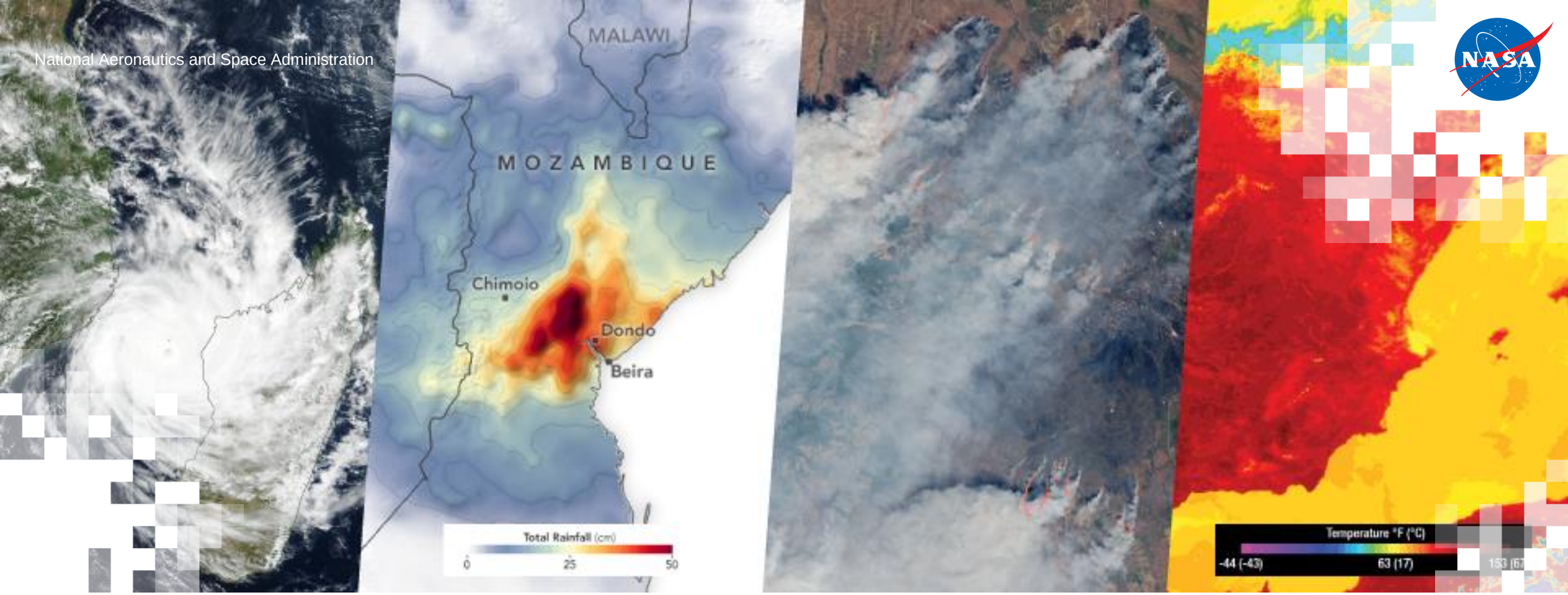


Earth Observations for Disaster Risk Assessment and Resilience

Amita Mehta and Sean McCartney

6 August 2019

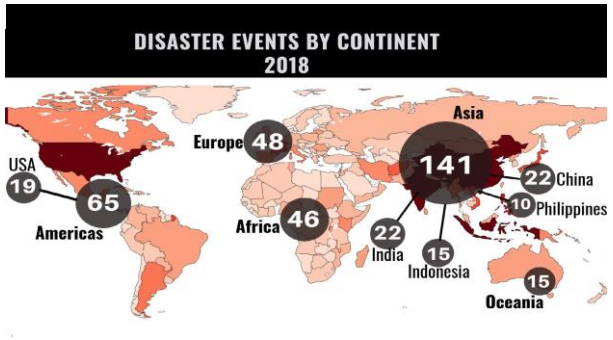
Learning Objectives

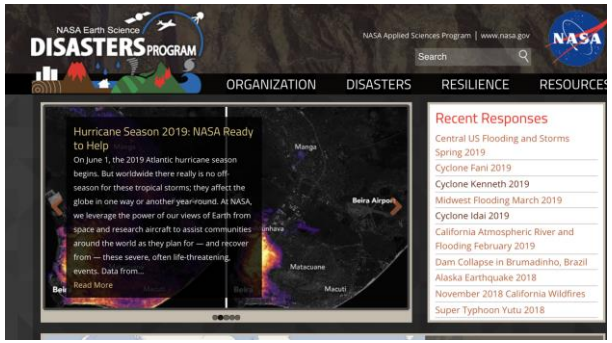
- Learn about available NASA remote sensing and socioeconomic data and how to combine them for Disaster Risk Assessment (DRA)

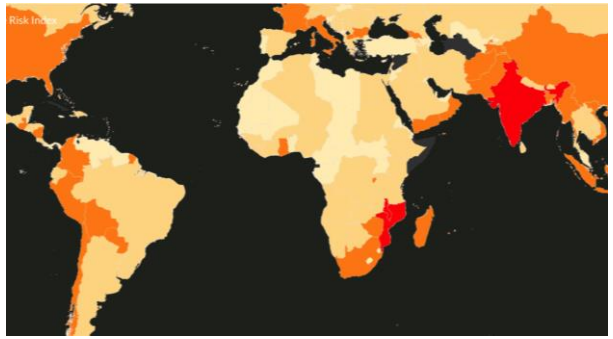
- Understand how to apply these data for assessing risk from floods, tropical cyclones, and extreme heat in specific regions

- Demonstrate how operational agencies are using NASA data for risk management

Training Outline







Aug 6, 2019	Aug 8, 2019	Aug 13, 2019	Aug 15, 2019
NASA Remote Sensing and Socioeconomic Data for Disaster Risk Assessment	Assessing the Risk of Floods & Cyclones Using NASA Data	Disaster Risk Assessment Case Studies Using Remote Sensing Data	Operational Application of Remote Sensing for Disaster Management

Image Credits (left to right): EM-DAT; NASA; WRI Resource Watch; PDC

Homework and Certificate

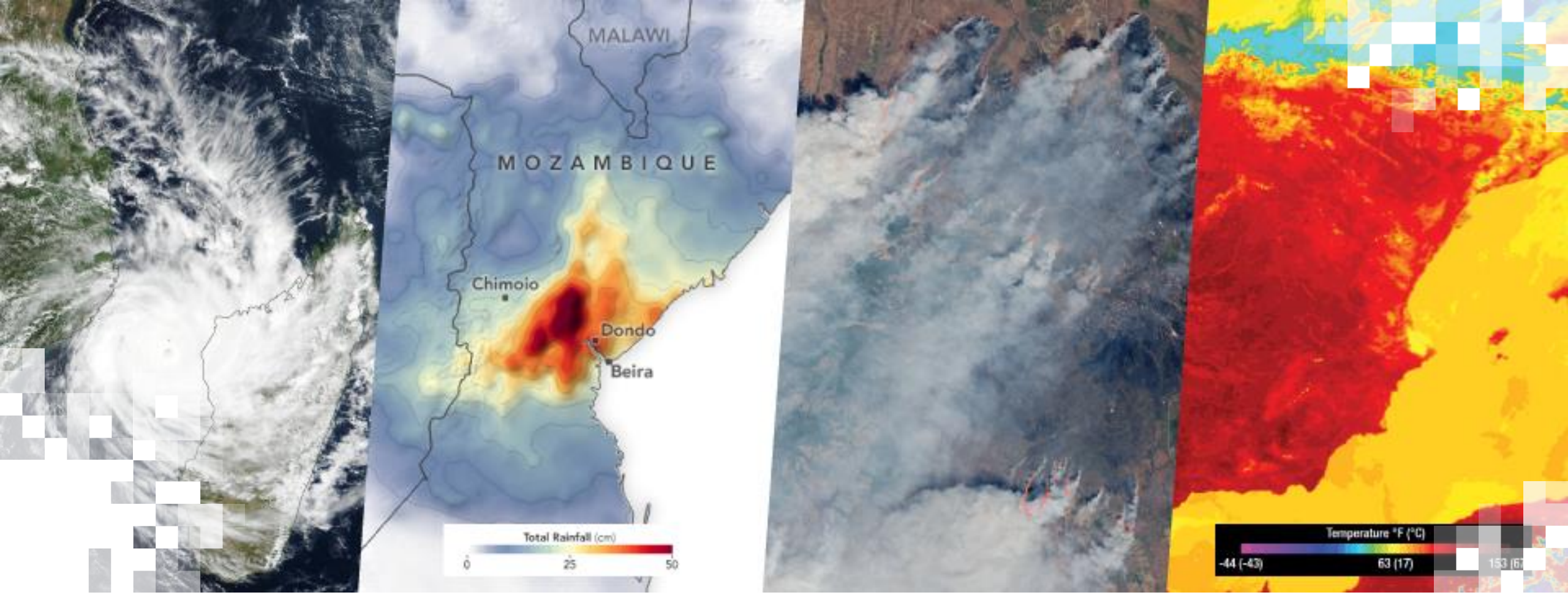
- Homework:
  - 2 homework assignments
  - Answers to homework must be submitted via Google Forms

