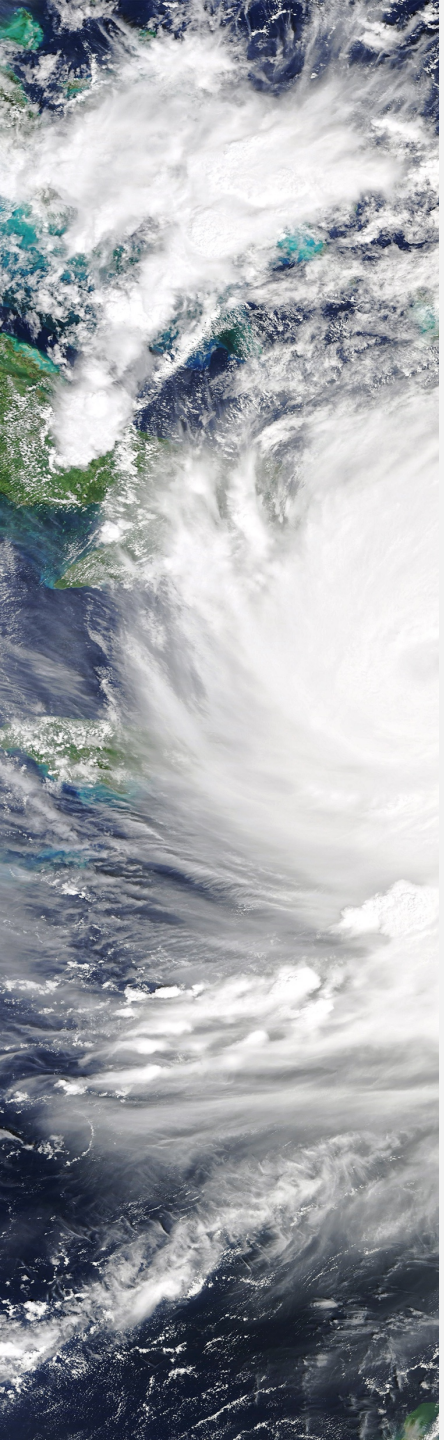


National Aeronautics and Space Administration

ARSET

Applied Remote Sensing Training

http://arset.gsfc.nasa.gov

@NASAARSET

Overview of the Global Disaster Alert & Coordination System (GDACS)

February 21, 2017
8:00-10:00 a.m. and 5:00-7:00 p.m. EST (UTC-8)

Amita Mehta

Guest Speaker: Luca Dell'oro (UNITAR)

Outline

- About ARSET
- Overview of GDACS
- Overview of UNITAR-UNOSAT*
- Demonstration of Satellite Mapping System
- Demonstration of GDACS Features for Monitoring Disasters

* The United Nations Institute for Training and Research (UNITAR) and UNITAR Operational Satellite Application Programme (UNOSAT)

About the Applied Remote Sensing Training Program (ARSET)

NASA's Applied Remote Sensing Training Program (ARSET)

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

- Empowering the global community through remote sensing training
- Part of NASA's Applied Sciences Capacity Building Program
- Goal: increase the use of Earth Science in decision-making through training for:
  - policy makers
  - environmental managers
  - other professionals in the public and private sector
- Trainings offered focusing on applications in:

Disasters

Ecoforecasting

Health & Air Quality

Water Resources

ARSET Training Levels

Fundamentals

Level 0

- Online only
- Assumes no prior knowledge of remote sensing
- Examples:
  - *Fundamentals of Remote Sensing*
  - *Satellites, Sensors, Data, and Tools for Land Management & Wildfire Applications*

Basic Trainings

Level 1

- Online and in-person
- Requires level 0 training or equivalent knowledge
- Specific applications
- Example:
  - *Remote Sensing of Forest Cover & Change Assessment for Carbon Monitoring*

Advanced Trainings

Level 2

- Online and in-person
- Requires level 1 training or equivalent knowledge
- More in-depth or focused topics
- Example:
  - *Advanced Webinar: Land Cover Classification with Satellite Data*

ARSET Training Formats

Online

- Offered through the internet
- Available live and recorded
- Typically 1 hr session, once per week, over 4-6 weeks
- Available at all training levels:
  - Fundamentals of Remote Sensing
  - Introductory
  - Advanced

In-Person

- 2-7 days in length
- Held in a computer lab
- Mixture of lectures and exercises
- Locally relevant case studies
- Available levels:
  - Introductory
  - Advanced

Train the Trainers

- Trainings and materials
- Offered online & in-person
- For organizers seeking to develop their own applied remote sensing training programs

ARSET Trainings

8,000+ participants

140+ countries

1,600+ organizations

36 online trainings

45 in-person trainings

Disasters
7 trainings

Ecoforecasting
10 trainings

Health & Air Quality
48 trainings

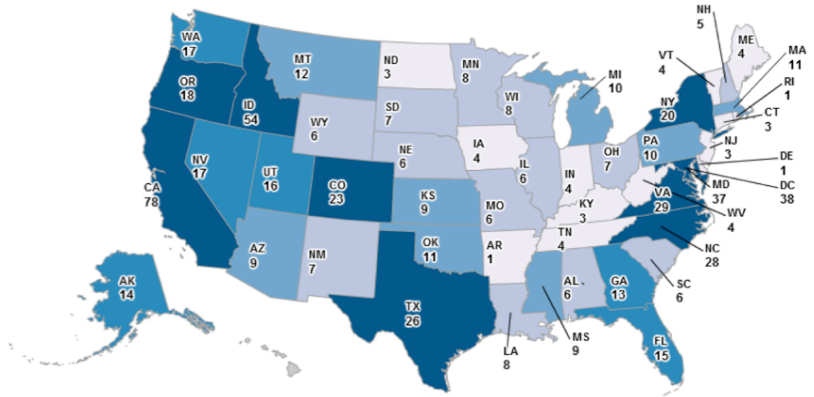
Water Resources
14 trainings

Train the Trainers
1 training

ARSET's Global Footprint

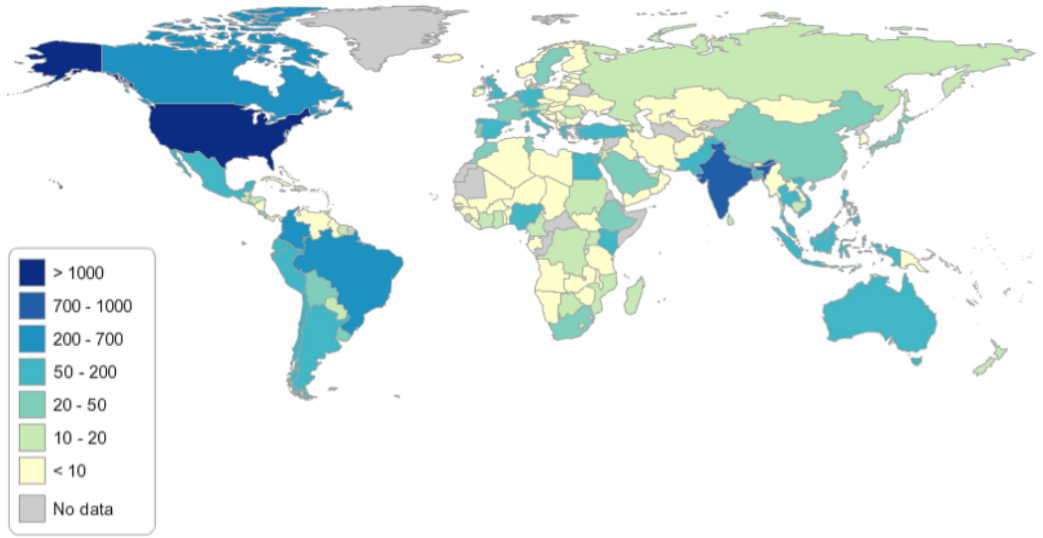
- 81 trainings
- 8,000+ participants
- 1,600+ organizations
- 140+ countries
- All 50 U.S. States

2009-2015



ARSET Participants by Country

2009 – 2016



Overview of the Global Disaster Alert & Coordination System (GDACS)

What is GDACS?

http://www.gdacs.org/

- A cooperation framework between the United Nations, the European Commission and disaster managers worldwide to improve alerts, information exchange and coordination in the first phase after major sudden-onset disasters.
- Initiated in 2003/4
- Develops data tools and services that complement existing materials, including
  - International Search and Rescue Advisory Group (INSARAG) Guidelines
  - UN Disaster Assessment and Coordination (UNDAC) Field Handbook
  - International Federation of Red Cross and Red Crescent Societies (IFRC) Publications
  - Standard Operating Procedures from the European Community Mechanism for Civil Protection
  - International Humanitarian Partnership (IHP)
  - Euro Atlantic Disaster Response Coordination Centre (EADRCC)

* *Global Disaster Alert and Coordination System Guidelines* [PDF]. (2014). GDACS.org

GDACS Tools and Services

http://www.gdacs.org/

- GDACS offers the following information via its websites:
  - Disasters alerts and impact estimations after major disasters through a multi-hazard disaster impact assessment service managed by the European Commission Joint Research Centre (JRC)
  - The Virtual On-Site Operations Coordination Center (OSOCC), a password-restricted site managed by the United Nations Office for the Coordination of Humanitarian Affairs (OCHA)
  - Maps and Satellite Imagery
  - A Science portal

GDACS Tools and Services

http://www.gdacs.org/

- GDACS offers the following information:
  - Disasters alerts and impact estimations after major disasters
  - The Virtual On-Site Operations Coordination Center (OSOCC)
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  - A Science portal

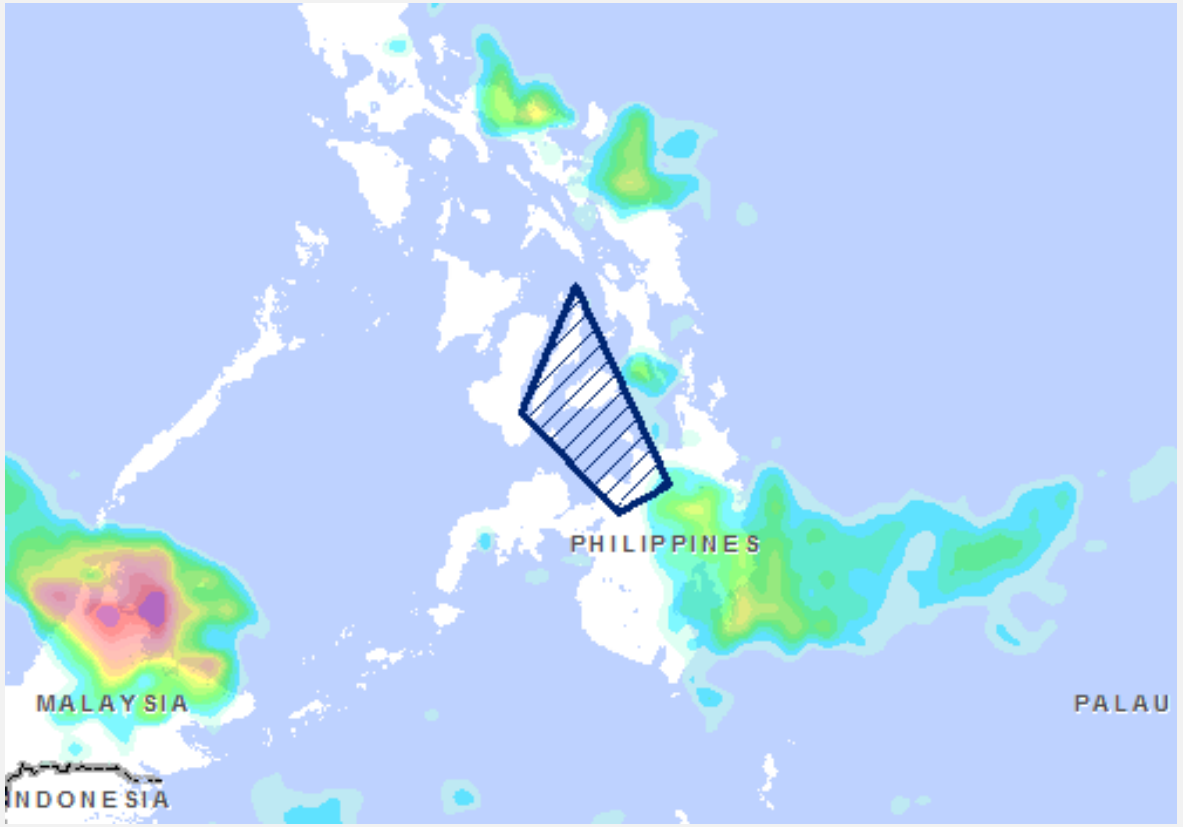


Image Credit: GDACS Event Report Summary, Flood Alert for the Philippines 16-26 Jan 2017
http://www.gdacs.org/report.aspx?eventtype=FL&eventid=1000038

GDACS Disaster Alerts

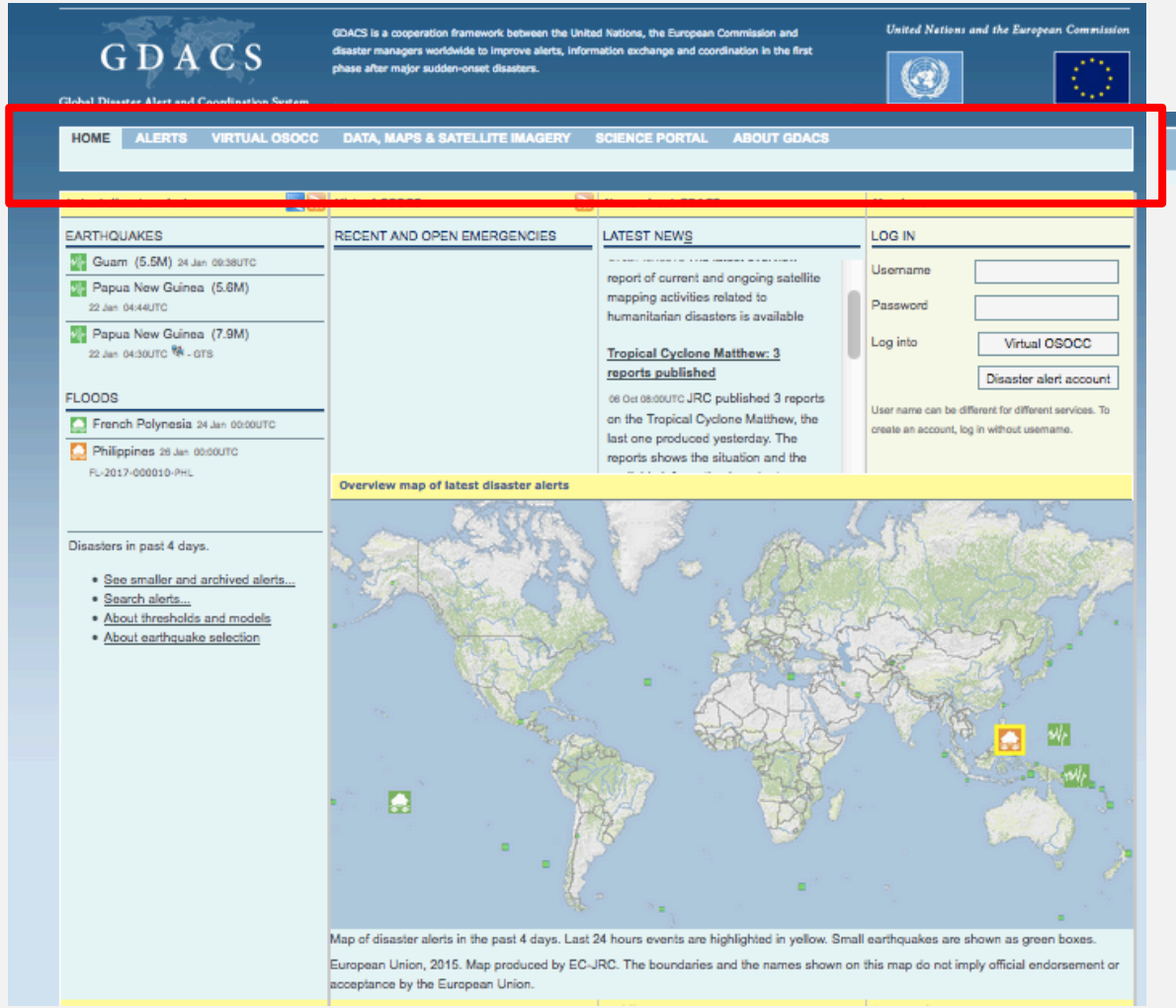
http://www.gdacs.org/

- **Floods**
  - inundation
  - deaths
  - displacement
- **Tropical Cyclones**
  - winds
  - heavy rain
  - storm surge
- **Earthquake and Tsunamis**
  - Intensity and magnitude
  - hypocenter depth
  - population within 100 km from the epicenter
  - vulnerability of the affected countries

