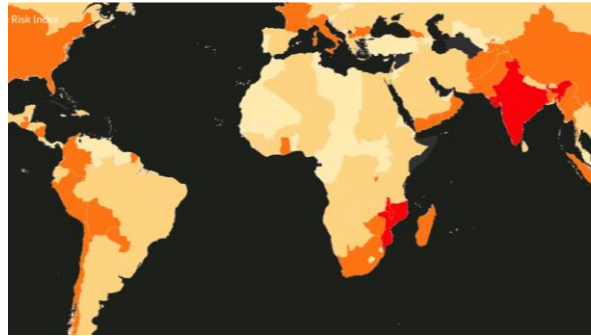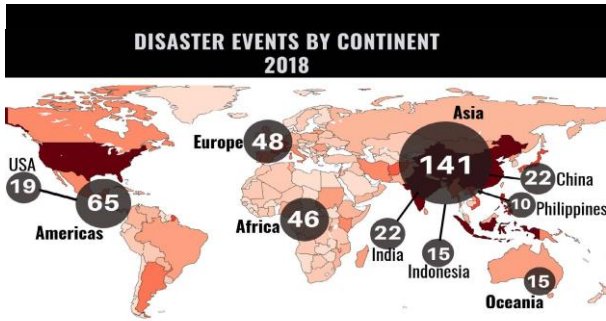# Earth Observations for Disaster Risk Assessment and Resilience

Amita Mehta and Sean McCartney

8 August 2019

Training Outline

Aug 6, 2019

NASA Remote Sensing and Socioeconomic Data for Disaster Risk Assessment

Aug 8, 2019

Assessing the Risk of Floods & Cyclones Using NASA Data

Aug 13, 2019

Disaster Risk Assessment Case Studies Using Remote Sensing Data

Aug 15, 2019

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 from Parts 2 & 4 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-2 Outline

- Examples of Hazard Assessment from Past Data for Disaster Risk Assessment (DRA)
- Demonstrations:
  - Past Earth Observations to Assess Hazard Information
  - Application of Past Hazard Information for Near Real-time and Future DRA
- Case Studies:
  - i.   Cyclones over Mozambique
 - ii. Extreme Rain over Houston