- Certificate of Completion:
  - Attend all webinars
  - Complete 2 homework assignments by 30 August

- You will receive certificates approximately two months after the completion of the course from: marines.martins@ssaihq.com

Part-1 Outline

- About ARSET
- Disaster Risk Assessment (DRA): Concept and Definitions
- Remote Sensing and Earth System Model Data Sources Relevant for DRA
- Socioeconomic Data Relevant for DRA


MALAWI
MOZAMBIQUE
Chimoio
Dondo
Beira
Total Rainfall (cm)
0
25
50
Temperature °F (°C)
-44 (-43)
63 (17)

About ARSET

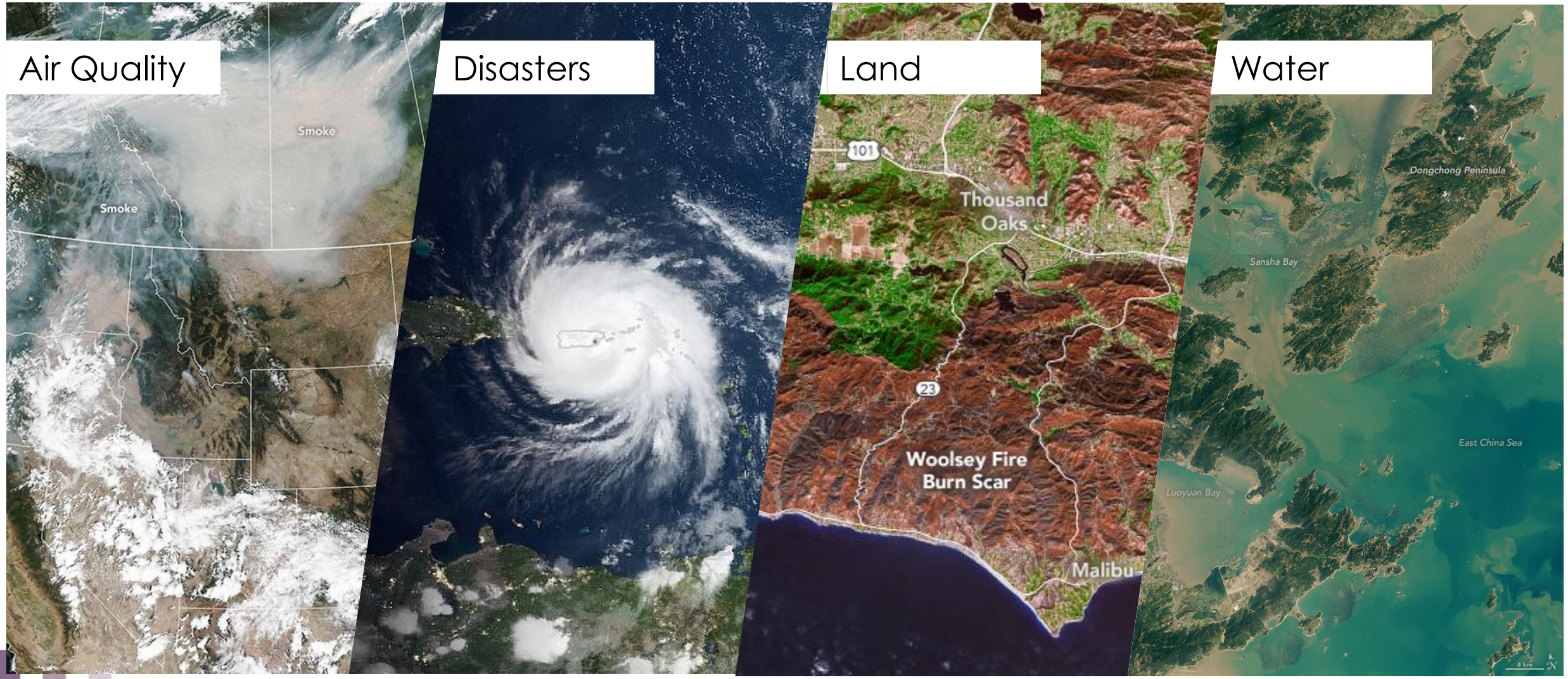
NASA's Applied Remote Sensing Training Program (ARSET)

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

- Empowering the global community through remote sensing training
- Seeks to increase the use of Earth science in decision-making through training for:
  - policy makers
  - environmental managers
  - other professionals in the public and private sector
- Training topics focus on:
  - air quality
  - disasters
  - land
  - water

Helping Professionals Solve Problems Including…

ARSET Training Focus Areas



ARSET Team Members

Program Support

- Ana Prados, Program Manager (GSFC)
- David Barbato, Spanish Translator (GSFC)
- Brock Blevins, Training Coordinator (GSFC)
- Annelise Carleton-Hug, Program Evaluator (Consultant)
- Elizabeth Hook, Technical Writer/Editor (GSFC)
- Selwyn Hudson-Odoi, Training Coordinator (GSFC)
- Marines Martins, Project Support (GSFC)
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- Amita Mehta, Instructor (GSFC)
- Erika Podest, Instructor (JPL)
- Sean McCartney, Instructor (GSFC)

Land & Wildfires

- Amber Jean McCullum, Lead (ARC)
- Juan Torres-Pérez, Instructor (ARC)

Health & Air Quality

- Pawan Gupta, Lead (MSFC)
- Melanie Follette-Cook, Instructor (GSFC)

Acknowledgement: We wish to thank Nancy Searby for her continued support

GSFC: Goddard Space Flight Center, JPL: Jet Propulsion Laboratory, ARC: Ames Research Center, MSFC: Marshall Space Flight Center

ARSET Training Formats

Online

Free

Online training

1-5 weeks long

1-6 hours a week

Available at all levels

Materials available in English & Spanish

In-Person

Hosted with a partner

Typically in a computer lab

2-7 days long

Focus on locally-relevant case studies

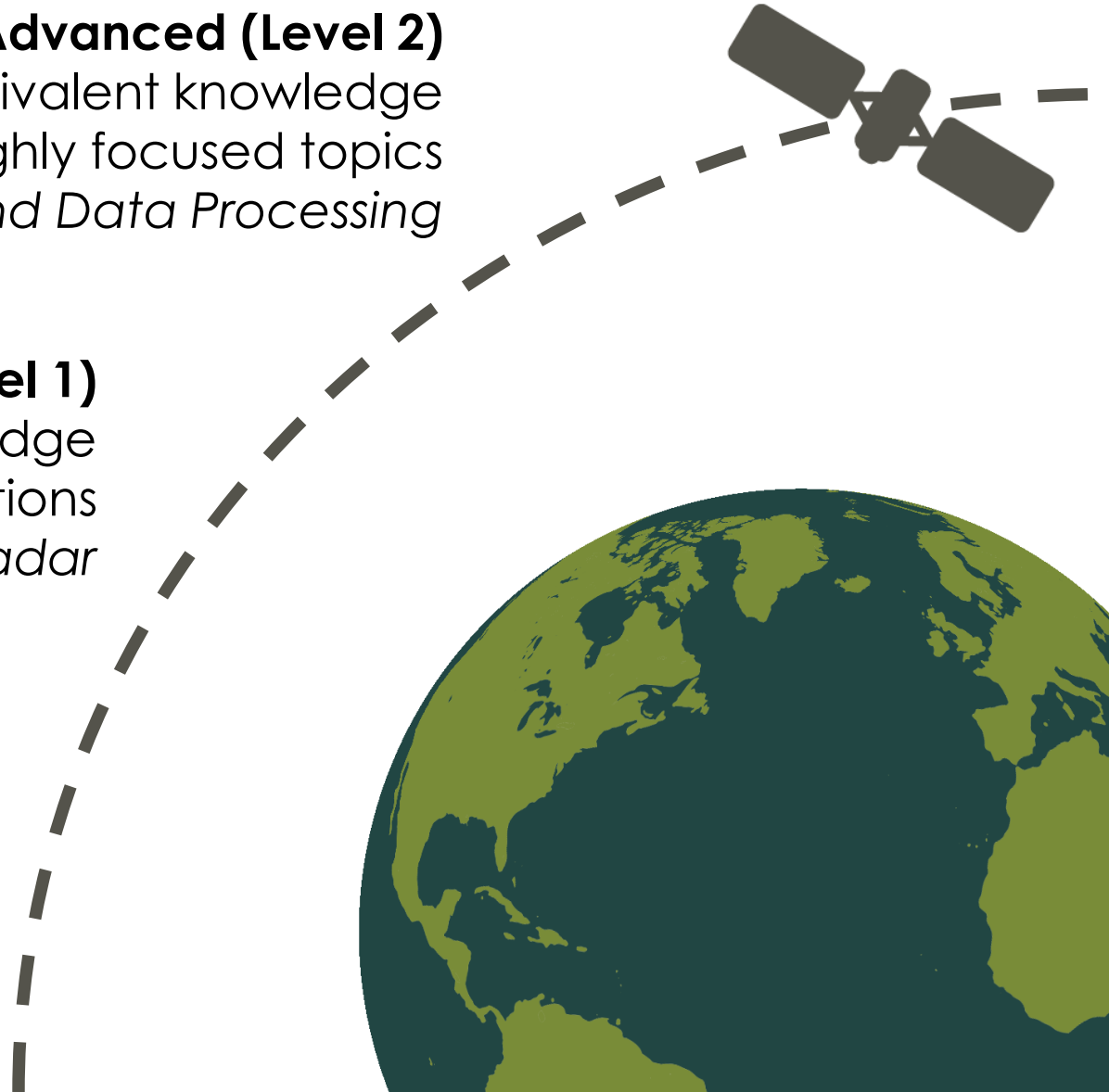
Certain topics presented in Spanish

ARSET Training Levels

Advanced (Level 2)
Requires level 1 training or equivalent knowledge
In-depth and highly focused topics
Advanced Webinar: SAR Image and Data Processing