Various models and data are used to obtain this information:
http://portal.gdacs.org/Models/

GDACS Tools and Services

http://www.gdacs.org/



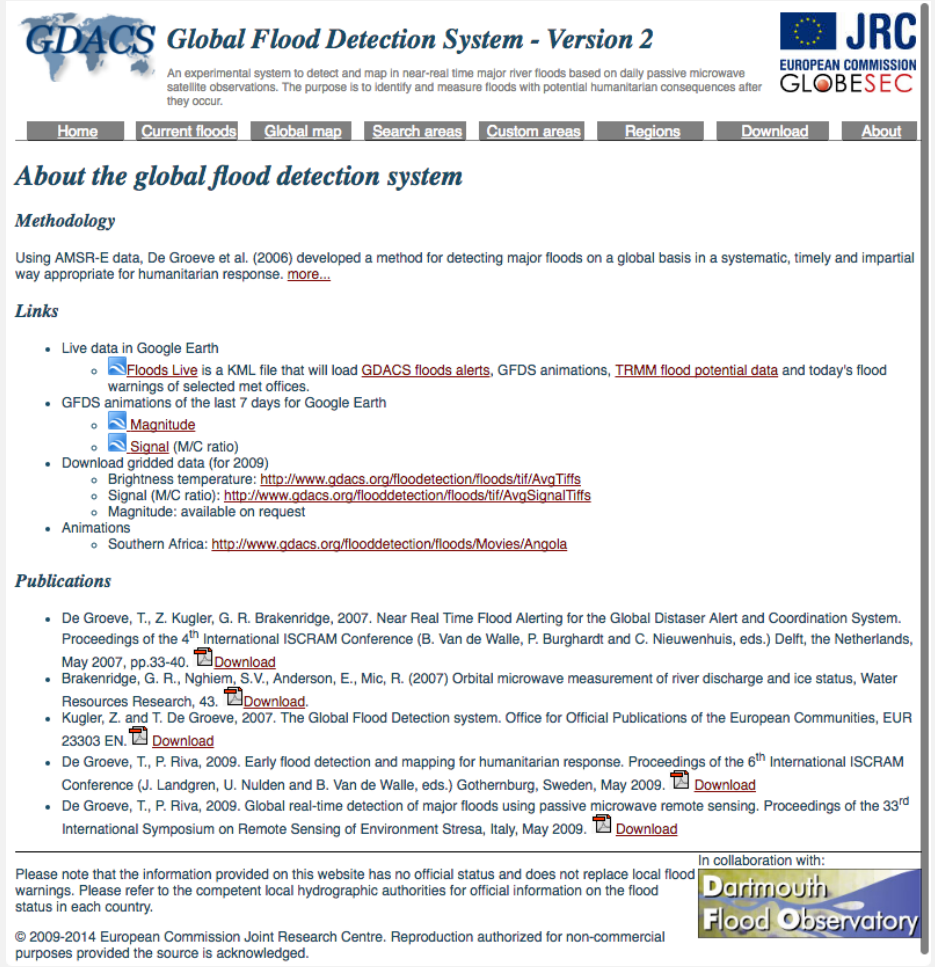
ALERTS VIRTUAL OSOCC DATA, MAPS & SATELLITE IMAGERY SCIENCE PORTAL

- Interactive map with near real-time disasters alerts
- Color coded alerts
  - white: minor events
  - green: moderate events
  - orange: potential local disasters
  - red: potentially severe disasters

GDACS Approach for Disaster Alerts: Floods

http://www.gdacs.org/

- Uses info from Dartmouth Flood Observatory (DFO) http://floodobservatory.colorado.edu/ to provide alerts for individual events
- Uses DFO-GDACS Global Flood Detection System – Version 2 to map inundation from microwave radiometer data based on near-real time satellite:
  - Advanced Microwave Scanning Radiometer (AMSR-E)
  - NASA Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI)
  - NASA Global Precipitation Measurements (GPM) Microwave Imager (GMI)
- River discharge estimates produced from microwave brightness temperatures

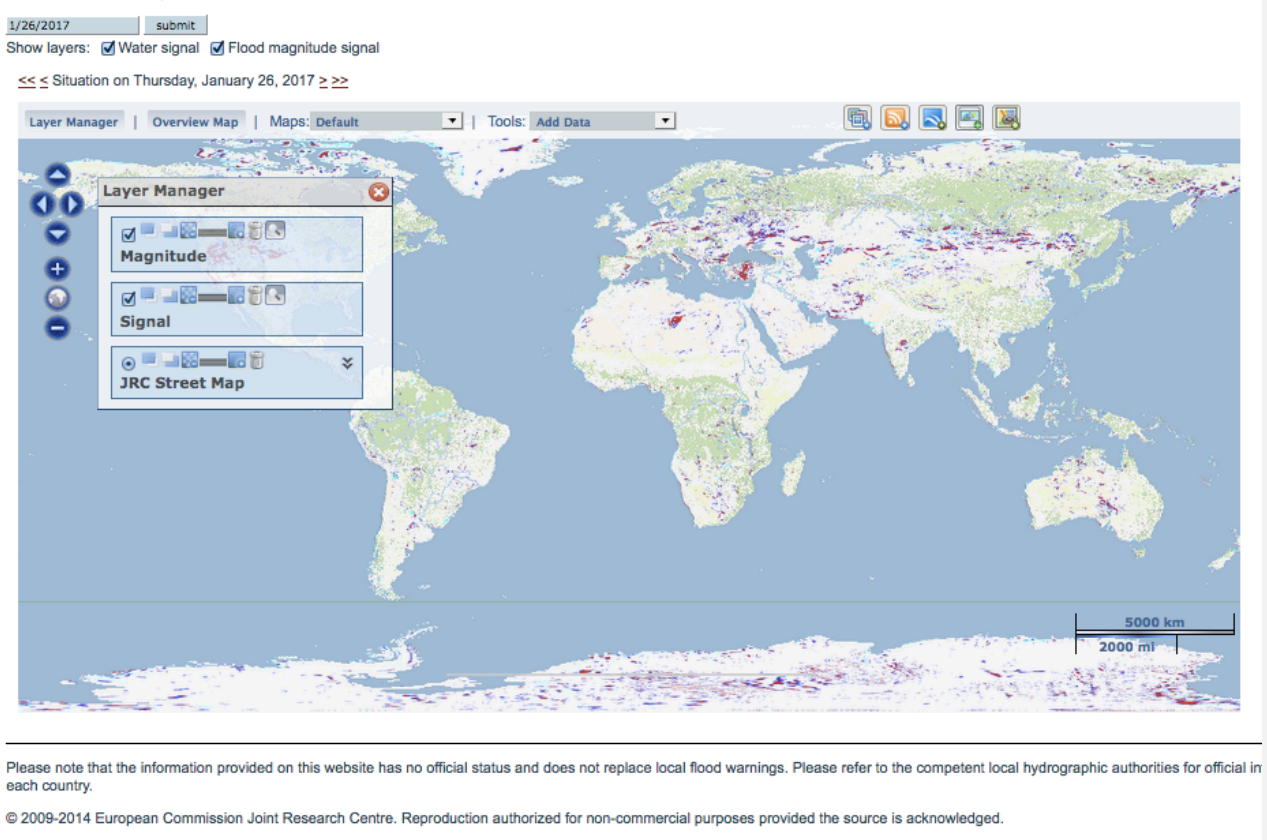


http://www.gdacs.org/flooddetection/about.aspx

GDACS Approach for Disaster Alerts: Floods

http://portal.gdacs.org/Models/

Issues flood alerts and maps based on the satellite-based flood information from GFDS and population data



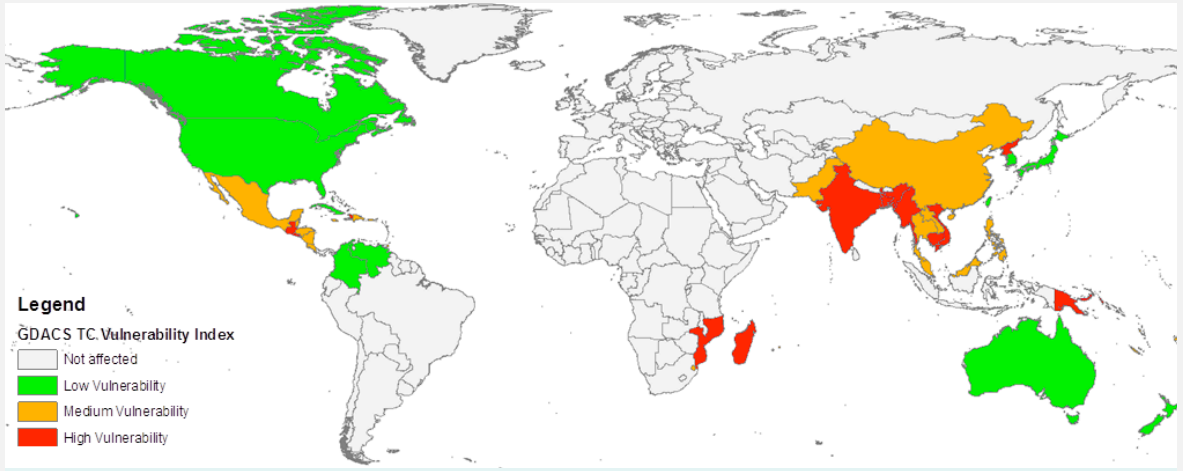
- Red Alert
  - more than 1,000 dead or 800,000 displaced
- Orange Alert
  - more than 100 dead or 80,000 displaced
- Green Alert
  - All other floods

Image Credit: GFDS Version 2 http://www.gdacs.org/flooddetection/global_map.aspx

GDACS Approach for Disasters Alerts: Tropical Cyclones

http://portal.gdacs.org/Models/

- Information used to issue cyclone alerts:
  - Rainfall from NOAA NESDIS
  - Winds from JRC
  - Official advisory from Pacific Disaster Center
  - Impact models based on wind speed and affected population
  - Vulnerability index based on indicators for:
    - human development
    - population
    - population in low elevation areas



Wind speed	Population	Vulnerability	Alert Level
38 – 73 mph (TS)	< 10M	Low – Medium - High	Green
38 – 73 mph (TS)	> 10M	High	Orange
74 – 110 mph (Cat 1-2)	> 100K or > 10%	Medium – High	Orange
74 – 110 mph (Cat 1-2)	> 1M	High	Red
> 111 mph (Cat 3)	> 100K or > 10%	Medium – High	Red
> 111 mph (Cat 3)	> 1M	Low	Orange
> 131 mph (Cat 4)	> 1M	Low	Red

GDACS Approach for Disasters Alerts: Tropical Cyclones

http://portal.gdacs.org/Models/

- Storm Surge
  - Derived from a hydrodynamic shallow water equation model based on surface pressure drop and wind-water friction
  - Affected population by a storm surge is calculated
- Extreme Rainfall
  - Obtained from NOAA NESDIS, multi-satellite passive microwave remote sensing data
  - Accumulated rainfall (72 hrs) and instantaneous rain rates are used to obtain extreme rainfall potential

- Storm Surge
  - Red Alert > 3 m
  - Orange Alert > 1 m < 3 m
  - Green Alert < 1 m
- Total Cyclone Accumulation Alerts
  - Red Alert > 500 mm
  - Orange Alert > 200 mm < 500 mm
  - Green Alert < 200 mm
- Rain Rate Alerts
  - Red Alert > 33 mm/hr
  - Orange Alert > 17 mm/hr < 33 mm/hr
  - Green Alert < 17 mm/hr

GDACS Approach for Disasters Alerts: Earthquakes

http://portal.gdacs.org/Models/

- Magnitude and depth, obtained from
  - seismological sources
- Population within 100 km from the epicenter and national vulnerability, obtained from:
  - GIS-based on epicenter location (latitude and longitude)
  - population database and index for risk management: http://www.inform-index.org/Results/Global

- Earthquake Alert Score is calculated as a product of
  - magnitude
  - population density within 100 km
  - vulnerability index
- Red Alert: magnitude > 6 (Alert Level=2)
- Orange Alert: depth > 70 km (Alert Level=1)
- Green Alert: depth < 300 km (Alert Level=0)

GDACS Approach for Disasters Alerts: Earthquakes

http://portal.gdacs.org/Models/

- Calculated as a product of:
  - magnitude
  - population density within 100 km of epicenter
  - vulnerability index
- Alert Levels:
  - Red Alert: magnitude > 6
    - Alert Level = 2
  - Orange Alert: depth > 70 km
    - Alert Level = 1
  - Green Alert: depth < 300 km
    - Alert Level = 0

- Magnitude:

  Obtained from seismological sources

- Population density and vulnerability index:

  Obtained from a geographic information system (GIS) based on epicenter location, population database and index for risk management: http://www.inform-index.org/Results/Global