DRA Requires Hazard Assessment

- 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

DRA Requires Exposure Information with Hazard Assessment

- 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
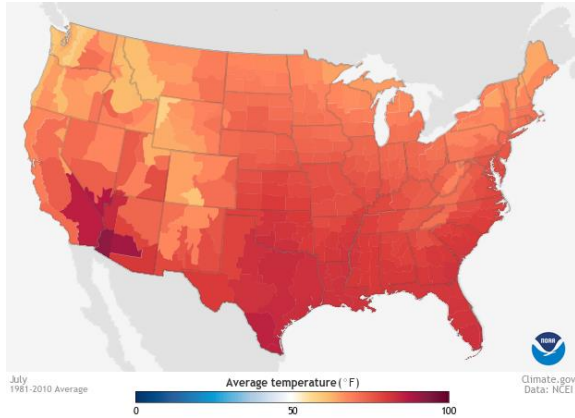
Text Credit: UNISDR
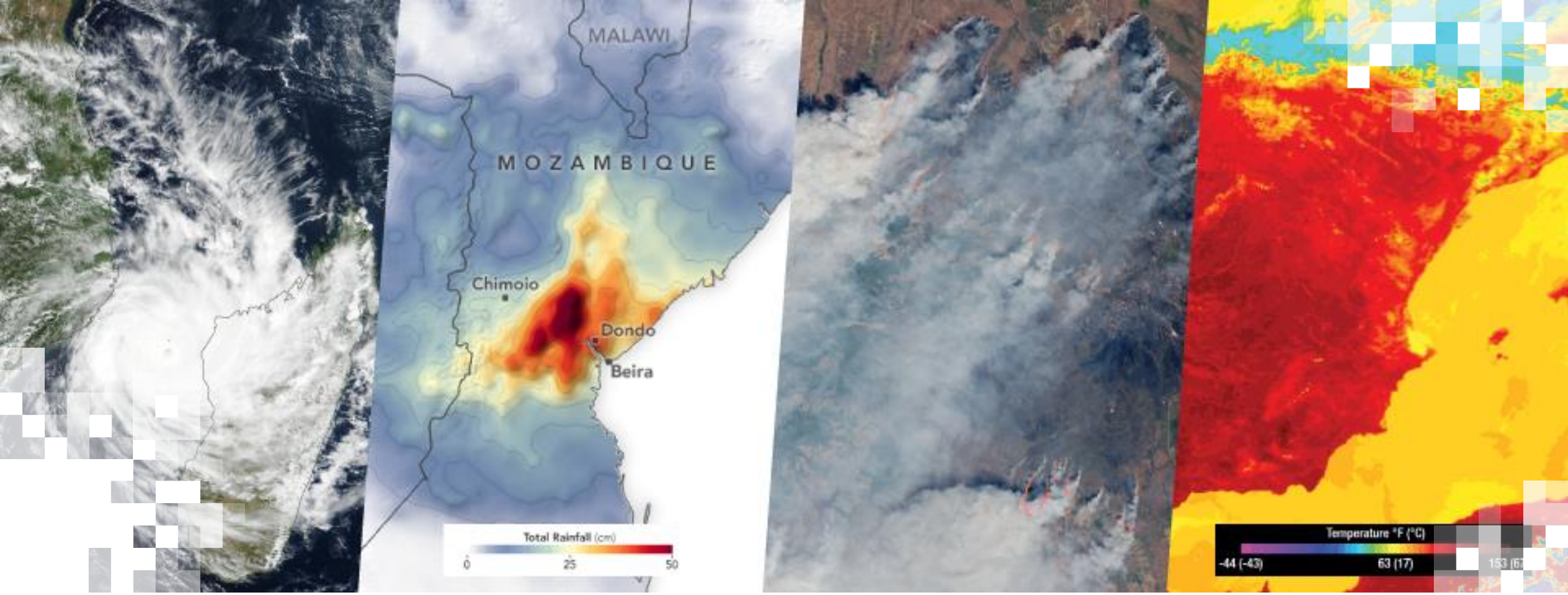
Examples of Hazard Assessment from Past Data for Disaster Risk Assessment
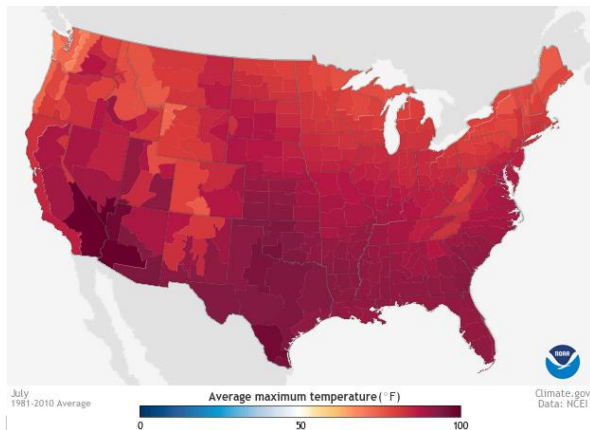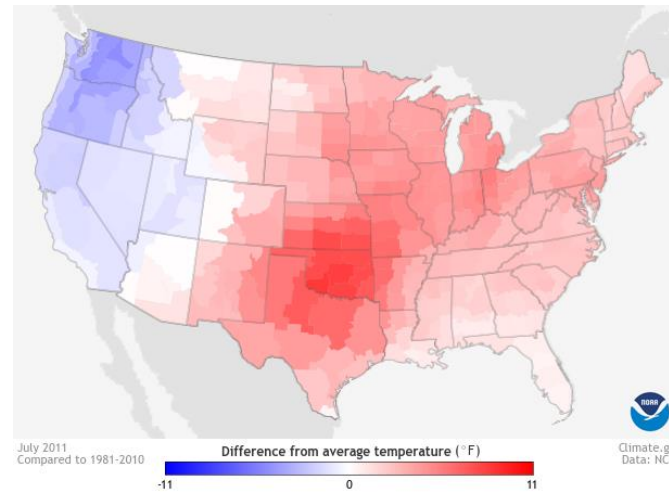
Hazard Assessment from Past Data: Extreme Temperatures
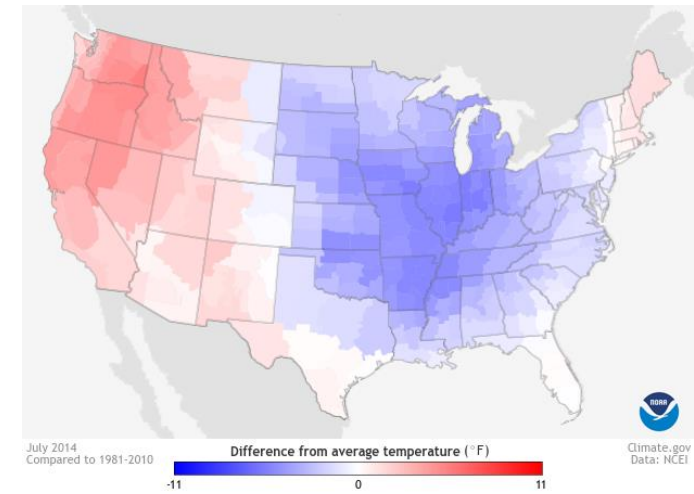
July Mean (1981-2010)