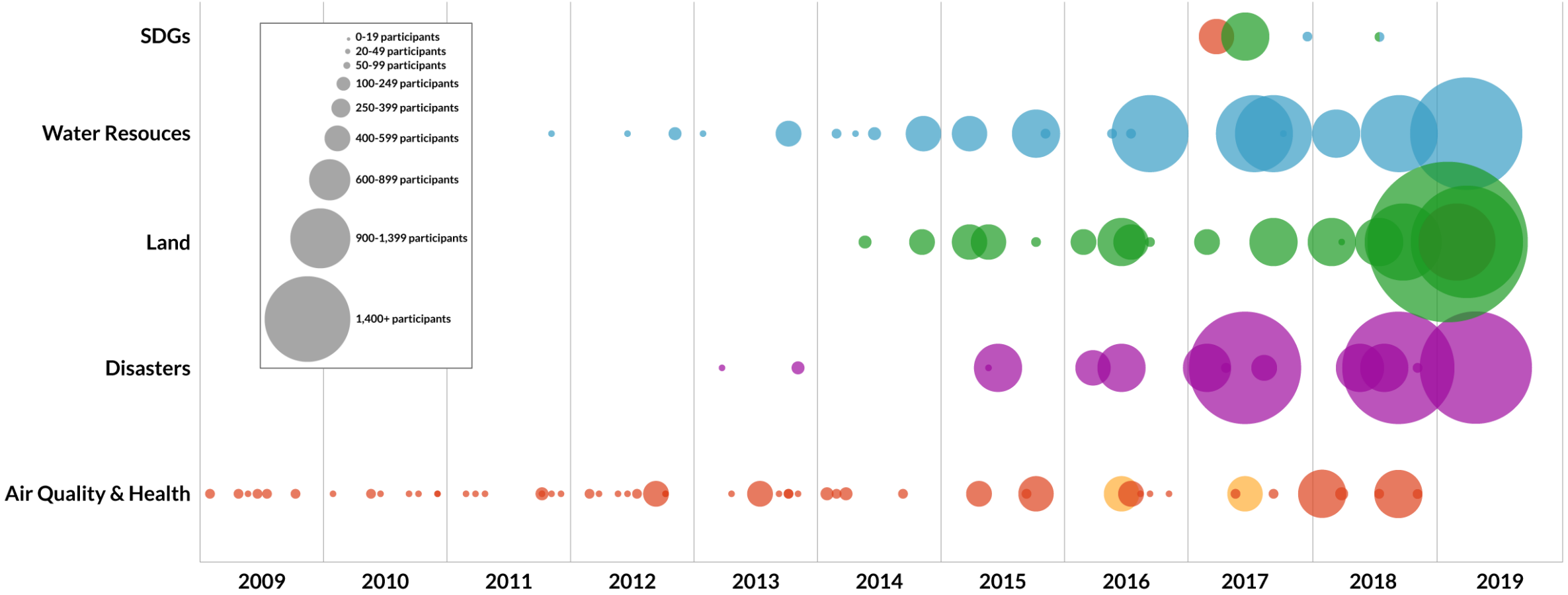
Basic (Level 1)
Requires level 0 training or equivalent knowledge
Covers specific applications
Introduction to Synthetic Aperture Radar

Fundamentals (Level 0)
Assumes no prior knowledge of remote sensing
Fundamentals of Remote Sensing



ARSET Trainings

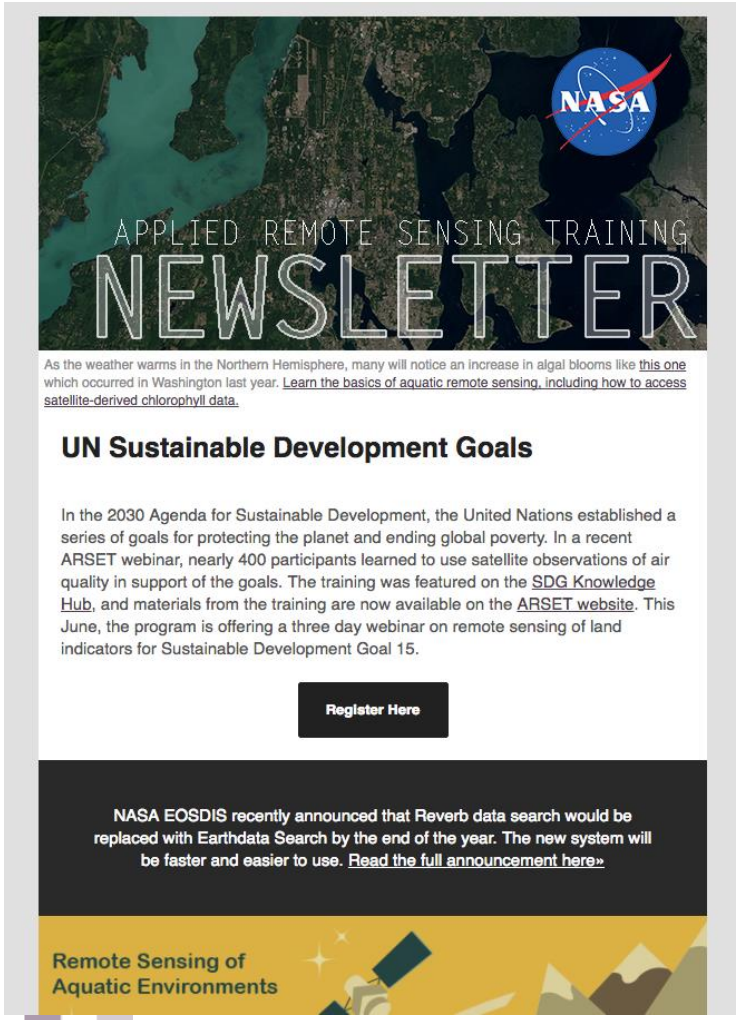
110+ trainings 19,400+ participants 160+ countries 5,000+ organizations