GDACS Approach for Disasters Alerts: Tsunamis

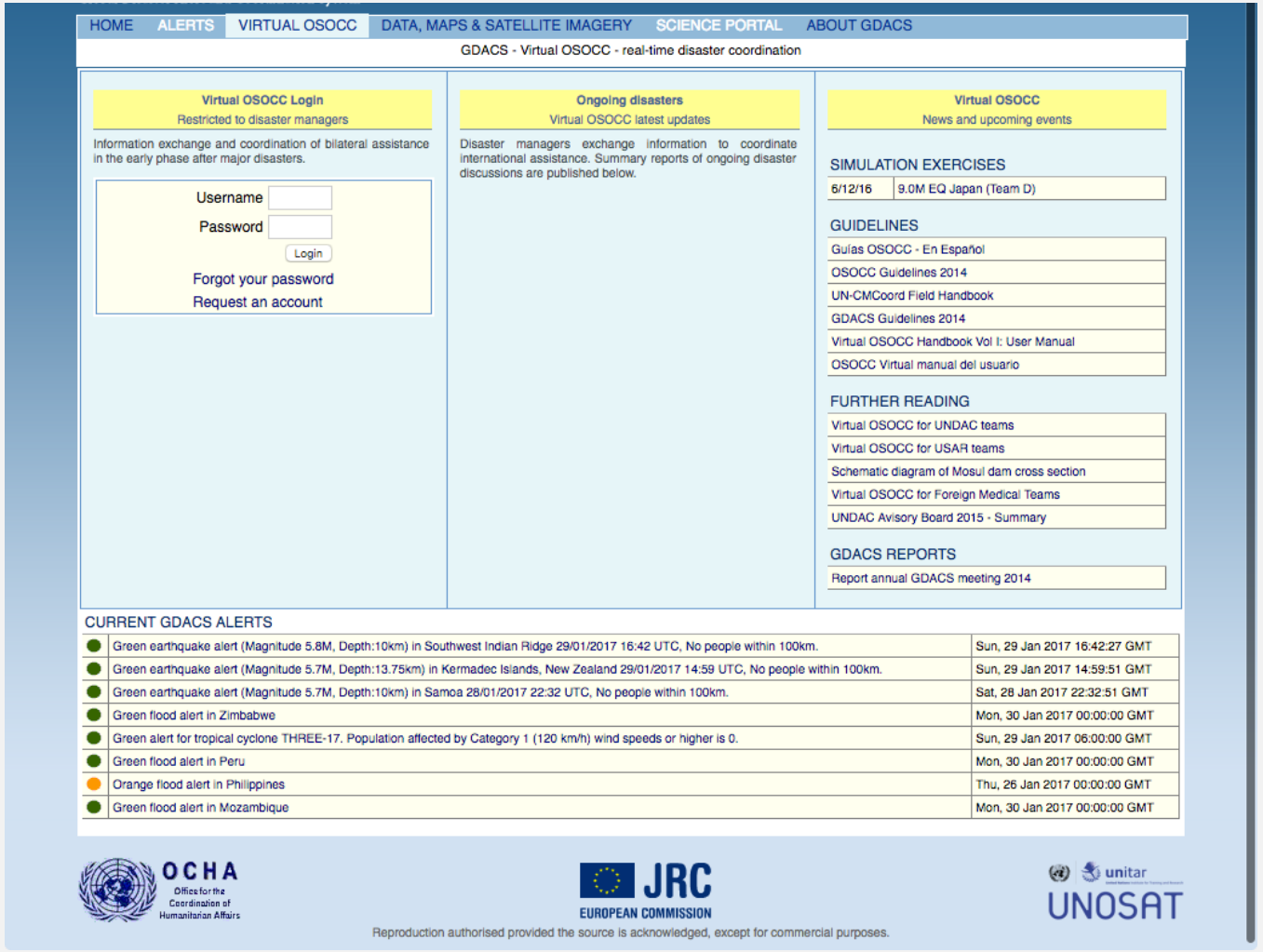
http://portal.gdacs.org/Models/

- Triggered when earthquakes > 6.5 magnitude occur near water
- Tsunami wave heights are calculated using earthquake magnitude and depth from the JRC tsunami database
- Tsunami Alerts
  - Red Alert: maximum wave height ≥ 3 m
  - Orange Alert: maximum wave height ≥ 1 m
  - Green Alert: maximum wave height < 1 m

GDACS Virtual On-Site Operations Coordination Center (OSOCC)

http://vosocc.unocha.org

- Real-time disaster information system portal
- User account required
- Disaster managers exchange information
- Summary reports of on-going disaster reports posted

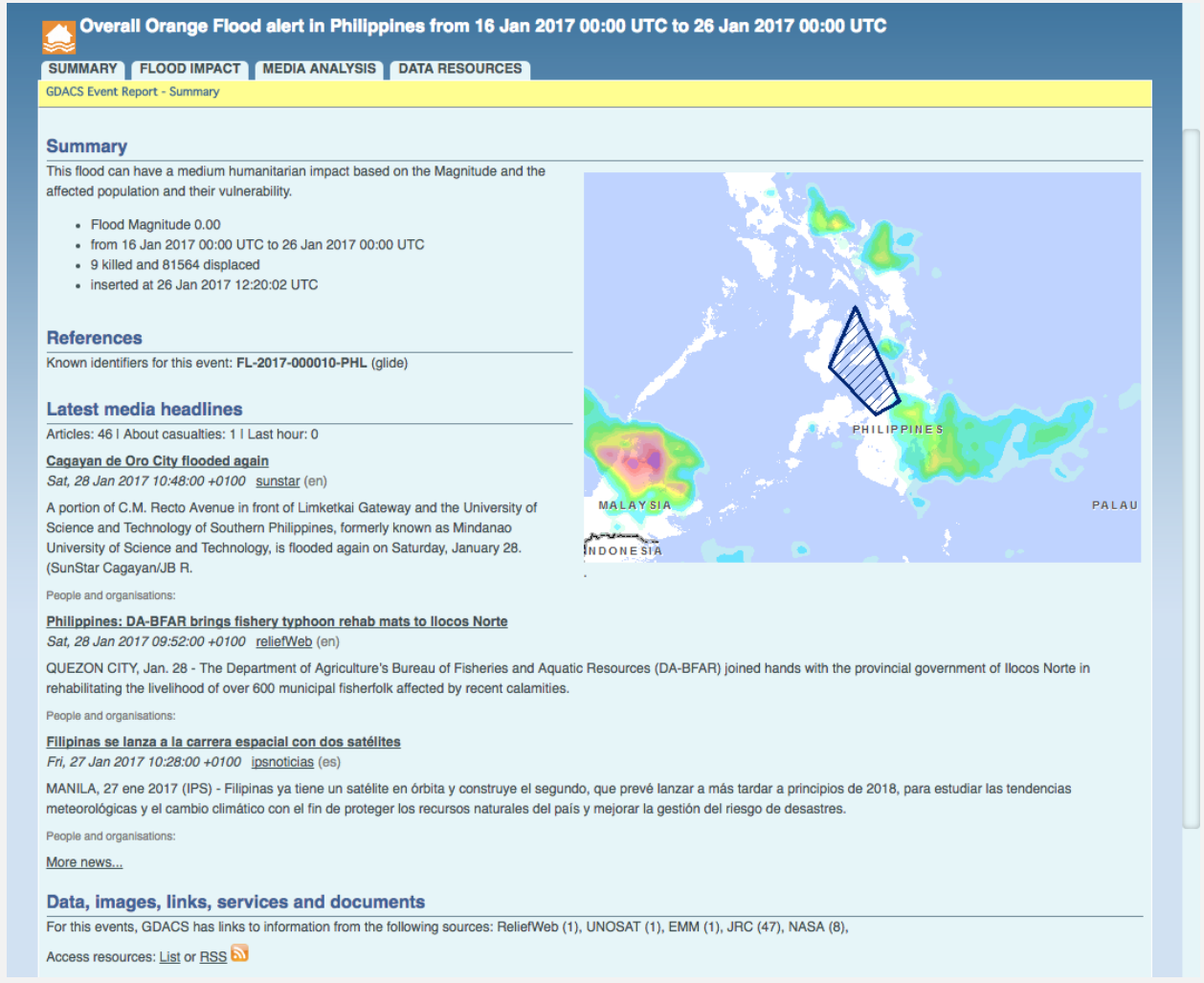


GDACS Virtual OSOCC Disaster Information

http://vosocc.unocha.org

Current Flood in the Philippines

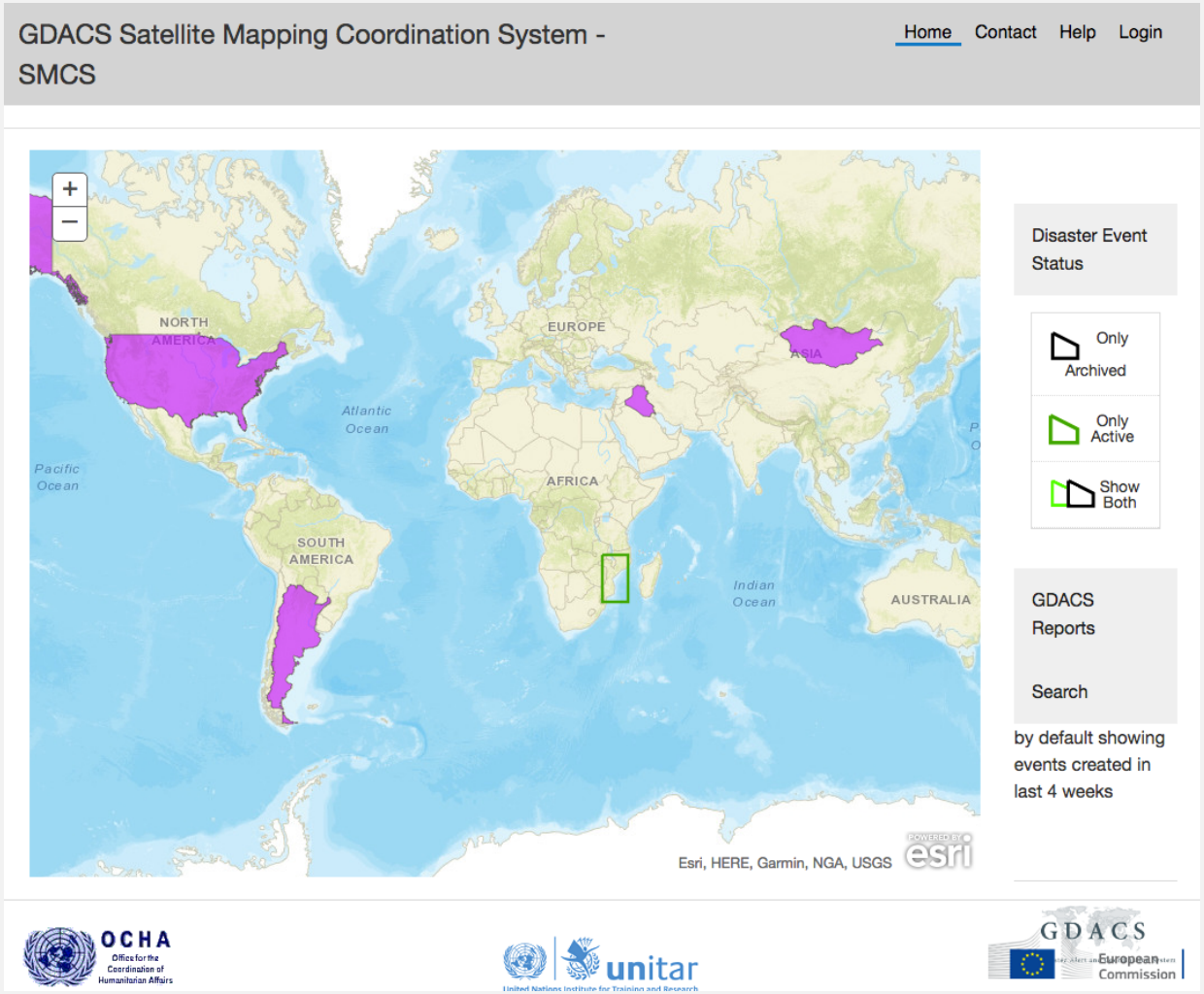
- Summary Report: deaths, displacement
- Latest news
- Data, images, documents



GDACS Satellite Mapping Coordinate System (SMCS)

http://gdacs-smcs.unosat.org/

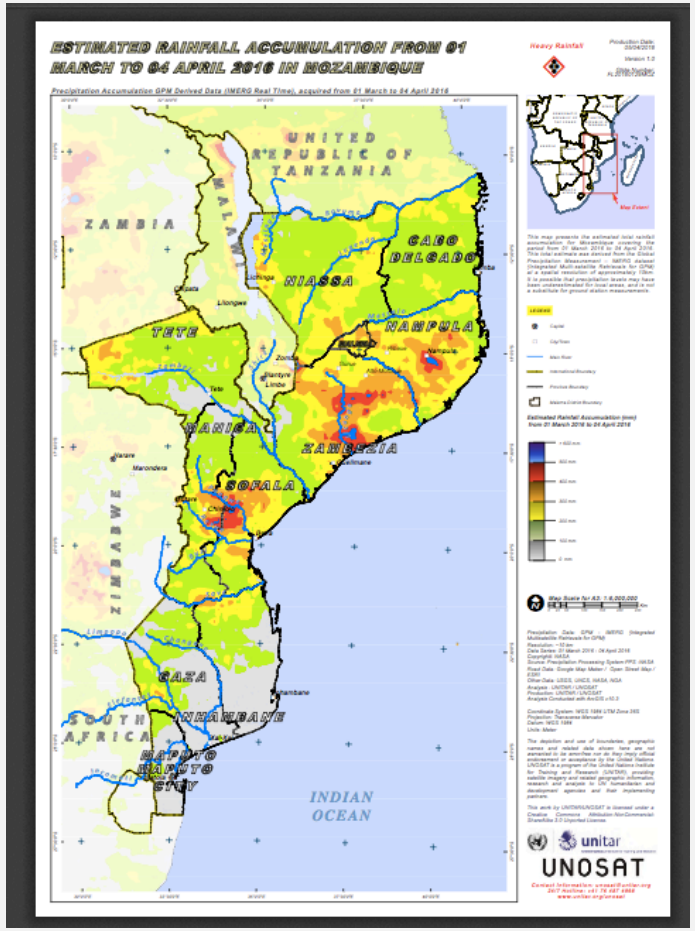
- Led by UNITAR-UNOSAT
- Includes NASA and ESA satellite data
- A GIS-based tool of satellite imagery for specific disaster events
  - requires user registration
- Provides past and real-time imagery for an event
- Also offers:
  - baseline maps
  - situation specific maps
  - damage assessment maps
  - weather forecast maps



NASA Remote Sensing Data Used by GDACS-SMCS

http://gdacs-smcs.unosat.org/

- Global Precipitation Measurement (GPM)
  - Rainfall Data from Integrated Multi-satellitE Retrievals for GPM (IMERG)
  - GPM Microwave Imager (GMI) used by GFDS to assess flooding
- For more details about the satellites see Fundamentals of Remote Sensing, Session 2B
  - http://arset.gsfc.nasa.gov/webinars/fundamentals-remote-sensing#water