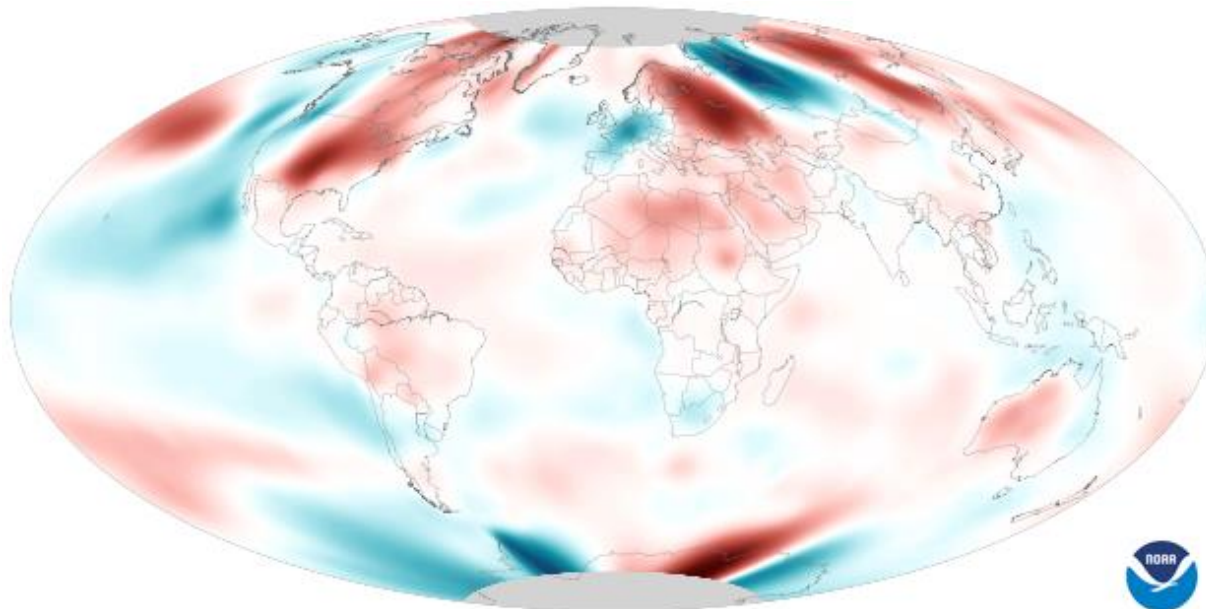July Max (1981-2010)