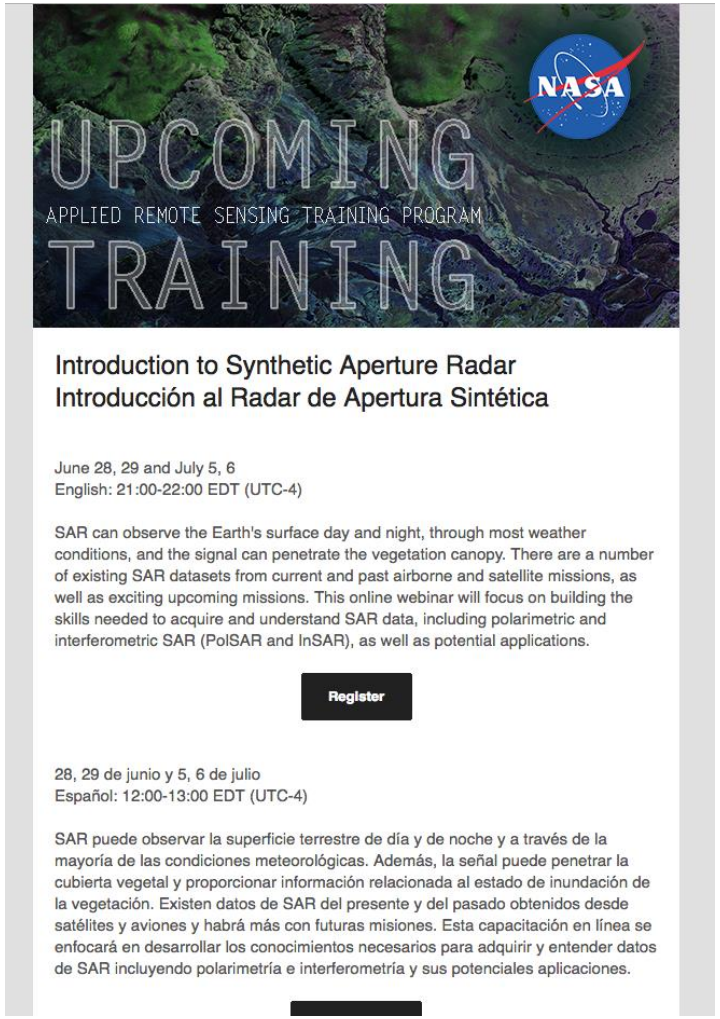


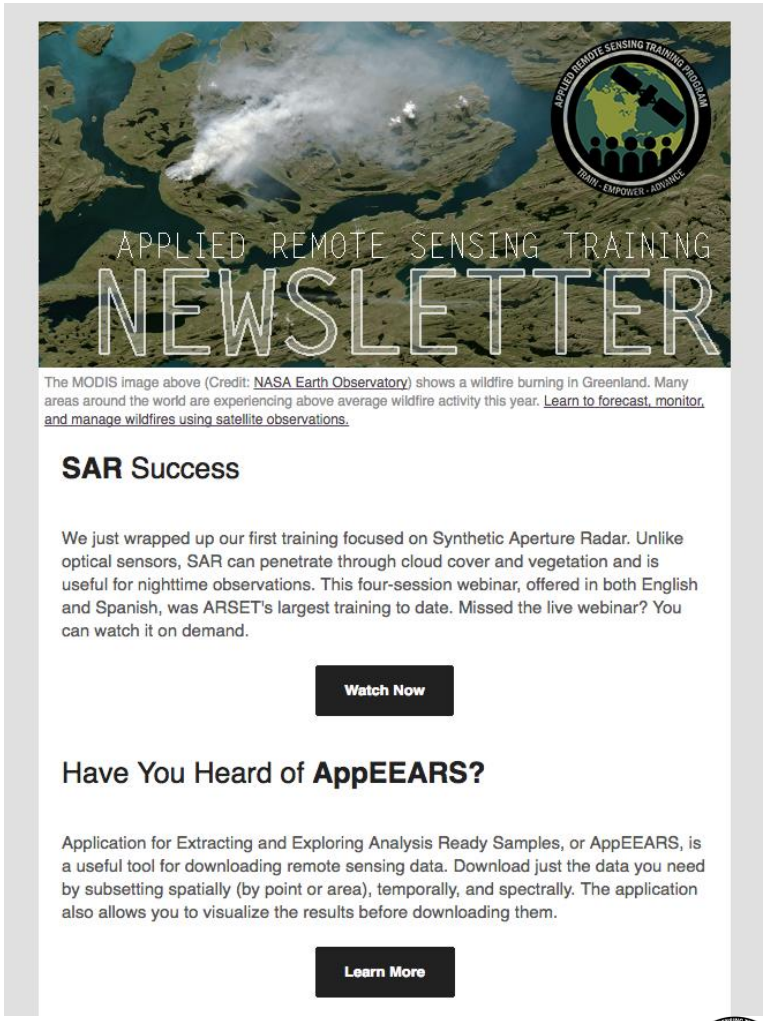
* size of circle corresponds to number of participants

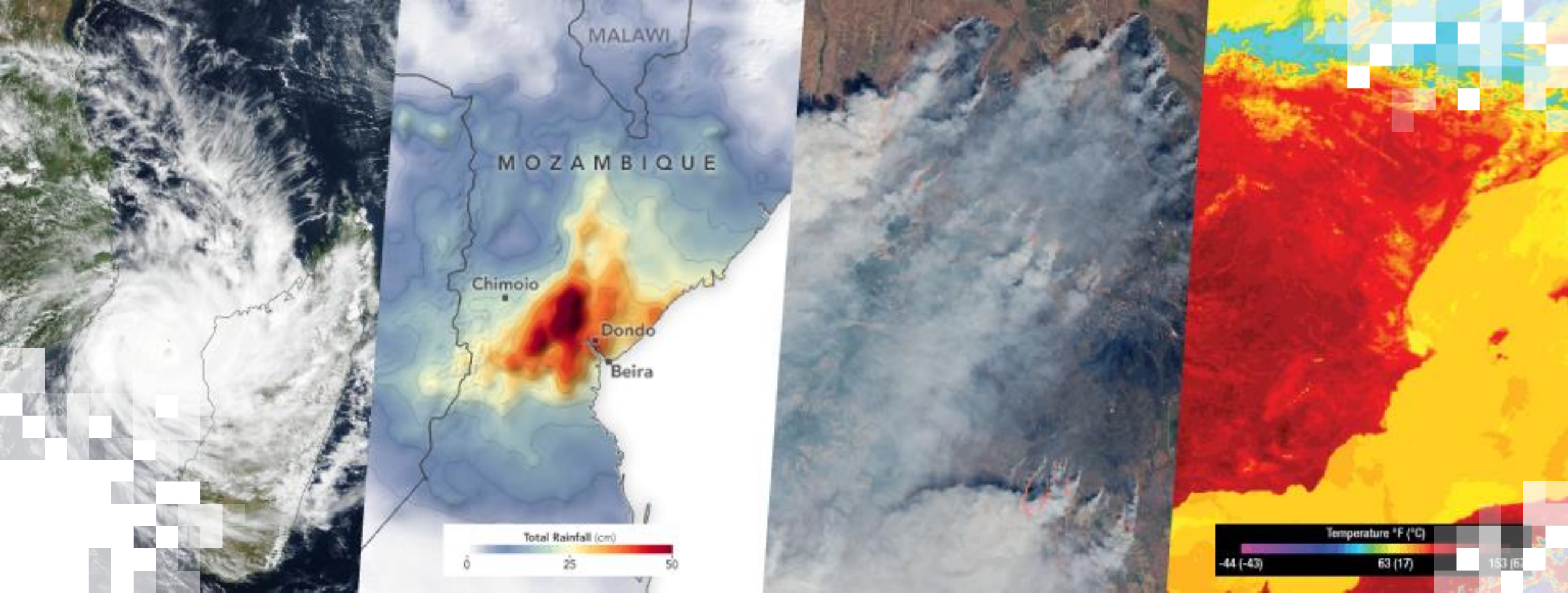
Sign up for the ARSET Listserv

https://lists.nasa.gov/mailman/listinfo/arset









Disaster Risk Assessment: Concept and Definitions

Terminology

- **Disaster Risk Assessment (DRA)**
- Hazard
- Exposure
- Vulnerability
- Disaster
- Disaster Risk
- Resilience
- Disaster Risk Reduction (DRR)
- Disaster Risk Management (DRM)

- A process to determine the nature and extent of risks

- Requires analysis of hazards and existing conditions of exposure and vulnerability

- Focuses on potential harm to
  - people
  - property
  - services
  - livelihoods
  - and the environment people depend on

Text Credit: UNISDR

Terminology

- **Disaster Risk Assessment (DRA)**
- Hazard
- Exposure
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- Disaster
- Disaster Risk
- Resilience
- Disaster Risk Reduction (DRR)
- Disaster Risk Management (DRM)

- A comprehensive DRA evaluates the magnitude and likelihood of potential losses
- It provides full understanding of the causes and impact of those losses
- DRA is an integral part of **Disaster Risk Management**, decision and policy-making processes, and requires close collaboration among various parts of society

Text Credit: UNISDR

Terminology

- Disaster Risk Assessment
- **Hazard**
- Exposure
- Vulnerability
- Disaster
- Disaster Risk
- Resilience
- Disaster Risk Reduction (DRR)
- Disaster Risk Management (DRM)

- A process, phenomenon, or human activity that may cause:
  - loss of life
  - injury or other health impacts
  - property damage
  - social and economic disruption
  - environmental degradation

- A hazard is characterized by:
  - location or geographic area
  - intensity or magnitude
  - frequency or return period
  - probability of occurrence

Text Credit: UNISDR

Terminology

- Disaster Risk Assessment
- **Hazard**
- Exposure
- Vulnerability
- Disaster
- Disaster Risk
- Resilience
- Disaster Risk Reduction (DRR)
- Disaster Risk Management (DRM)

- Natural hazards arise from events, sometimes acting in combination, including:
  - geological (earthquakes, landslides, volcanoes)
  - meteorological (storms, extreme temperatures, wildfires)
  - hydrological (floods, droughts)
  - oceanic (wave surge)
  - biological (disease epidemics)

- Human induced hazards include:
  - industrial and transportation accidents
  - environmental pollution
  - human conflicts
  - migration

Text Credit: UNISDR

Terminology

- Disaster Risk Assessment
- Hazard
- **Exposure**
- Vulnerability
- Disaster
- Disaster Risk
- Resilience
- Disaster Risk Reduction (DRR)
- Disaster Risk Management (DRM)

- The situation of people, infrastructure, housing, production capacities, and other tangible human assets located in hazard-prone areas
- Exposure can be measured by the number of people or types of assets in an area
- To estimate quantitative risks associated with a **hazard**, exposure measurements can be combined with specific vulnerability and capacity of exposed elements

Text Credit: UNISDR

Terminology

- Disaster Risk Assessment
- Hazard
- Exposure
- **Vulnerability**
- Disaster
- Disaster Risk
- Resilience
- Disaster Risk Reduction (DRR)
- Disaster Risk Management (DRM)