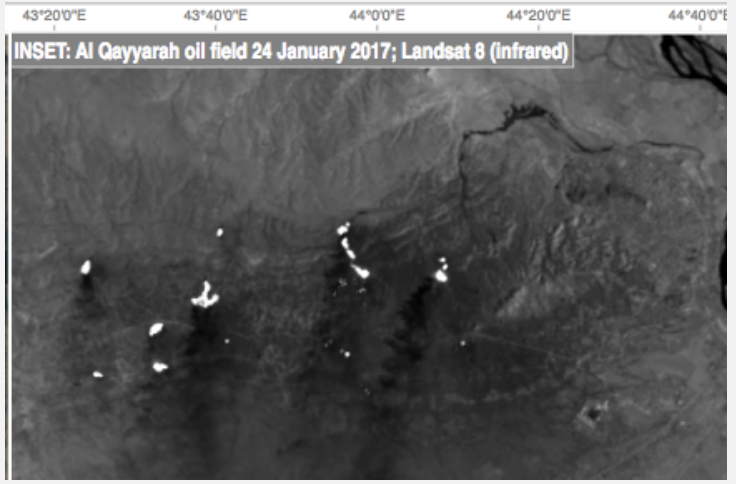


Rainfall Accumulation over Mozambique from 1 March to April 4, 2016, from GPM IMERG

NASA Remote Sensing Data Used by GDACS-SMCS

http://gdacs-smcs.unosat.org/

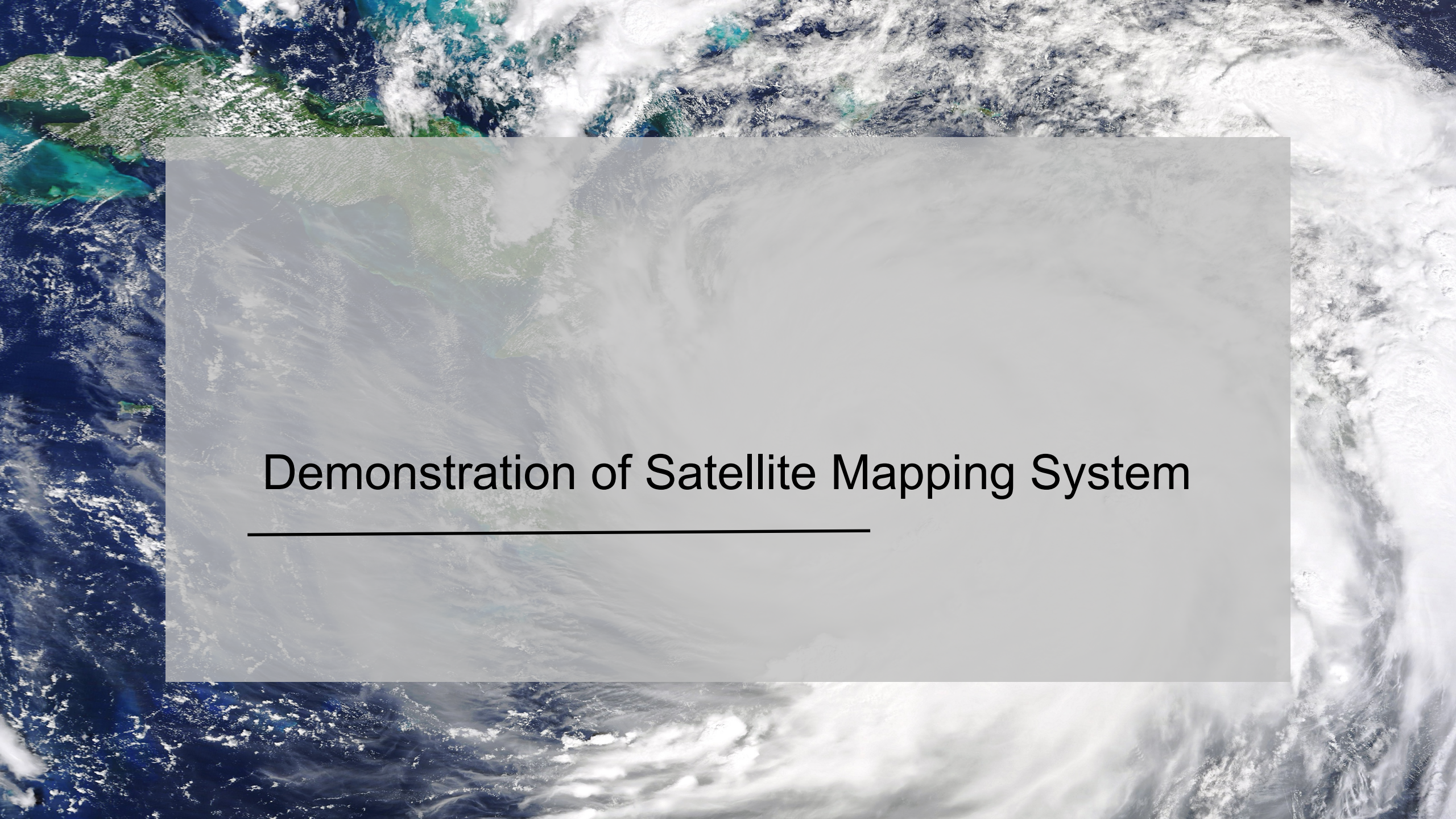
- Terra and Aqua: Moderate Resolution Imaging Spectroradiometer (MODIS); Landsat: Operational Land Imager (OLI)
  - Land and Snow Cover Data
  - Volcanoes
  - Wildfires
- For more details, see: http://arset.gsfc.nasa.gov/webinars/fundamentals-remote-sensing#water



Top: Terra-MODIS showing a puff of ash from the Colima Volcano in Mexico on January 4, 2017

Bottom: Landsat image collected on January 24, 2017, indicating the Mosul fires in white

Overview of UNITAR-UNOSAT



Demonstration of Satellite Mapping System

United Nations Institute for Training and Research

UNOSAT

Overview of UNITAR-UNOSAT and GDACS Satellite Mapping Coordination System

Trainer
Luca Dell'Oro

21 Feb 2017

Applied Remote Sensing Training Program

In Partnership with the National Aeronautics and Space Administration

NASA

Outline

- **Overview of UNITAR's Operations Satellite Applications Programme (UNOSAT)**
- **UNOSAT Humanitarian Rapid Mapping Framework**
- **Operational Case Studies**
  - Natural Hazards
  - Complex Emergencies
- **UNOSAT Platforms and Tools for Data Sharing And Satellite Mapping Coordination**
  - GDACS Satellite Mapping Coordination System - SMCS
- **Questions and Answers**

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Learning Objectives

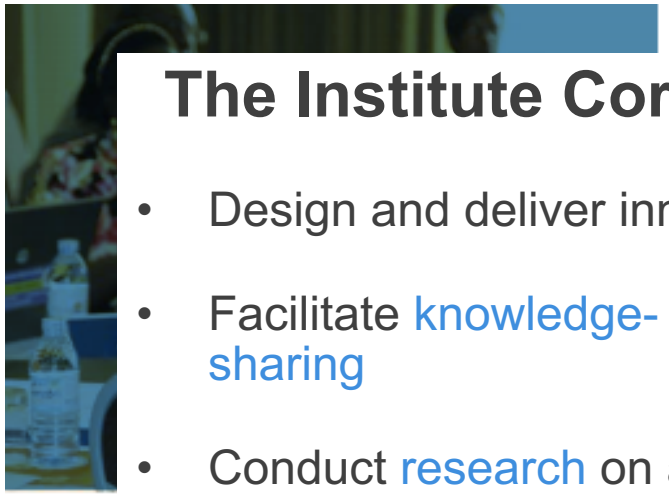
The aim of the lecture is to provide participants with an overview of the UNOSAT operational humanitarian rapid mapping service to support planning and coordination of UN agencies and UN Member States during humanitarian crises.

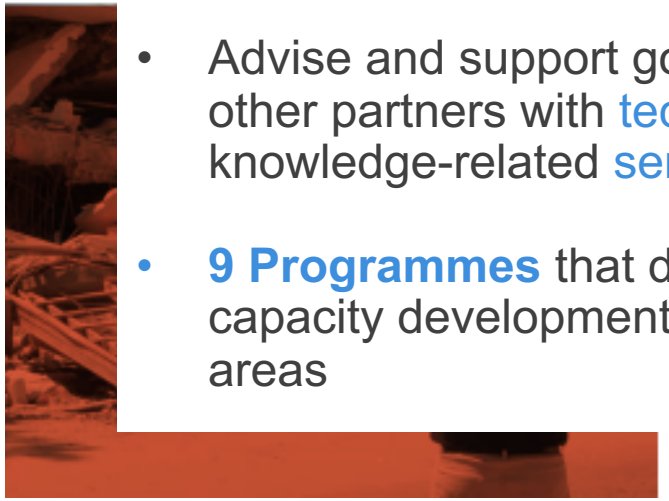
At the end of the lecture participants should be able to:

- Describe UNOSAT's operational activities including satellite derived analysis in support of international humanitarian operations.

- Describe how the GDACS-Satellite Mapping Coordination System (SMCS) supports data sharing and satellite mapping coordination during major disasters.

About the United Nations Institute for Training and Research (UNITAR)





The Institute Core Functions

- Design and deliver innovative training
- Facilitate knowledge- and experience-sharing
- Conduct research on and pilot innovative learning strategies
- Advise and support governments, UN and other partners with technology-based knowledge-related services
- **9 Programmes** that deliver training and capacity development in specific focus areas

Thematic Areas

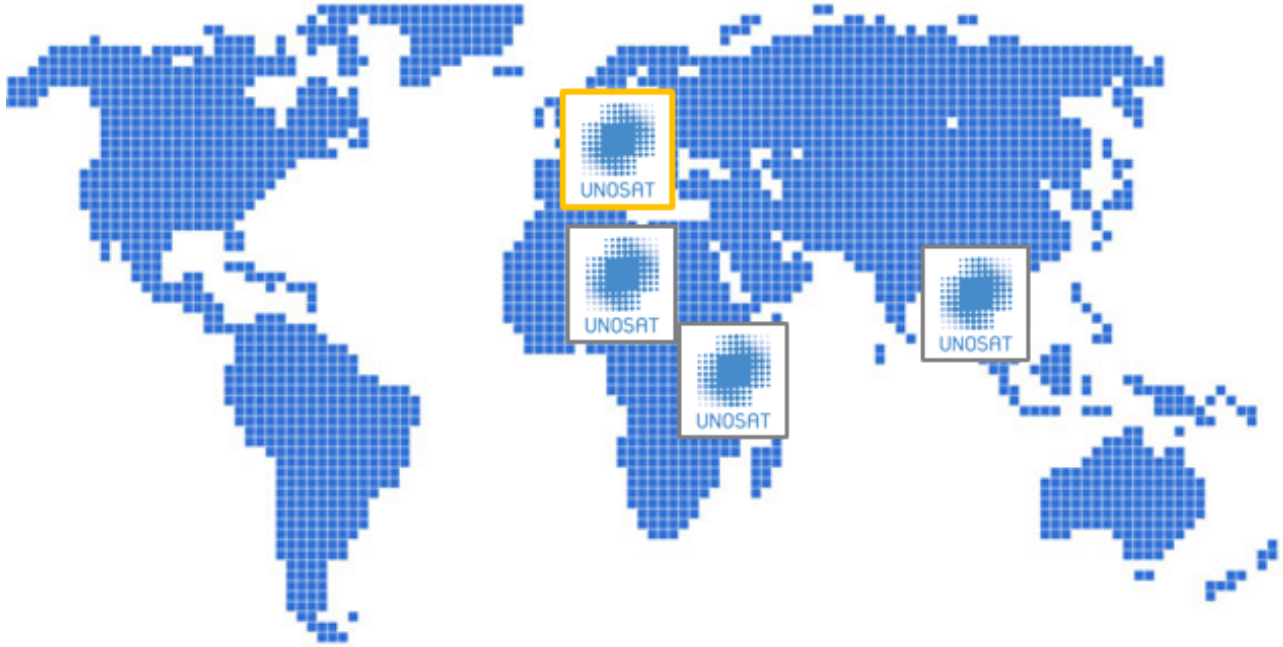
- Capacity for the 2030 Agenda
- Strengthening multilateralism
- Advancing environmental sustainability and green development
- Improving resilience and humanitarian assistance
- Promoting sustainable peace
- Promoting economic development and social inclusion

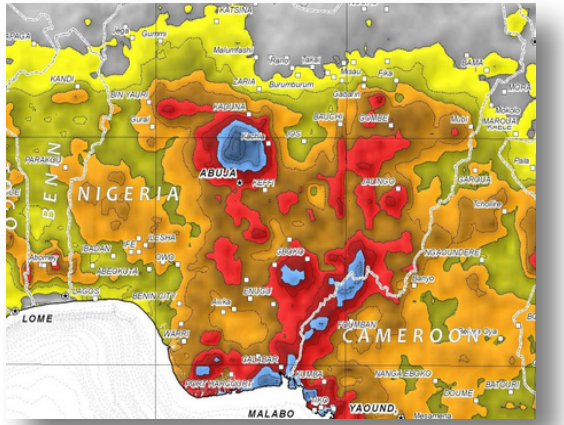
www.unitar.org

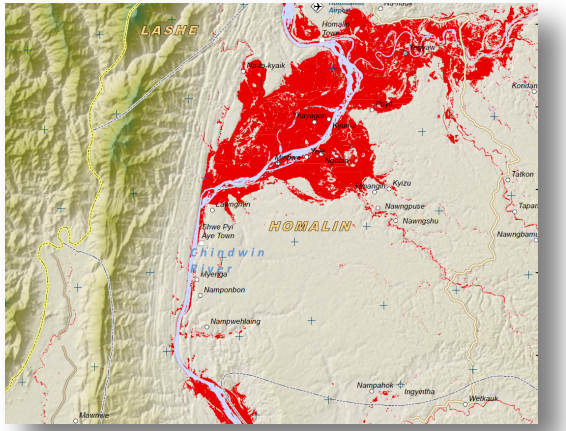
unitar

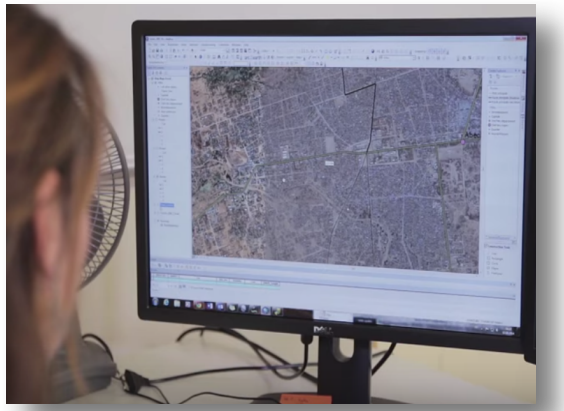
UNOSAT: UNITAR Satellite Applications Programme