July 2011

July 2014

-------- Departure from 30-year Mean ------
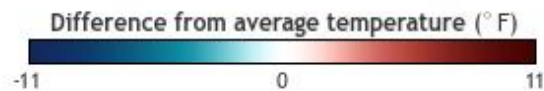
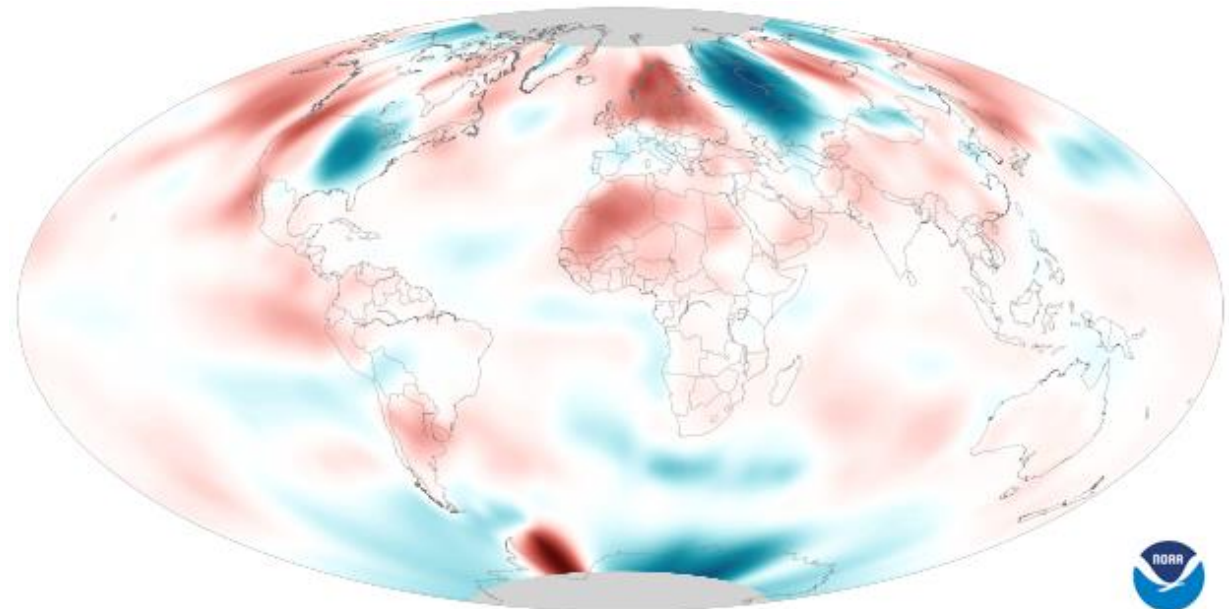# Hazard Assessment from Past Data: Extreme Temperatures

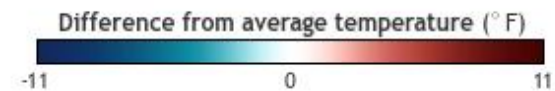July 2011   July 2014

July 2011
Compared to 1981-2010

Difference from average temperature (° F)

-11   0   11

NOAA NNVL
Data: NCEI

July 2014
Compared to 1981-2010

Difference from average temperature (° F)