- Determined by physical, social, economic, and environmental factors or processes
- Assesses the susceptibility of an individual, community, asset, or system to the impact of **hazards**
- Depends on cultural and institutional factors, including:
  - poor design and construction of buildings
  - poor environmental management
  - inadequate protection of assets
  - lack of public information and awareness
  - levels of poverty and education
  - limited official recognition of risks and preparedness
  - weak governance

Text Credit: UNISDR

Terminology

- Disaster Risk Assessment
- Hazard
- Exposure
- Vulnerability
- **Disaster**
- Disaster Risk
- Resilience
- Disaster Risk Reduction (DRR)
- Disaster Risk Management (DRM)

- A serious disruption of the functioning of a community or a society at any scale due to hazardous events leading to one or more of the following losses and impacts:
  - human
  - material
  - economic
  - environmental

Text Credit: UNISDR

Terminology

- Disaster Risk Assessment
- Hazard
- Exposure
- Vulnerability
- Disaster
- **Disaster Risk**
- Resilience
- Disaster Risk Reduction (DRR)
- Disaster Risk Management (DRM)

- The potential loss of life, injury, or destroyed or damaged assets that could occur to a community as a function of a hazard, exposure, or vulnerability
- Made up of different types of potential losses that can be difficult to quantify

Text Credit: UNISDR

Terminology

- Disaster Risk Assessment
- Hazard
- Exposure
- Vulnerability
- Disaster
- Disaster Risk
- **Resilience**
- Disaster Risk Reduction (DRR)
- Disaster Risk Management (DRM)

- Ability of a system, community, or society exposed to hazards to:
  - resist
  - absorb
  - accommodate
  - adapt to
  - recover from effects

- Refers to the timely and efficient response, including through preservation & restoration of basic structures and functions

Text Credit: UNISDR

Terminology

- Disaster Risk Assessment
- Hazard
- Exposure
- Vulnerability
- Disaster
- Disaster Risk
- Resilience
- **Disaster Risk Reduction (DRR)**
- Disaster Risk Management (DRM)

- Aimed at
  - preventing new disasters
  - reducing existing disaster risk
  - managing residual risk
- These contribute to strengthening **resilience**
- Involves developing strategies and policy objectives
  - across different timescales
  - with concrete targets, indicators, and timeframes

Text Credit: UNISDR

Terminology

- Disaster Risk Assessment
- Hazard
- Exposure
- Vulnerability
- Disaster
- Disaster Risk
- Resilience
- Disaster Risk Reduction (DRR)
- **Disaster Risk Management (DRM)**

- Application of **Disaster Risk Reduction** policies and strategies to:
  - prevent new disaster risk
  - reduce existing disaster risk
  - manage residual risk
- Can be categorized into:
  - Prospective Disaster Risk Management
  - Corrective Disaster Risk Management
  - Compensatory Disaster Risk Management (also referred to as Residual Risk Management)

Text Credit: UNISDR

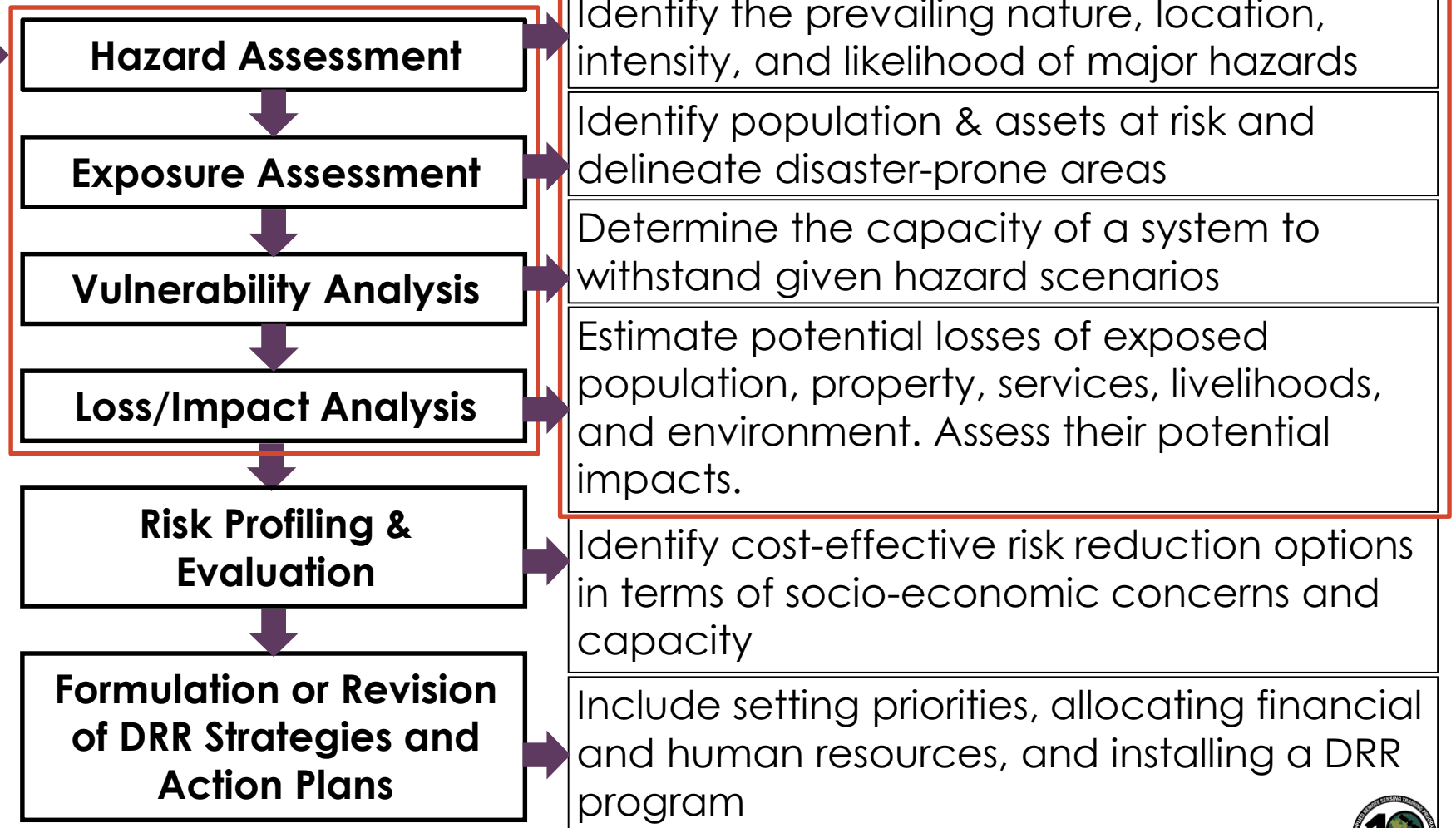
How to Conduct a Disaster Risk Assessment

According to the UN Development Program (UNDP) the following steps are required for a comprehensive risk assessment:

Understanding of Current Situation, Needs, and Gaps:

- systematic inventory and evaluation of existing risk assessment studies, available data and information, and current institutional framework and capabilities

Steps within red boxes can be derived from data freely available from NASA



Text Credit: UNDP

Types of Natural Hazards

- Cyclones
- Droughts
- Earthquakes
- Extreme Precipitation
- Extreme Temperatures
- Floods
- Landslides
- Tsunamis
- Volcanoes
- Wildfires

Image Credits (Clockwise from Top Left): NOAA, USAF, USDA, Kieran Wood

Global Disaster Statistics (1998-2017)