- An operational programme of UNITAR serving the UN, international organizations and governments
- Fully dedicated to satellite imagery analysis, applications of geospatial information technologies, training and capacity development
- Operational since 2001
- Currently 30 employees





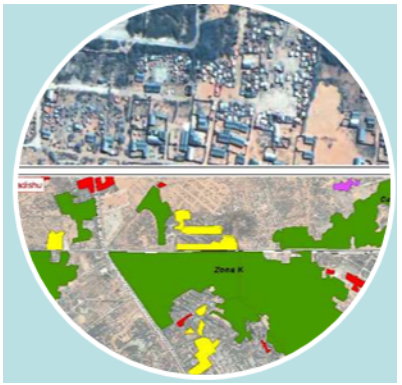




www.unitar.org/unosat

unitar

UNOSAT Activities



ANALYSIS & MAPPING

Satellite Analysis, Climate Service, Applied Research and Innovation

TRAINING AND CAPACITY DEVELOPMENT

Hands on, National and Regional level, Technical Backstopping

Geospatial Support services & Knowledge Transfer

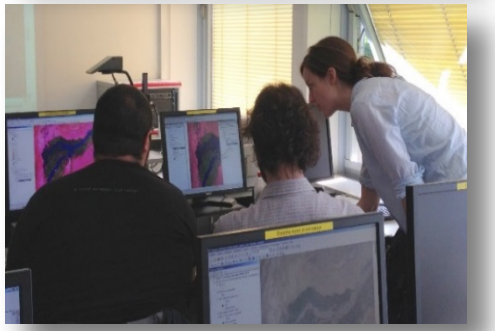
Training and Capacity Development

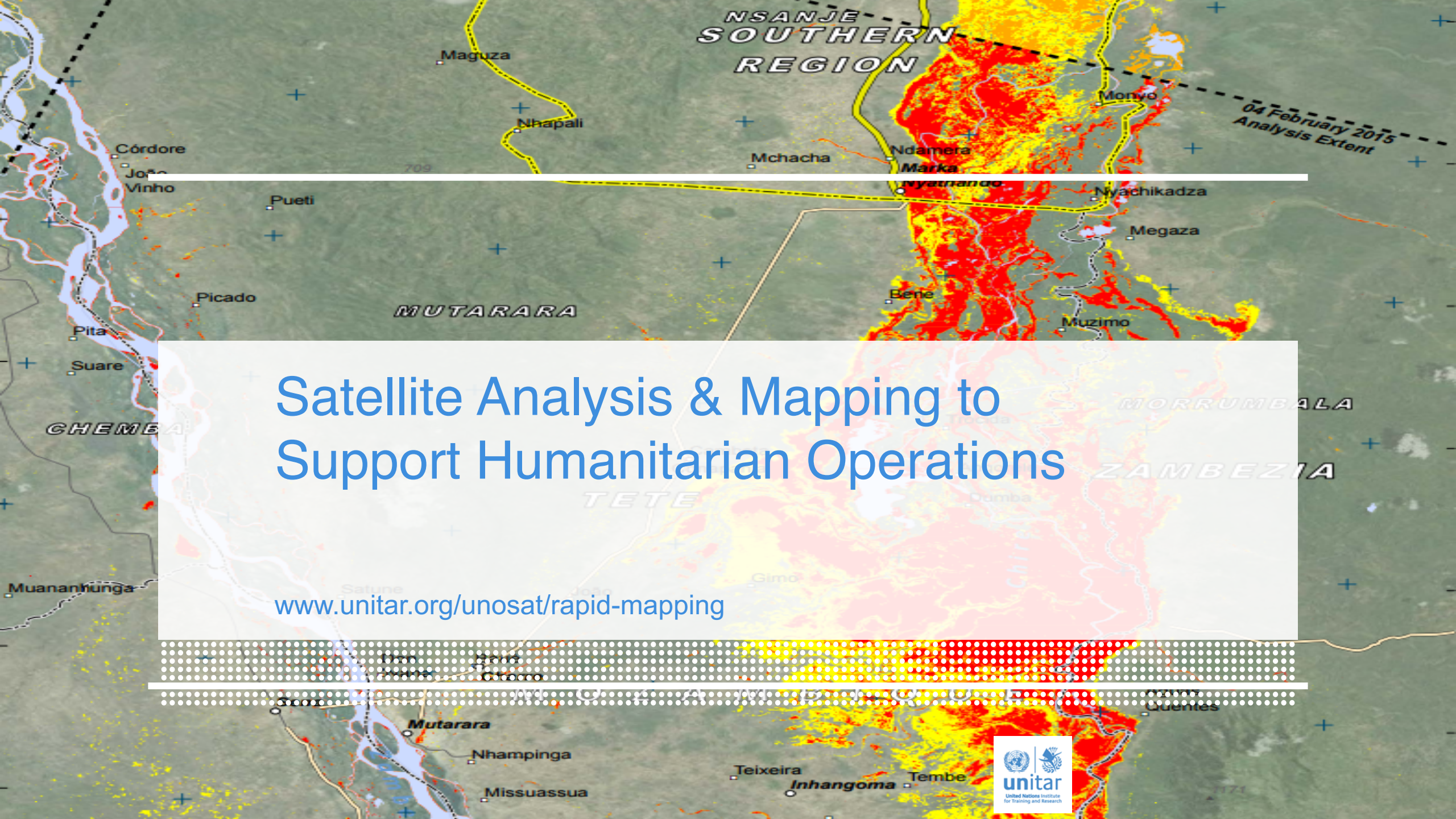
unitar
United Nations Institute for Training and Research

Training & Capacity Development Activities

- Master level courses
- Basic and advanced courses
- Capacity development programmes
- Workshops and information sharing

- We design and deliver (basic and advanced) training on the use and applications of Geospatial Information Technology (GIT) for disaster risk reduction.
- Courses are delivered face-to-face either in situ or at the headquarters in Geneva, Switzerland, and can be customized to needs.
- **Target Audience:** Professionals from:
  - National governments
  - Regional and international organizations
  - UN agencies
  - Academia
  - The private sector





Satellite Analysis & Mapping to Support Humanitarian Operations

www.unitar.org/unosat/rapid-mapping

UNOSAT's Humanitarian Rapid Mapping Service

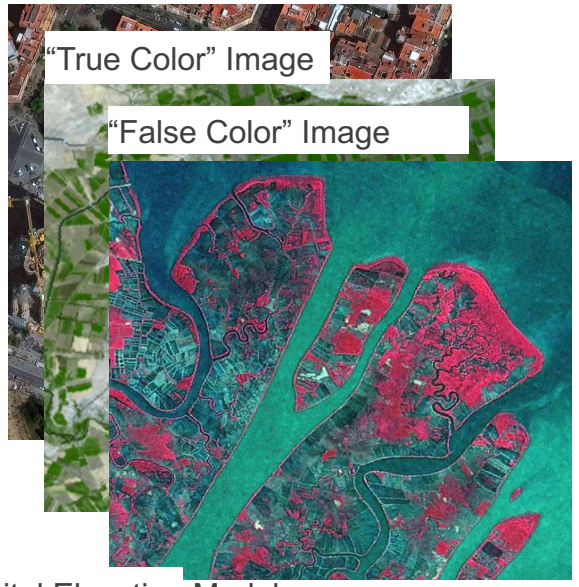
- UNOSAT provides **Satellite Imagery Analysis** during **Humanitarian Emergencies** – **Natural Disasters and Conflict-Situations** (Maps, GIS-ready data, statistics and reports).
- Several hundred-thousands sqkm of satellite images from commercial and scientific sensors are acquired and processed by UNOSAT (per year): from very high resolution (50 cm), to low resolution (1km)

OPTICAL:

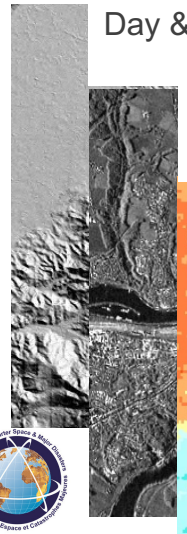
DG (Worlview-1/2/3, GeoEye) ; Pléiades ; MODIS, Landsat-8 ; Sentinel-1/2, Landsat 8, Deimos, KOMPSAT-2/3

RADAR :

- Sentinel-1 / Radarsat-2 / TerraSAR-X / CosmoSkyMed/ RISAT, ALOS-PALSAR

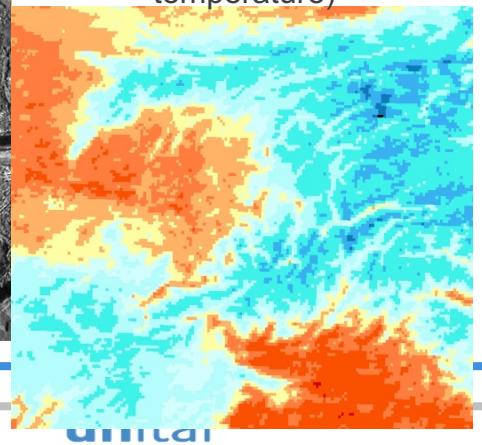


Digital Elevation Models



Day & night – Cloud free radar image

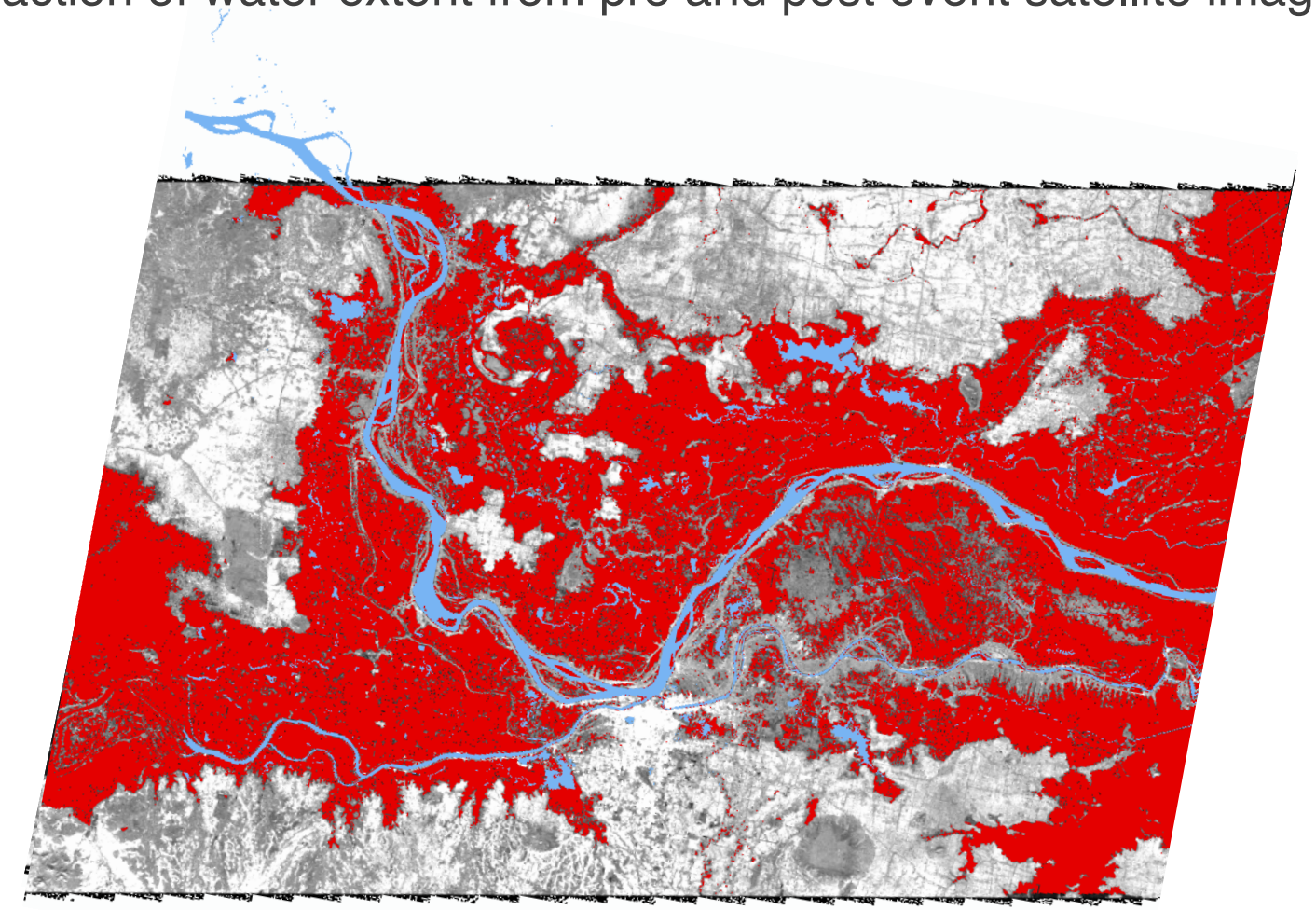
Gridded data (e.g., Precipitation, soil/water temperature)



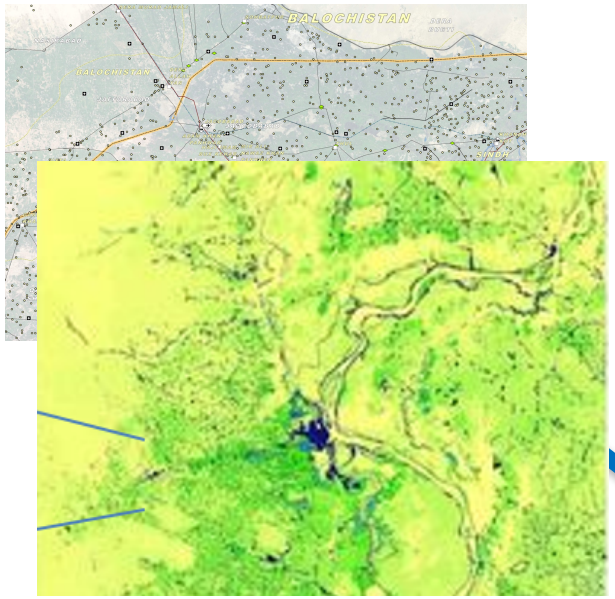
Benefits of Satellite Imagery in Emergency Response

- Scale flexibility
  Many different optical and radar sensors orbiting the earth capable to provide evidence based information at global, regional and local scale.
- Daily to weekly imagery acquisition
  Capability to monitoring sudden/slow onset disasters as well as protracted crisis worldwide.
- Multiplicity of spectral bands
  Fine discrimination of physical and spectral characteristics of objects and features on the ground (to assess impacts and damages: buildings, infrastructures, roads, agricultural areas etc.).
- Absence of political or physical limits
  Imagery acquisition covering covering thousands of sqkm. Ideal to get information regarding remote, inaccessible or/and politically sensitive areas..
- Information-objectivity / evidence based
  Since satellites record what actually exist on the ground nobody can argue that information has been omitted or changed (common ground for stating facts and framework for negotiations)