-11   0   11

NOAA NNVL
Data: NCEI

-------- Departure from 30-year Mean (1981-2010) ------

Hazard Assessment from Past Data: Precipitation

https://www.climate.gov/maps-data

July Mean (1981-2010)　　　　　July 2011　　　　　July 2015
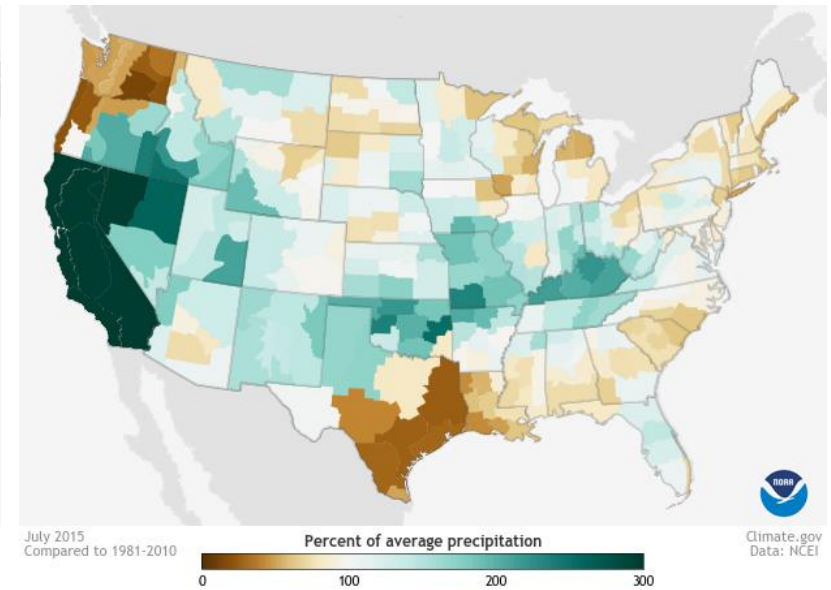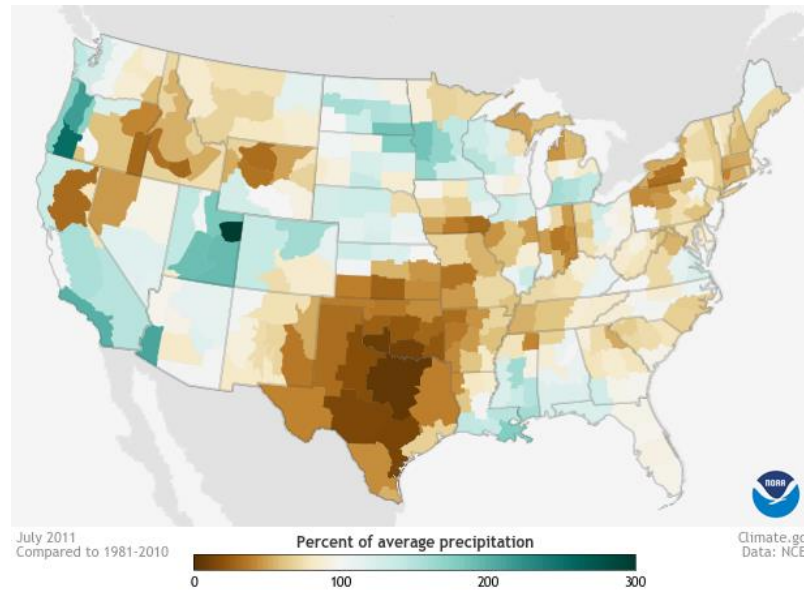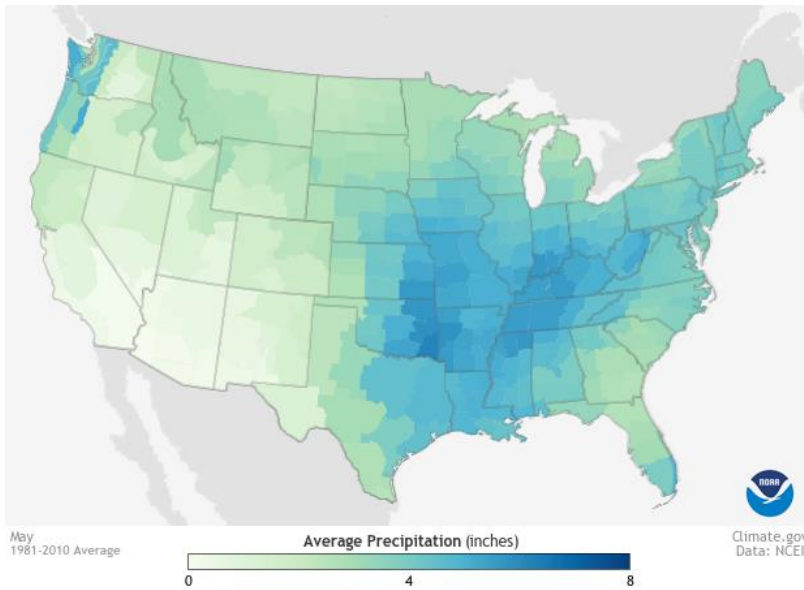
--------- Difference from 30-year Mean % -----