In this time frame, floods and storms were the most dominant hazards

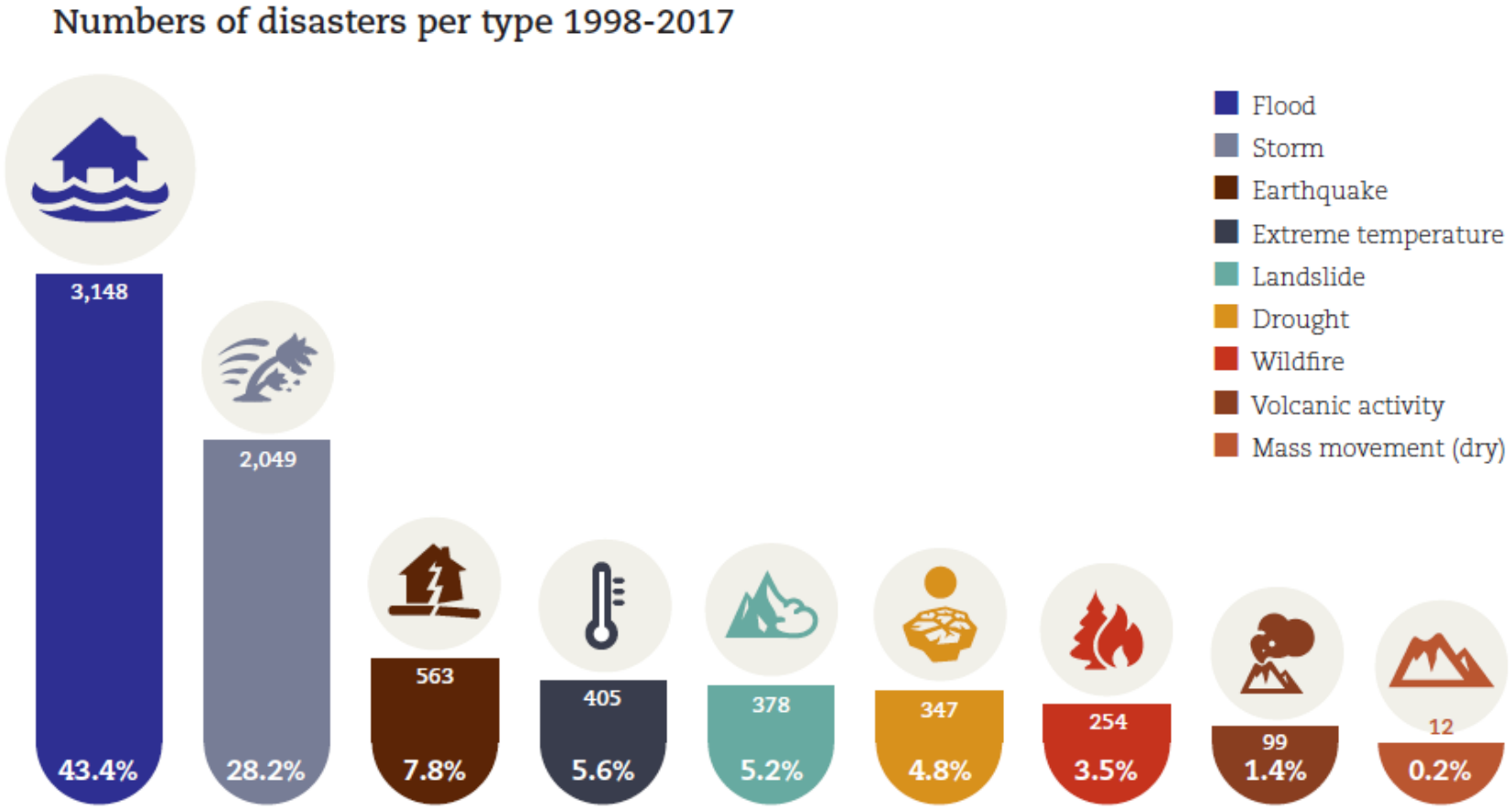


Image Credit: CRED and UNISDR

Global Disaster Statistics (1998-2017)

Floods, droughts, and storms affected the highest number of people

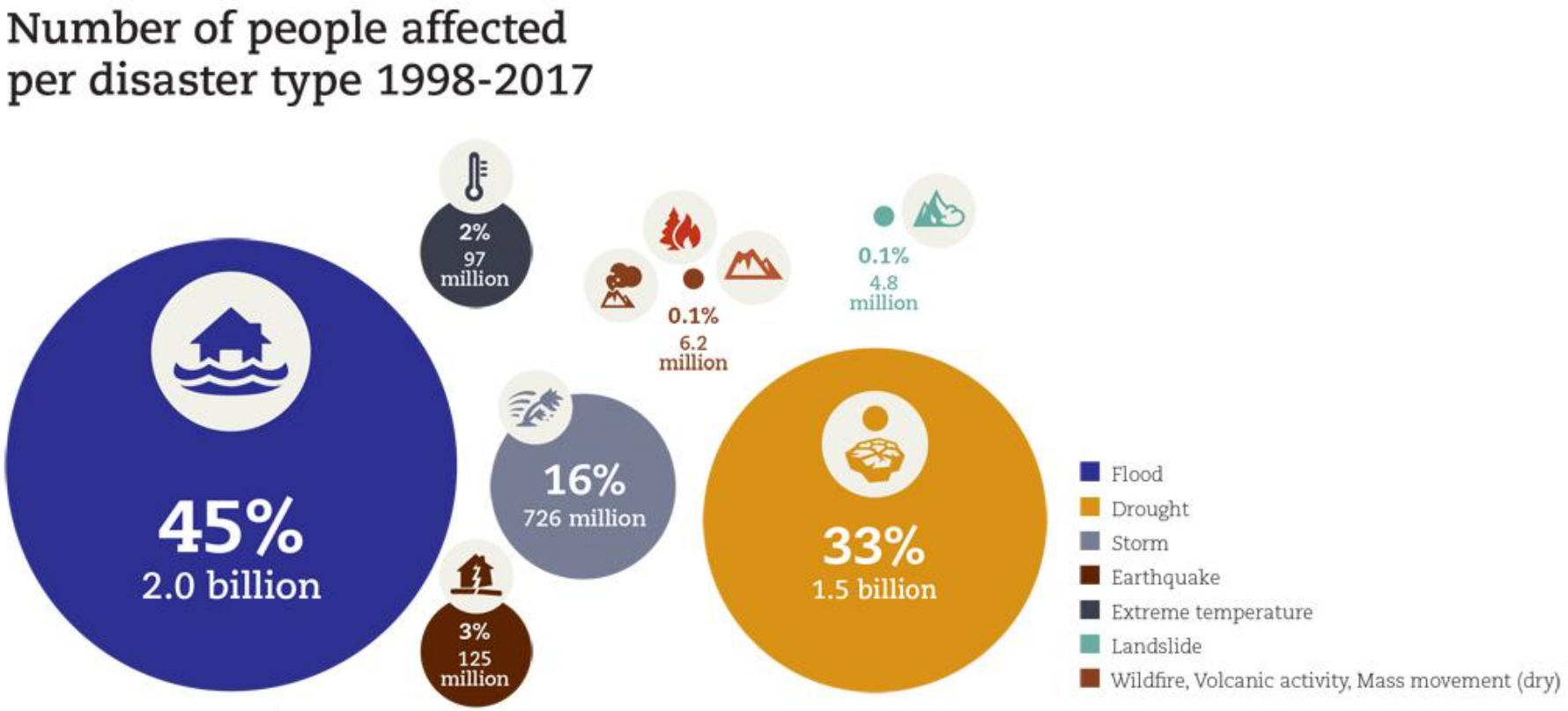


Image Credit: UNDRR, data from CRED and UNISDR

Global Disaster Statistics (1998-2017)

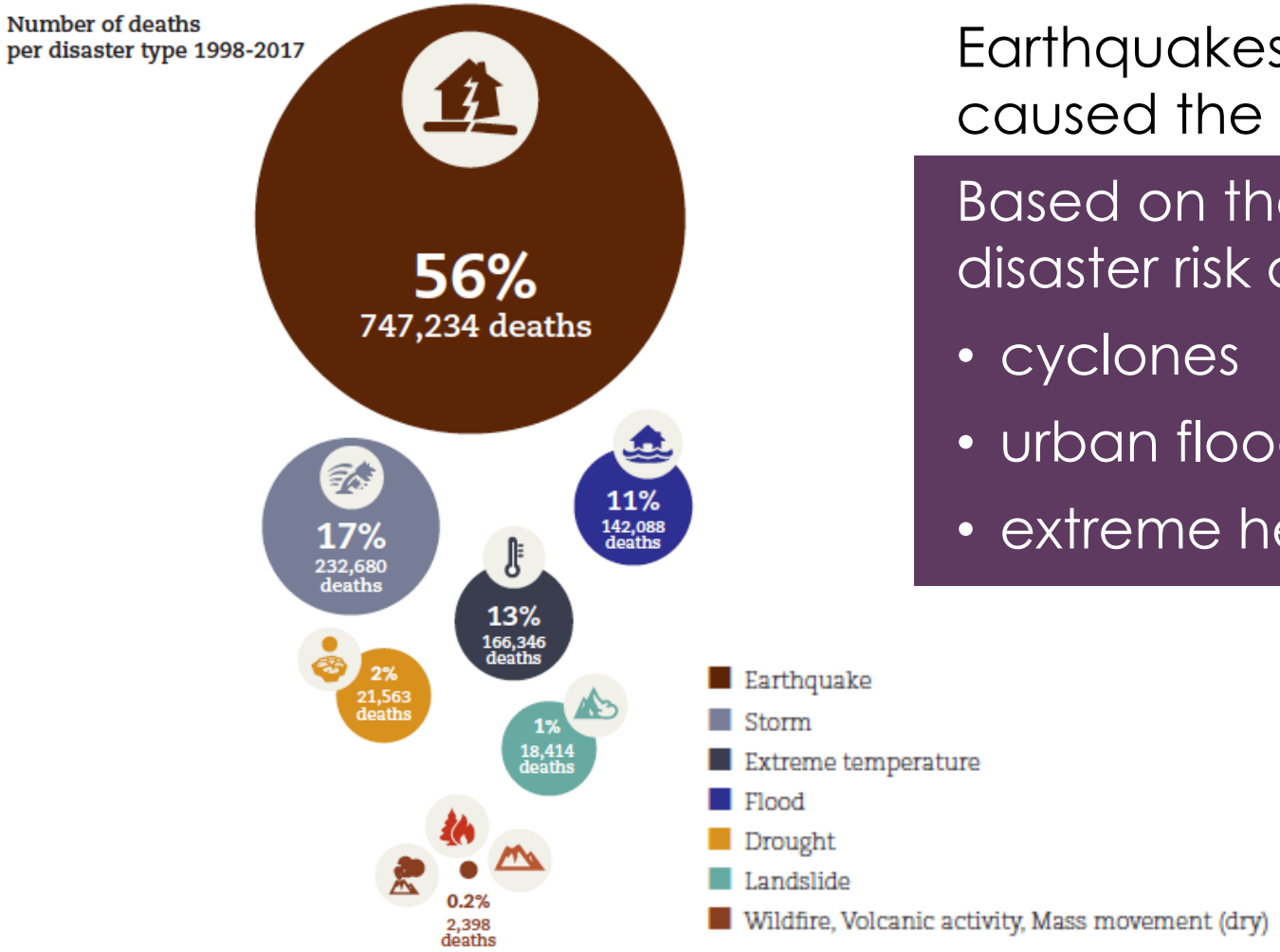


Image Credit: CRED and UNISDR

Earthquakes, storms, extreme heat, and floods caused the most number of deaths

Based on these statistics, this webinar will focus on disaster risk assessment (DRA) for:

- cyclones
- urban floods (Extreme Precipitation)
- extreme heat

Assessing the Potential Risk of a Hazard

Identify the nature, location, intensity, and likelihood of major hazards prevailing in a community or environment

- Requires data and information about a type of hazard or multiple hazards:
  - Past/historical data
    - identify hazard-prone regions
    - assess frequency and intensity of hazards
    - establish strategies for DRR
  - Current data for near-real time actions for DRR
  - Future data (forecast) for assessing potential risk to an approaching hazard, planning near-future actions for DRR
  - Quantitative analysis of past-current-forecast data

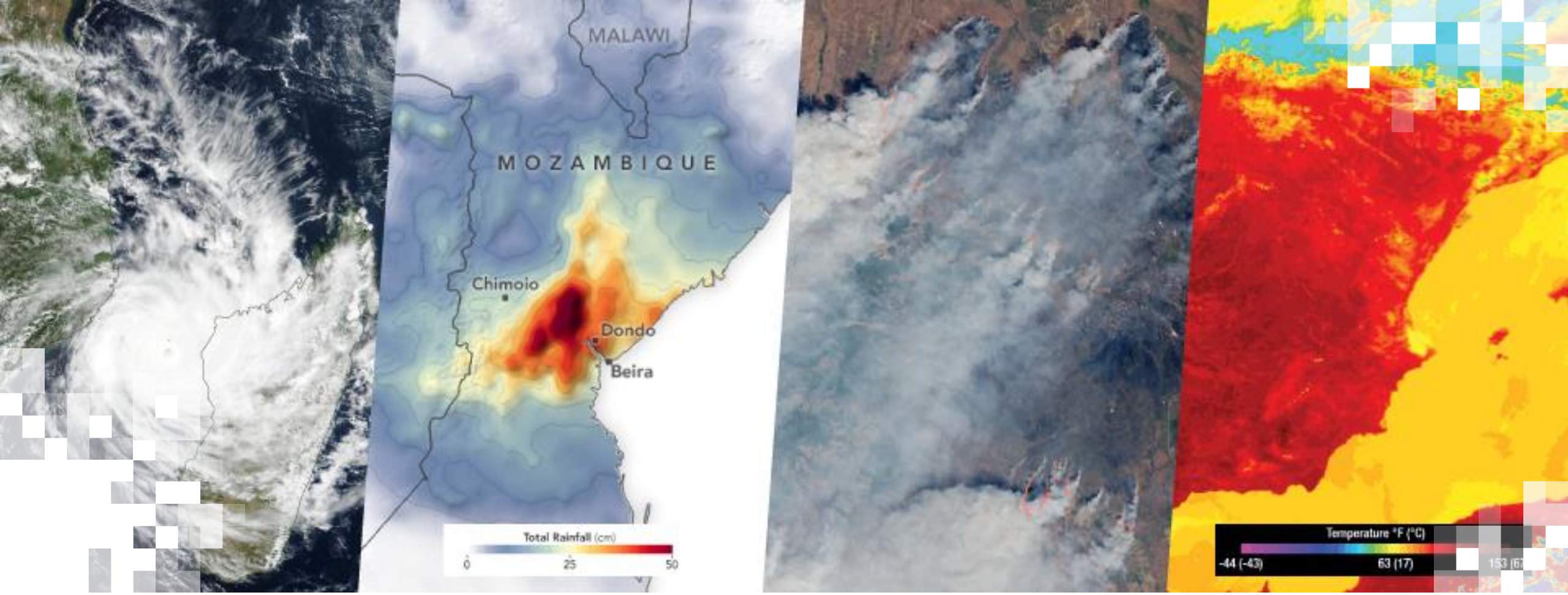
Hazard Assessment Data Needs

- **Cyclones**: frequency, probability, intensity
  - based on **tracks**, **landfall locations**, **storm surge**, **sea level pressure**, **winds**, **precipitation**
- **Floods**: flood plain extent, frequency, intensity, duration
  - based on **precipitation**, **soil moisture**, **terrain/slope**, **impermeable surface**
- **Extreme Heat**: frequency, probability, duration
  - based on **surface temperature**, **surface humidity**

Data in **blue** are derived from NASA Earth Observations and Models

Data in **brown** are available from NOAA, the Joint Typhoon Warning Center, and Worldwide Tropical Cyclone Centers

Reference: NOAA, Joint Typhoon Warning Center, Worldwide Tropical Cyclone Centers



Remote Sensing Data Sources Relevant for Disaster Risk Assessment

Data for Hazard Assessment: Past Data (>18 Years)

Data Parameter	Hazard	Source	Spatial Resolution	*Temporal Information
Land Surface Temperature Surface Air Temperature	Extreme Heat	MODIS, GLDAS, MERRA-2	1 Km 0.25° x 0.25° 0.5° x 0.667°	2000-present 2000-present 1980-Present
Surface Humidity	Extreme Heat	GLDAS, MERRA-2	0.25° x 0.25° 0.5° x 0.667°	2000-present 1980-Present
Winds	Cyclone	MERRA-2	0.5° x 0.667°	1980-Present
Precipitation	Flood, Cyclone	*TRMM TMPA GPM/IMERG-Final	0.25° x 0.25° 0.1° x 0.1°	1998-present 2000-present
Soil Moisture	Flood	GLDAS MERRA-2	0.25° x 0.25° 0.5° x 0.667°	2000-present 1980-Present
Elevation	Flood	SRTM	1-arc second 3-arc second	2000-present

*A combined TRMM/GPM precipitation data product is now available spanning 2000-present

Data for Hazard Assessment: Past Data (4-5 Years)

Data Parameter	Hazard	Source	Spatial Resolution	*Temporal Information
Precipitation	Flood, Cyclone	GPM/IMERG-Early and Late	0.1° x 0.1°	3/2014 - present
Storm Surge	Cyclone	*SLOSH (US Only)	Tens of meters to 1 km	2014 - present
Soil Moisture	Flood	GEOS-5 SMAP	0.3125° x 0.25° 36 km, 9 km	4/2015 - present

*All data have global coverage except for SLOSH

Data for Hazard Assessment: Near-Real Time and Forecasts

Data Parameter	Hazard	Source	Spatial Resolution	Temporal Information
Land Surface and Surface Air Temperature	Extreme Heat	MODIS, GEOS-5	1 Km 0.3125° x 0.25°	NRT NRT and 10-day Forecast
Surface Humidity	Extreme Heat	GEOS-5	0.3125° x 0.25°	
Winds	Cyclone	GEOS-5	0.3125° x 0.25°	
Soil Moisture	Flood	GEOS-5 SMAP	0.3125° x 0.25° 36 km, 9 km	
Precipitation	Flood Cyclone	GEOS-5 GPM/IMERG	0.3125° x 0.25° 0.1° x 0.1°	
Storm Surge	Cyclone	*SLOSH (US Only)	Tens of meters to 1 km	NRT and 48-hour Forecast

* All data have global coverage except for SLOSH

For More Information on Data for Hazard Assessment

- Past Data (>18 Years)
  - Fundamentals of Remote Sensing, Water Resources Management
  - Intermediate Webinar: Remote Sensing for Disaster Scenarios (2019)
  - Introductory Webinar: Monitoring Tropical Storms for Emergency Preparedness (2018)

- Past Data (4-5 Years) & Near-Real Time Forecasts
  - Intermediate Webinar: Remote Sensing for Disaster Scenarios (2019)
  - Introductory Webinar: Monitoring Tropical Storms for Emergency Preparedness (2018)