Extraction of water extent from pre and post event satellite image



Preliminary Exposure/Impact Analysis

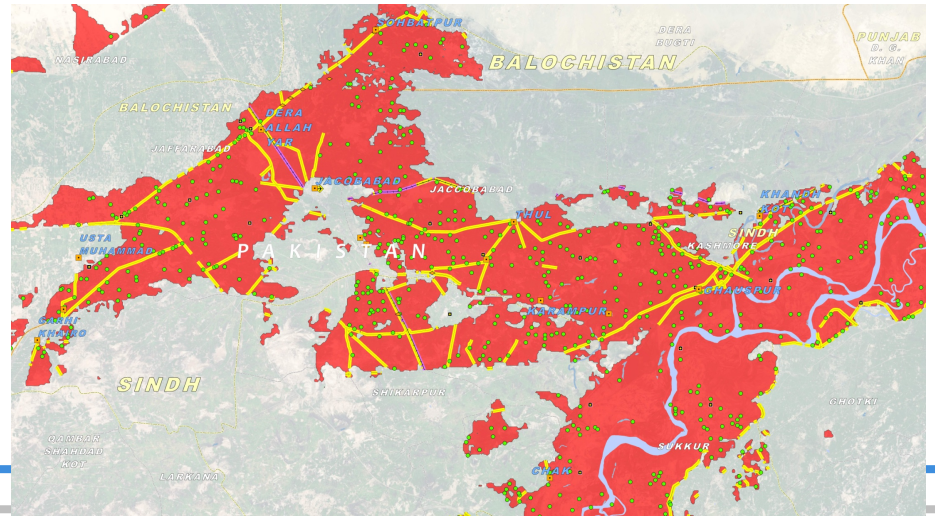


Vector Baseline Data

Population distribution

+

UNOSAT Flood Water Analysis



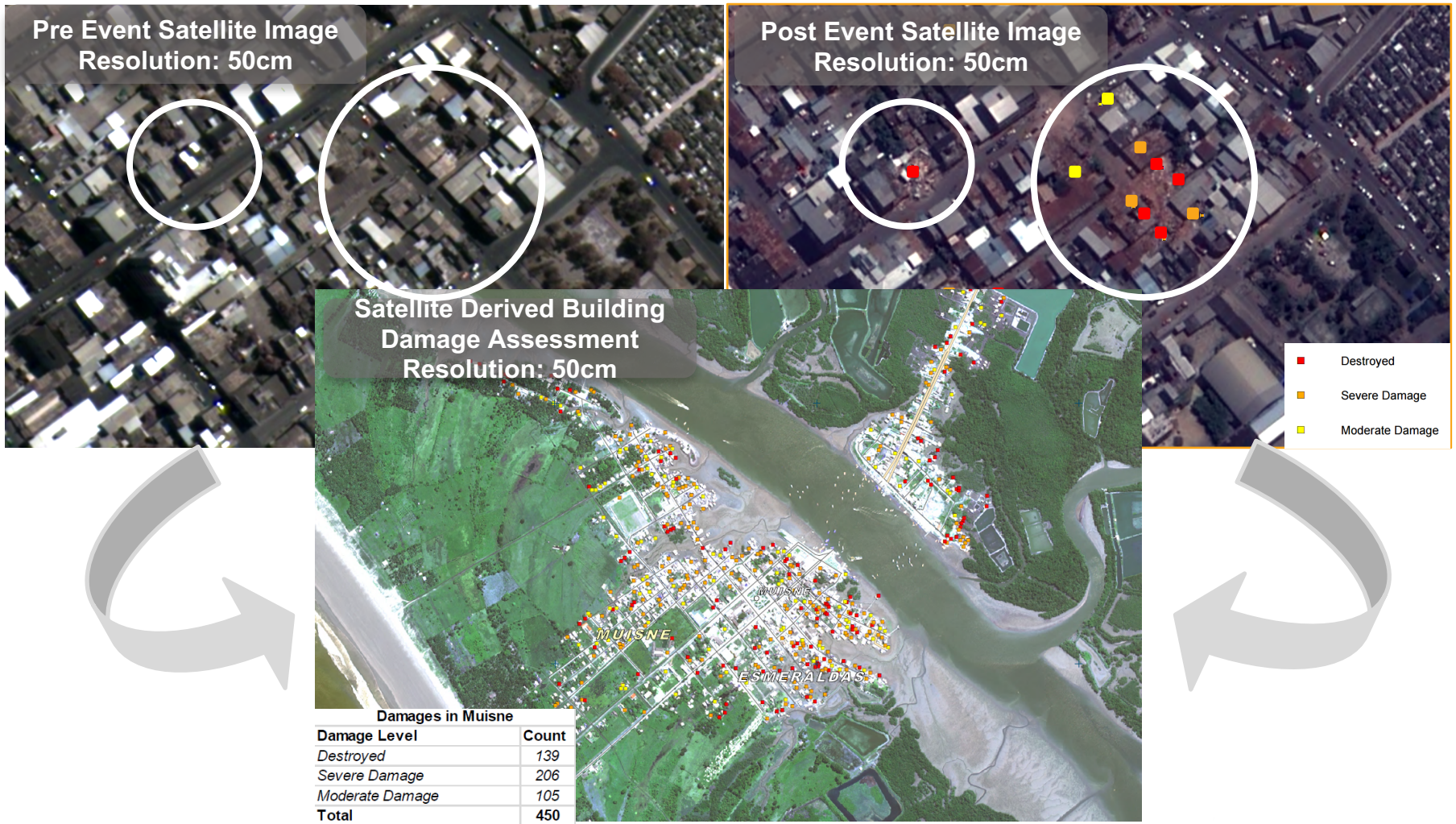
Combination of data allows for detailed and comprehensive preliminary exposure analysis

Summary of Flood-Affected Populated Places and Infrastructure

Province	BALOCHISTAN	KHYBER PAKHTUNKHWA	PUNJAB	SINDH	Others	Total
Village Count	174	808	4,037	2,463	10	**7,492**
Towns / Cities	6	39	54	36	0	**135**
Health facilities	12	20	70	88	0	**190**
Bridges	11	183	139	95	1	**429**
Roads (km)	313	772	1,613	2,331	21	**5,051**
Railways (km)	10	27	169	199	0	**406**

Satellite Analysis for exposure/impact and damage analysis

Visual Interpretation of level of building damage from Pre and Post VHR Image



Damages in Muisne

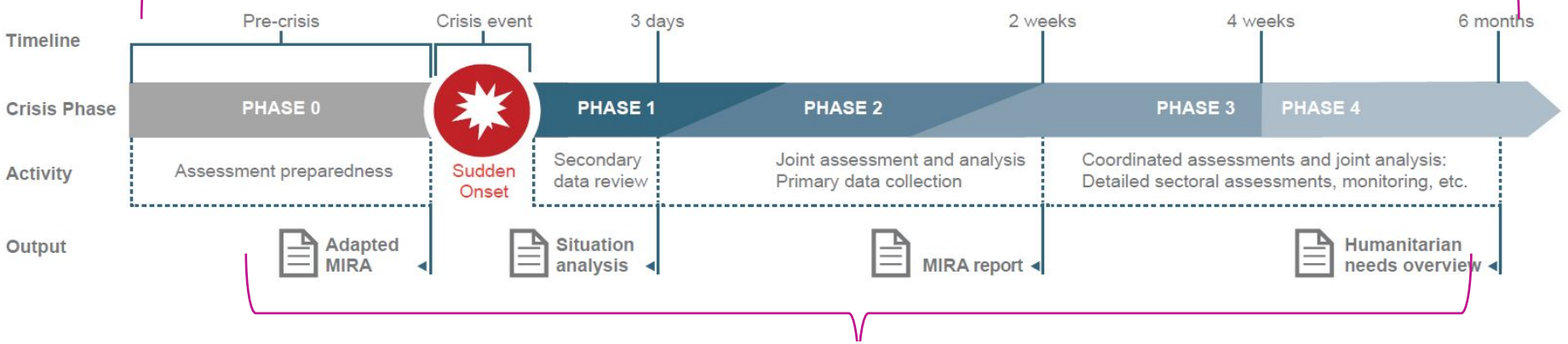
Damage Level	Count
Destroyed	*139*
Severe Damage	*206*
Moderate Damage	*105*
Total	**450**

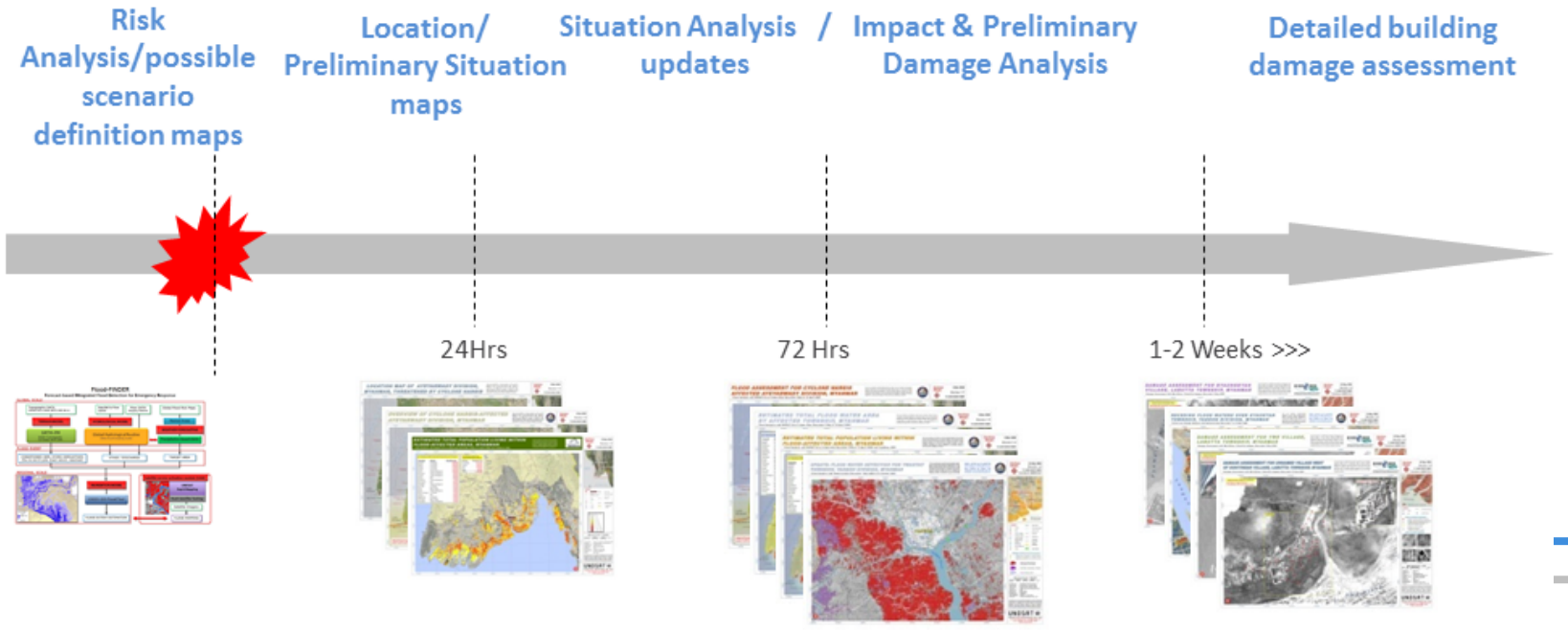
International Humanitarian Response

"A complex emergency or **major disaster** is a multifaceted humanitarian crisis in a country, region or society where there is total or **considerable breakdown of authority and response capacity** which requires a multi-sectoral, international response that **goes beyond the mandate or capacity of any single agency and/or ongoing UN country programme**"

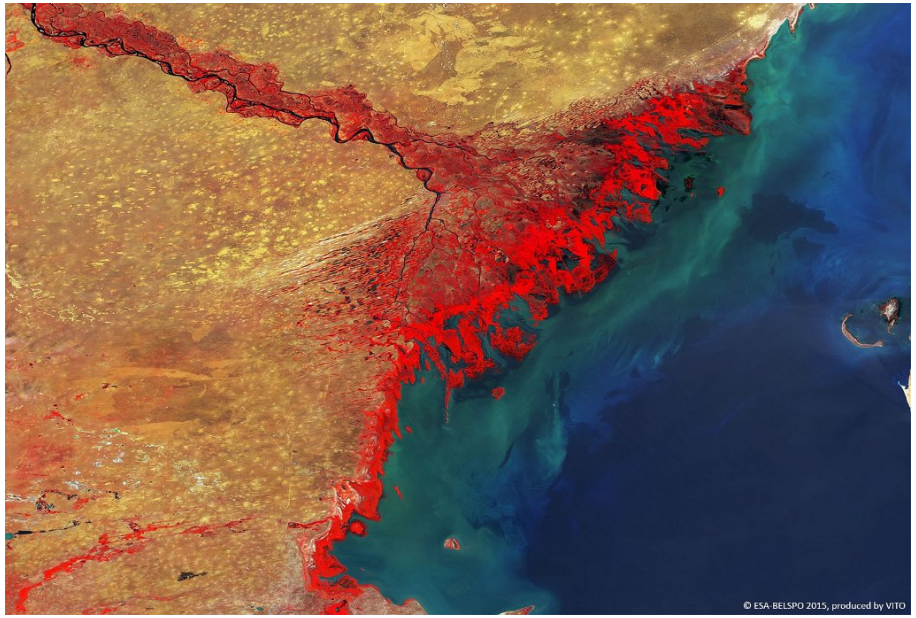
Inter-Agency Standing Committee, Dec 1994.

UNOSAT'S Rapid Mapping Operational Framework





UNOSAT Rapid Mapping: Satellite Derived Products



Natural Disasters:

- ✓ Floods
- ✓ Drought
- ✓ Cyclones
- ✓ Landslides
- ✓ Earthquakes
- ✓ Volcanic eruptions

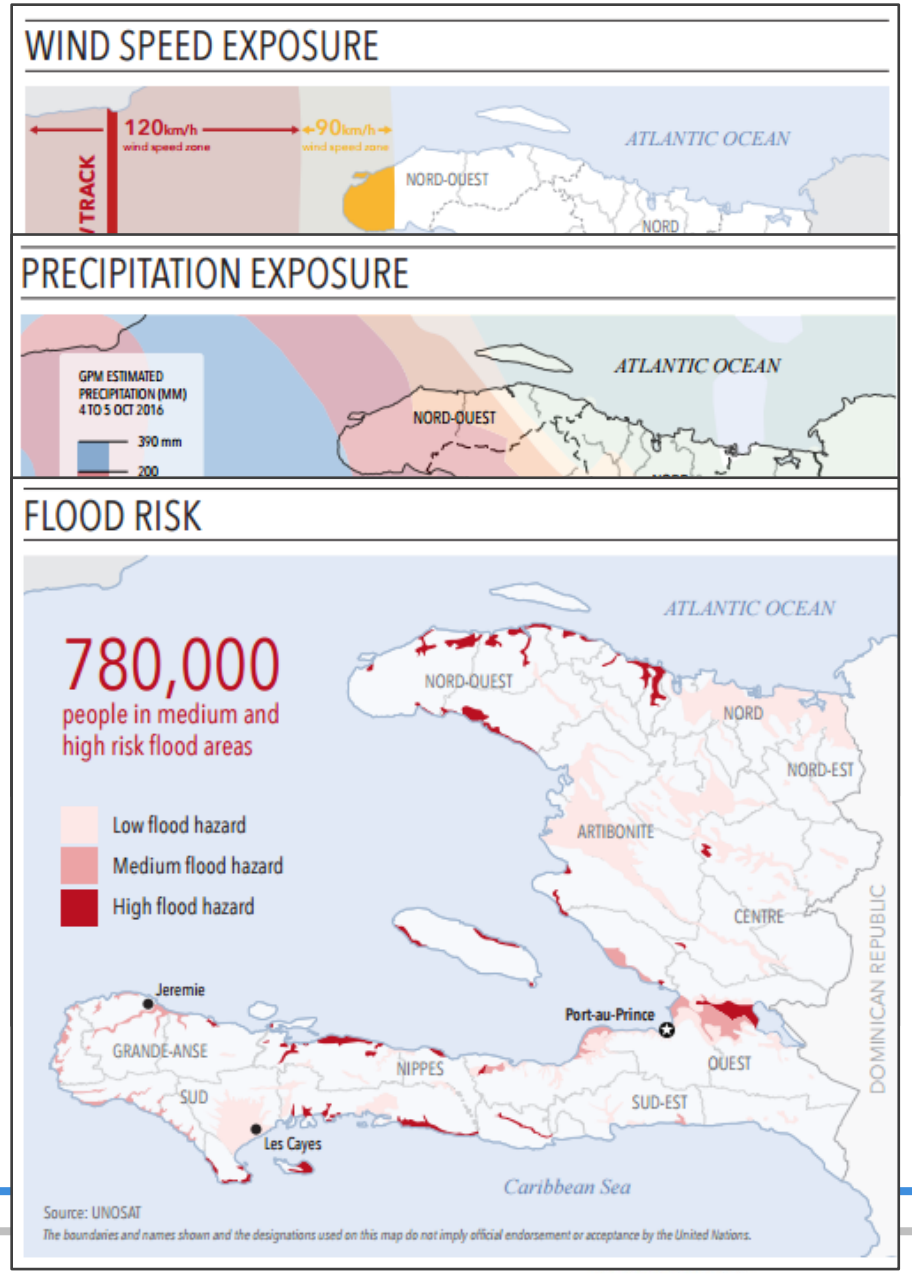
Conflicts:

- ✓ Refugee and IDPs mapping
- ✓ Conflict damage assessment
- ✓ World Heritage Sites
- ✓ And so on..

Source: NASA Earth Observatory

Haiti - Hurricane Matthew 2016: Geospatial approach to estimate Population exposure / impact and damage to infrastructures **(Natural Disaster)**

Hurricane Matthew, a Category 4 storm with sustained winds of 235 km/h, violently struck south-western Haiti on 4 October causing widespread damage, flooding and displacement.

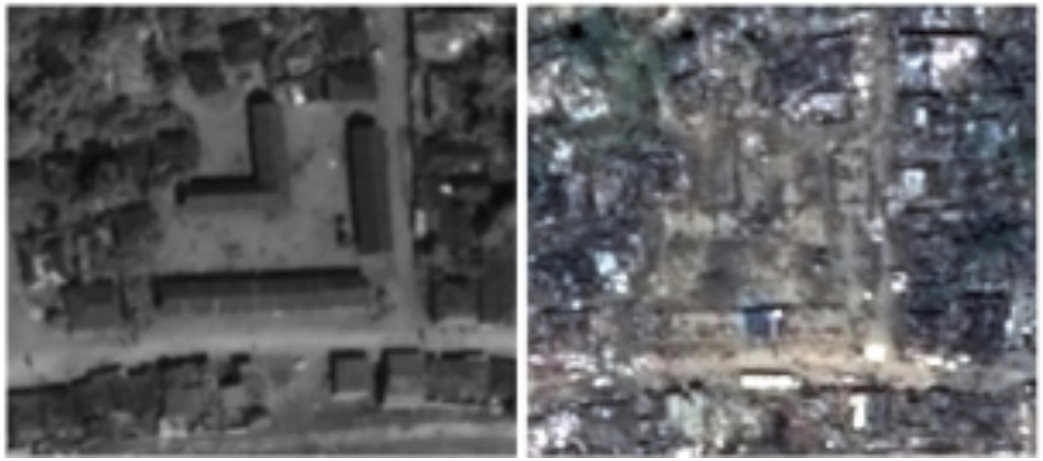


Haiti - Hurricane Matthew 2016: Geospatial approach to estimate Population exposure / impact and damage to infrastructures **(Natural Disaster)**

Building damage analysis, including a rapid assessment of transportation network conditions and locations of spontaneous people gathering sites.

http://www.unitar.org/unosat/maps/HTI

Buildings and/or structures damaged in Marfranc section Cmmunale



UNOSAT Satellite Analysis Support – SYRIA CONFLICT

Since the conflict in Syria started in March 2011, Humanitarian Community requires information to plan efficient delivery of humanitarian assistance to affected population and people in needs.

Due to accessibility constrains in conflict areas **UNITAR-UNOSAT has been requested by different humanitarian actors to monitoring conflict situation using satellite imagery and provide evidence based analysis**

ESTABLISH A DYNAMIC HUMANITARIAN MONITORING SYSTEM

DAMAGE ASSESSMENT IN URBAN CENTERS

REFUGEE, IDP & MIGRANT MAPPING

Military presence in the outskirts of Jisr Al Shugar, Idlib Governorate

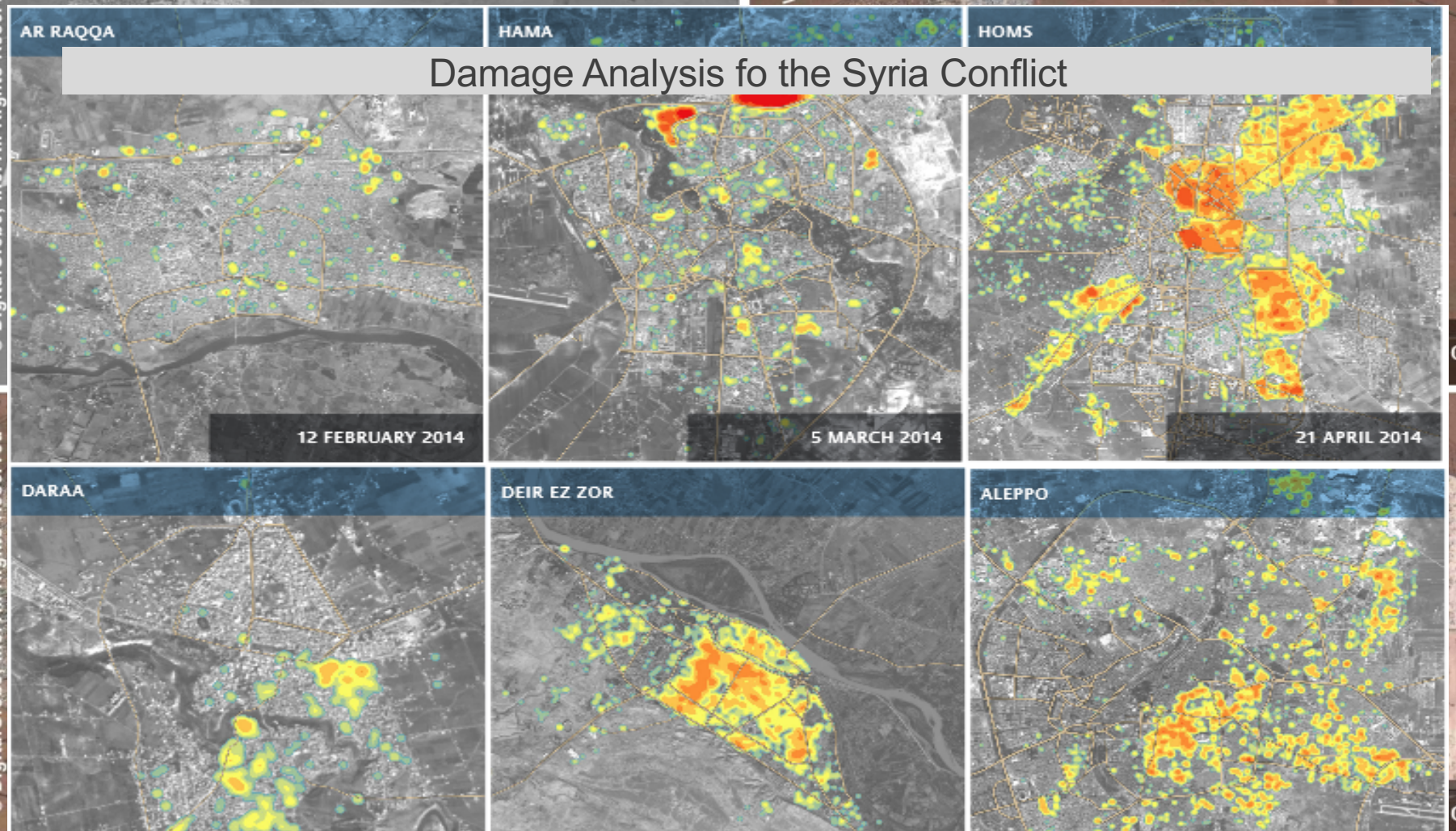
Monitoring Critical Facilities: Damage assessment to Markets

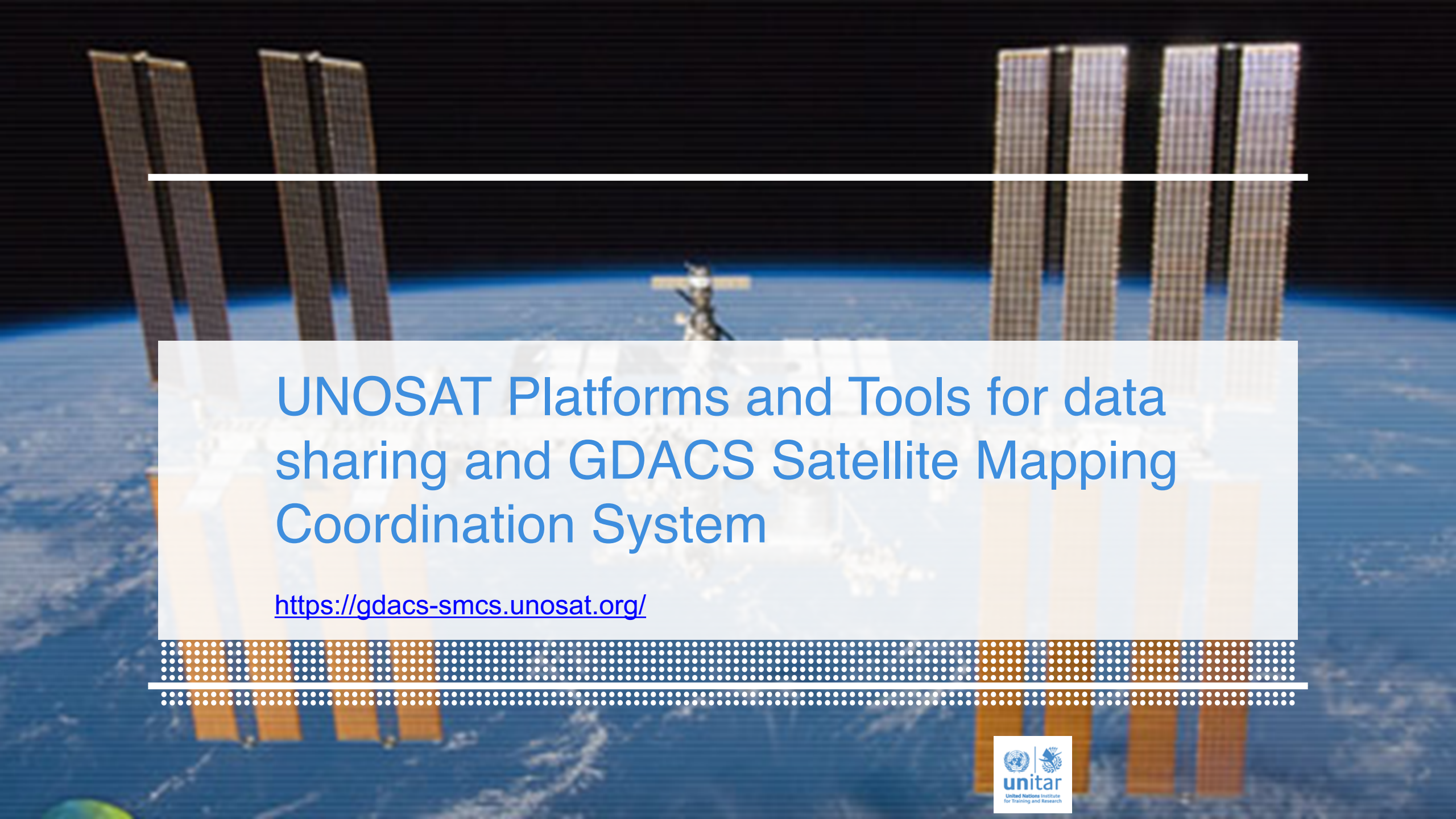
Oil Pipelines

Population Displacement

Monitoring of Refugee Camps

Damage Analysis fo the Syria Conflict





UNOSAT Platforms and Tools for data sharing and GDACS Satellite Mapping Coordination System