Data Access for Hazard Assessment

Data Access Tool	Web Address
Giovanni & NASA Earthdata GES DISC (MERRA-2, GLDAS, TRMM-TMPA, GPM-IMERG)	https://giovanni.gsfc.nasa.gov/giovanni/ https://disc.gsfc.nasa.gov/
Precipitation Measurement Mission (GPM-IMERG)	https://pmm.nasa.gov/data-access/downloads/
AppEARS (SMAP, MODIS)	https://nsidc.org/support/how/point-and-area-samples-smap-data-using-appeears
NCCS Data Portal-Data Share (GEOS-5)	https://fluid.nccs.nasa.gov/weather/ https://portal.nccs.nasa.gov/datashare/gmao_ops/pub/fp/forecast/
Probabilistic Tropical Storm Surge (P-Surge)	https://slosh.nws.noaa.gov/psurge2.0/

Hazard Assessment and DRR

- Analysis of past data help identify hazard-prone areas, intensity, and frequency of hazard(s)
- Based on past hazard analysis together with exposure, vulnerability, and socioeconomic impact (DRA), this helps prepare for current and future DRR
- Useful for planning overall DRM

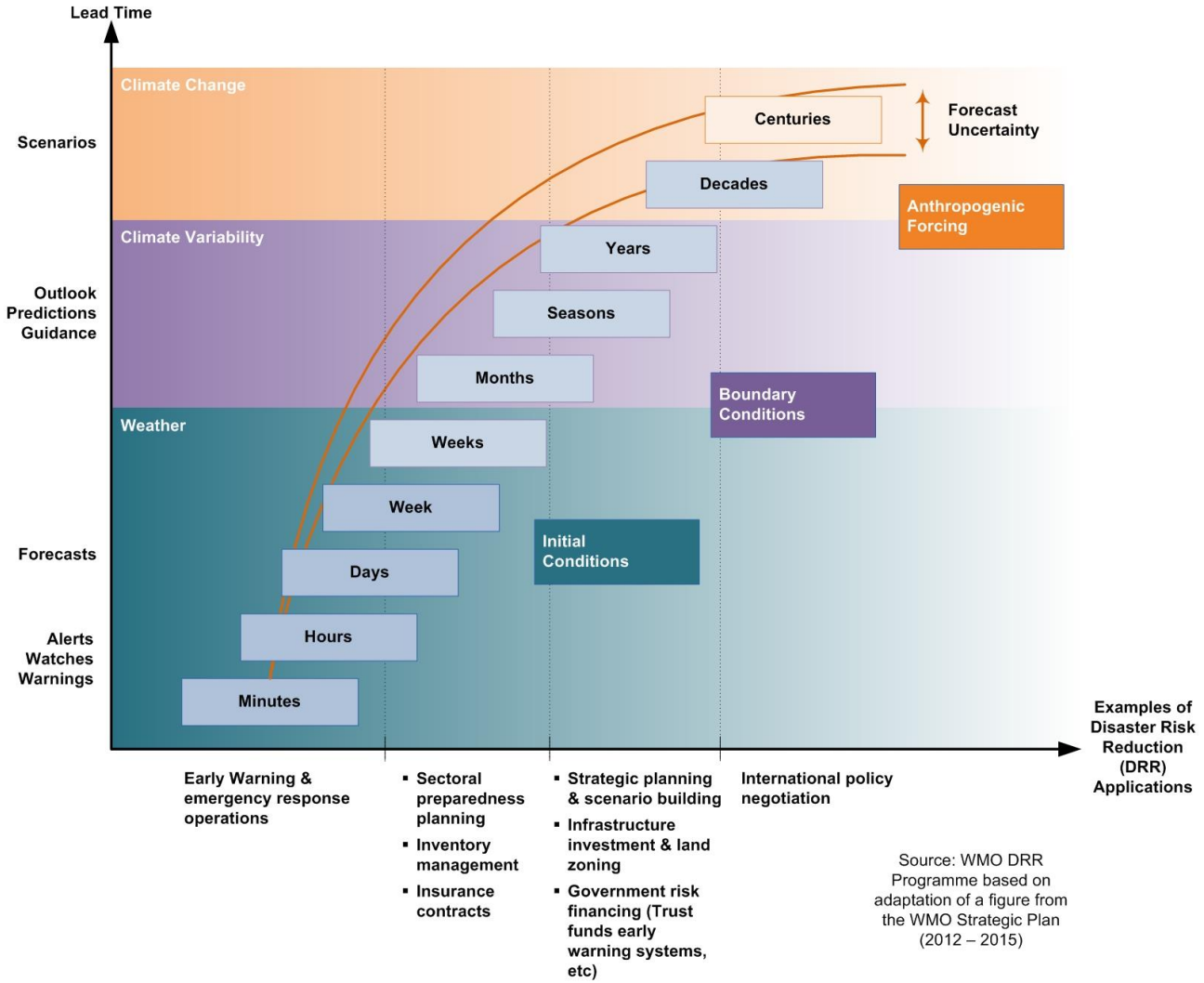


Image Credit: WMO

Disaster Risk Assessment

- DRA requires analysis of hazard assessment together with exposure (i.e. elements at risk) and vulnerability (physical, social, economic, and environmental)

- Next Susana Adamo from SEDAC will present socioeconomic data relevant for exposure and vulnerability for Disaster Risk Assessment

Reference

GEOS-5: Goddard Earth Observing System Model, Version 5

GLDAS: Global Land Data Assimilation System, version 2.1

GPM: Global Precipitation Measurement

IMERG: Integrated Multi-satellitE Retrievals for GPM

MERRA-2: Modern-Era Retrospective analysis for Research and Applications, Version 2

MODIS: MODerate-resolution Imaging Spectroradiometer

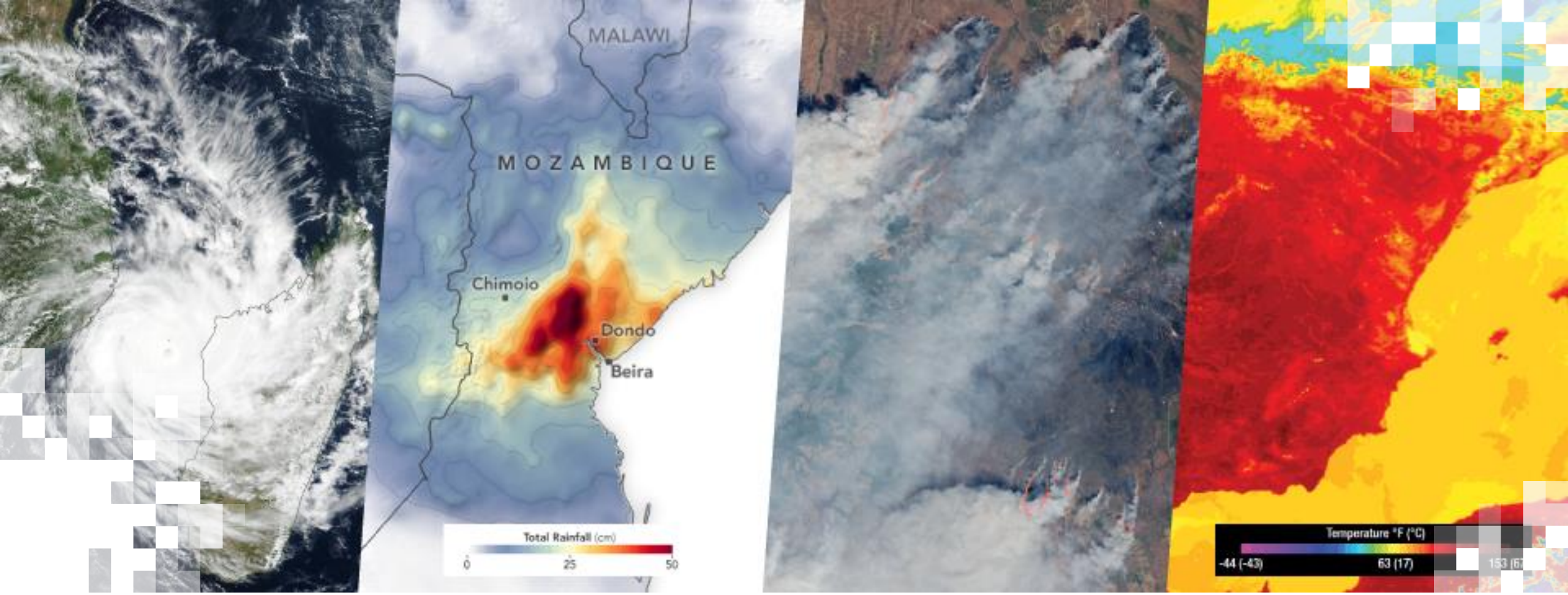
SLOSH: Sea Lake and Overland Surge from Hurricanes

SMAP: Soil Moisture Active Passive

SRTM: Shuttle Radar Topography Mission

TMPA: TRMM Multi-satellite Precipitation Analysis

TRMM: Tropical Rainfall Measuring Mission



Socioeconomic Data Relevant for Disaster Risk Assessment

Dr. Susana Adamo, CIESIN, Columbia University

Coming up Next Week -

- DRA from past earth observations
- DRA in near real-time and from10-day forecast