https://gdacs-smcs.unosat.org/

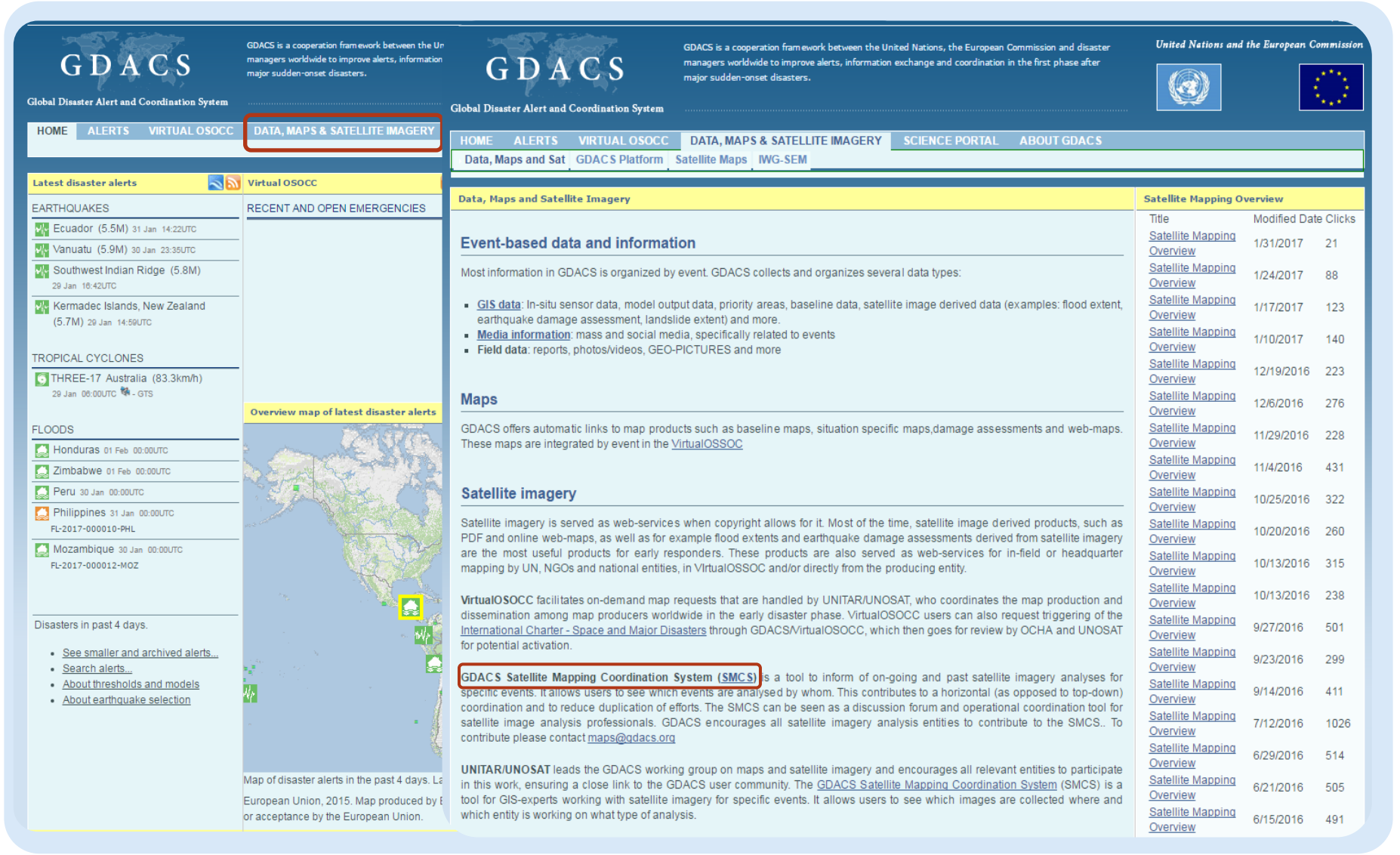
unitar
United Nations Institute for Training and Research

The Global Disaster Alert and Coordination System (GDACS)

The **Global Disaster Alert and Coordination System (GDACS)** was established in 2003 by the United Nations and the European Commission to fill the information gap in the immediate aftermath of sudden-onset natural disasters.

- GDACS is designed to alert the international community in the event sudden-onset disasters that might require international assistance, and to facilitate international information exchange and coordination in the first phase of a disaster.
- GDACS aims at supporting member states and relief organizations in their decision-making process through several tools and services provided in real time through the on-line platform.
- The services and tools provided by GDACS are:
  - **Automatic disaster alerts**
  - **Automatic impact estimations**
  - **Real-time coordination platform for disaster managers**
  - **Satellite Mapping Coordination System (SMCS)**
  - **A community of practice**

Global Disaster Alert and Coordination System (GDACS)



GDACS - Satellite Mapping Coordination System (SMCS)

Satellite Mapping Coordination System (SMCS)

GDCAS-SMCS is a platform for **coordinating satellite imagery analysis & mapping** following **major disaster events** for the benefit of **GDACS stakeholders** and the wider humanitarian community.

The SMCS is a tool used by users working with satellite imagery for specific events that allows to see which images have been collected, their coverage and which entity is working on what type of analysis. In addition to being an operational coordination tool for satellite image analysis professionals, SMCS is also a metadata archive for past events, and a discussion forum.

1. **S**atellite **M**apping **C**oordination
2. **S**atellite **M**apping Overview **R**eports
3. **L**ive **M**aps

https://gdacs-smcs.unosat.org/

Satellite Mapping Coordination – Overview 2016

11 Emergencies
1 Simulation

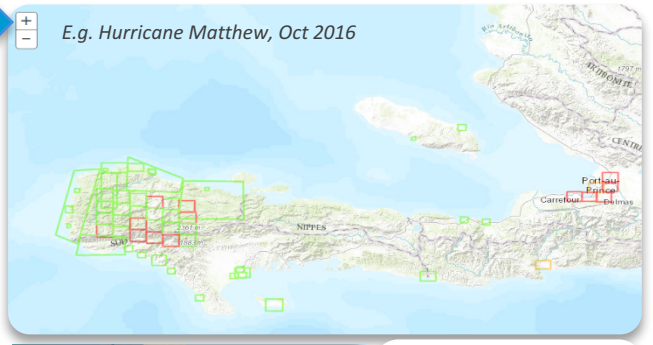
6 5 1

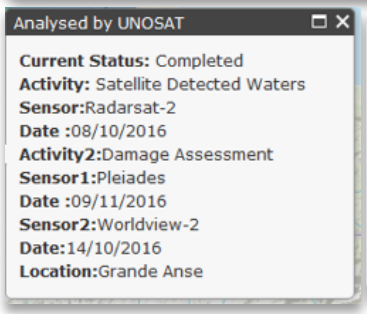
75% Requested by UNOCHA

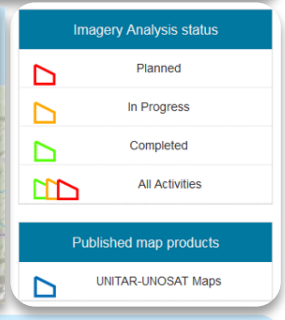
GDACS - Satellite Mapping Coordination

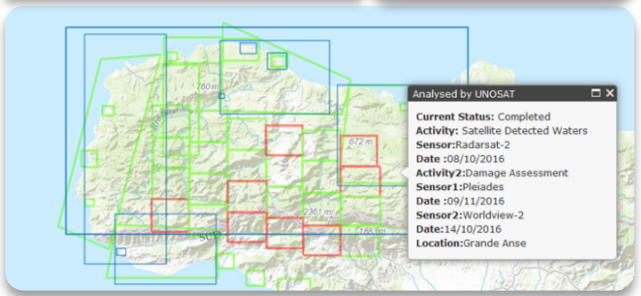
Satellite Mapping Coordination

- **Who does What, Where in terms of Satellite Analysis & Mapping?**





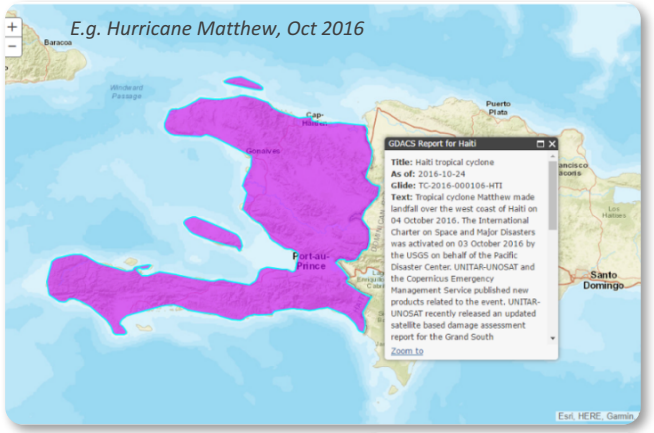


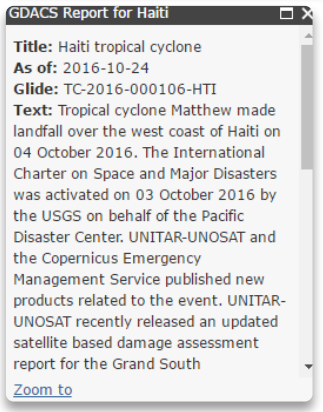


GDACS - Satellite Mapping Overview Report

Satellite Mapping Overview Reports

- **Narrative overview & summary of ongoing satellite mapping emergencies**



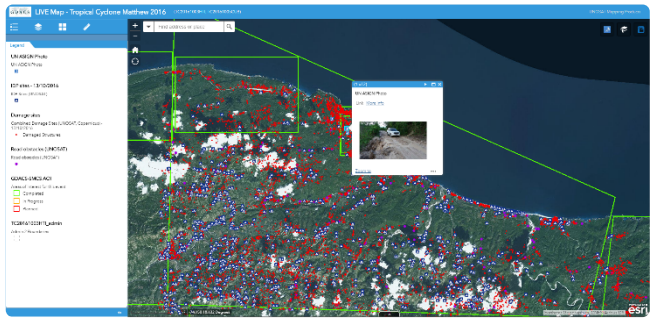


GDACS - Live Maps

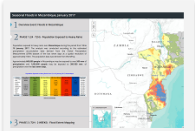
Live Maps

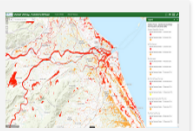
- **UNOSAT LIVE MAP** allows users to interact with satellite imagery analysis in an intuitive and eye-catching manner, allowing easy visualisation of the affected areas, and allowing users to focus on what interests them most, giving a better local understanding of the situation. These maps are updated as new data is available over the course of an event

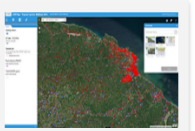
E.g. Hurricane Matthew, Oct 2016



Latest UNOSAT Live Maps


Seasonal Floods in Mozambi...


UNOSAT LIVE Map Vietnam ...


UNOSAT Live Map - Hurrican...

« »

Resources for Reference

UNITAR	https://www.youtube.com/watch?v=48bSEKW4W3w&feature
UNOSAT's Rapid Mapping	https://www.youtube.com/watch?v=FkR3N5ktt4U
Master level training course with University of Copenhagen	https://www.youtube.com/watch?v=oXe4aACkvzk
Unmanned Aerial Systems for Rapid Mapping	https://www.youtube.com/watch?v=3lU0-KqGqkg
Growth of AlZaatari Refugee Camp	https://www.youtube.com/watch?v=g2h-UEdgiQs
UNOSAT at TEDx: There is nothing natural about disasters	https://www.youtube.com/watch?v=h7fbfZxoWIY
Introduction to International Charter Space and Major Disasters	https://www.youtube.com/watch?v=dRN1dkHqIPM
NASA Earth Observatory:	http://earthobservatory.nasa.gov/
Advantages and challenges of satellite based response:	http://www.sciencedirect.com/science/article/pii/S1877042814016449

Questions and Answers

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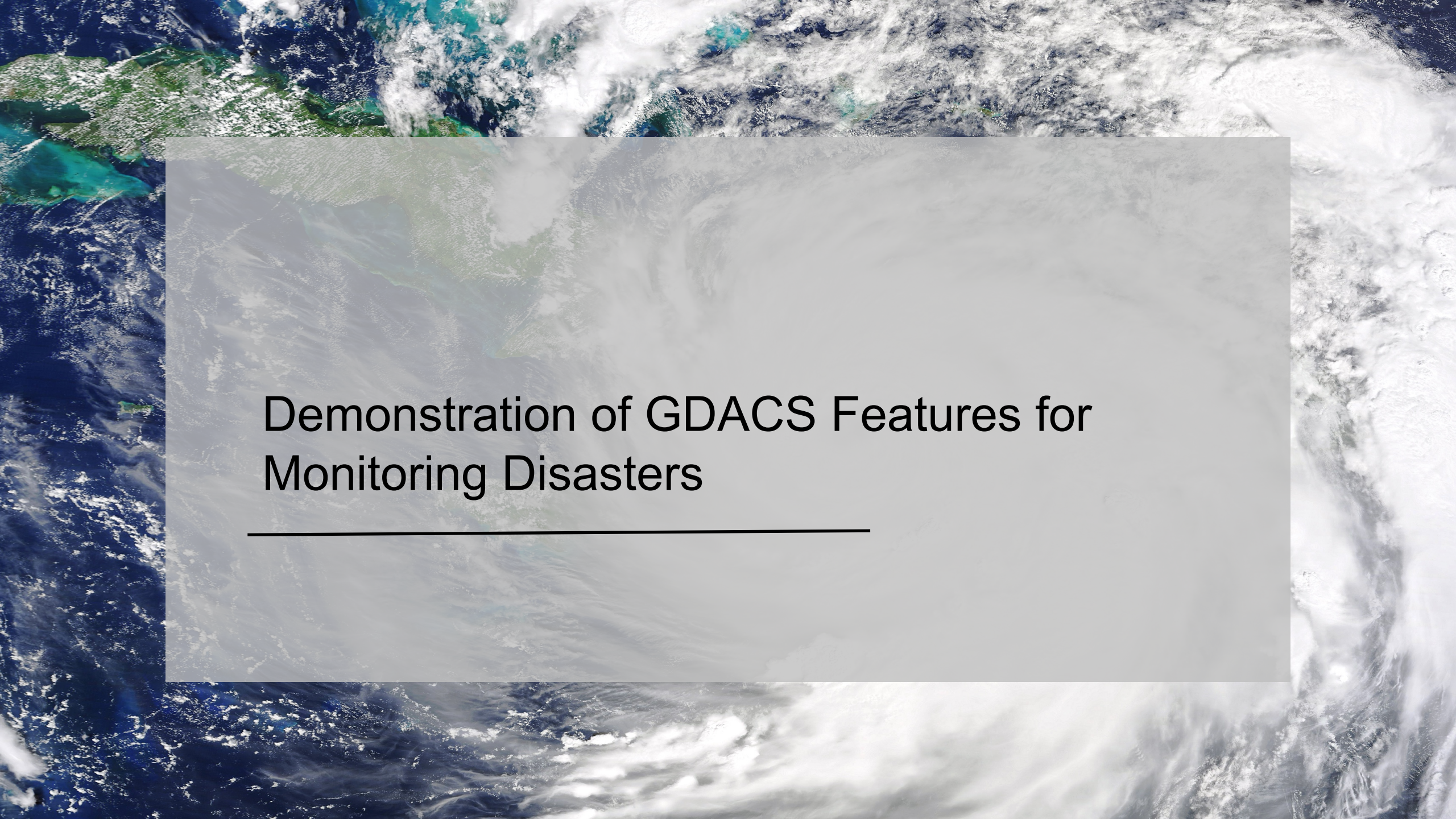
www.unitar.org

Applied Remote Sensing Training Program

In Partnership with the National Aeronautics and Space Administration



Demonstration of GDACS Features for Monitoring Disasters