Hazard Assessment from Past Data: Hurricane

https://www.nhc.noaa.gov/climo/#cp100
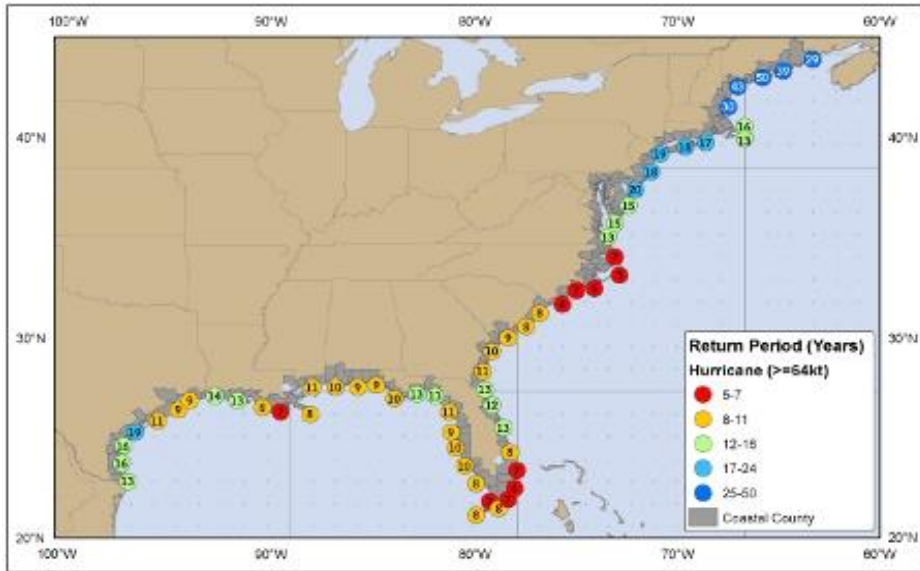
Estimated return period in years for hurricanes passing within 50 nautical miles of various locations on the U.S. coast
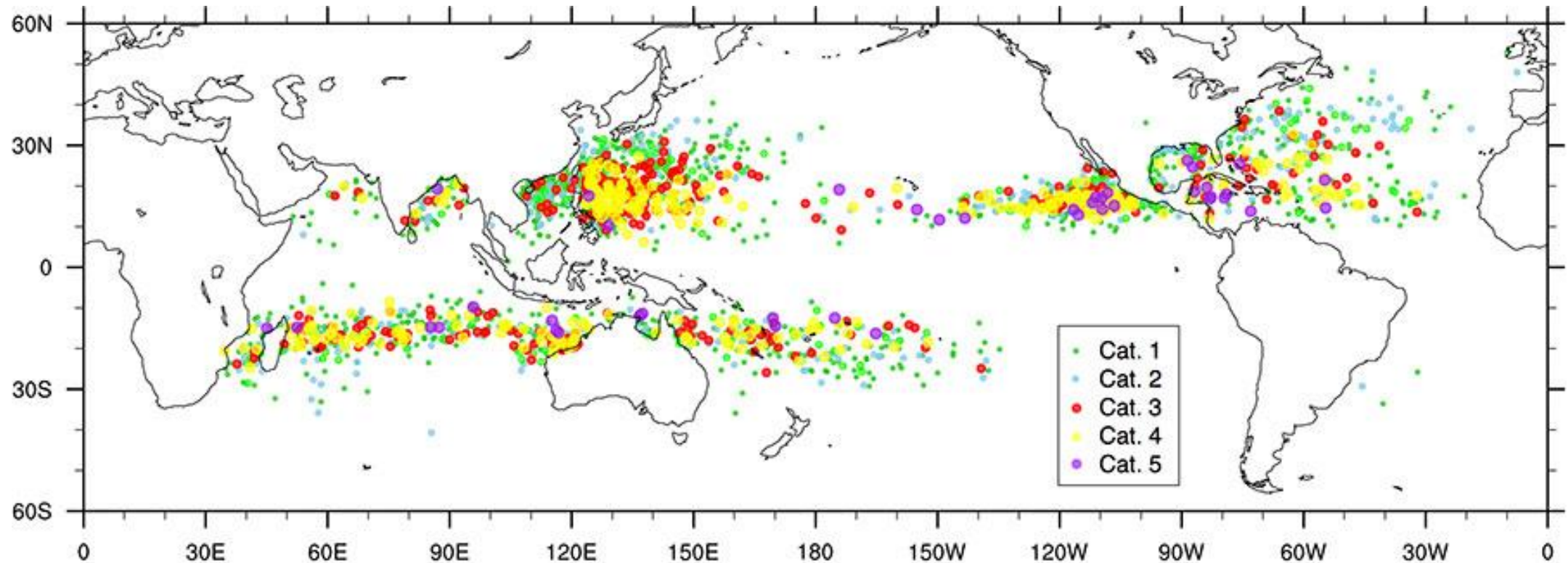

1950 - 2017 CONUS Hurricane Strikes
(Courtesy of NCEI)

1900-2010
U.S. Hurricane Strikes
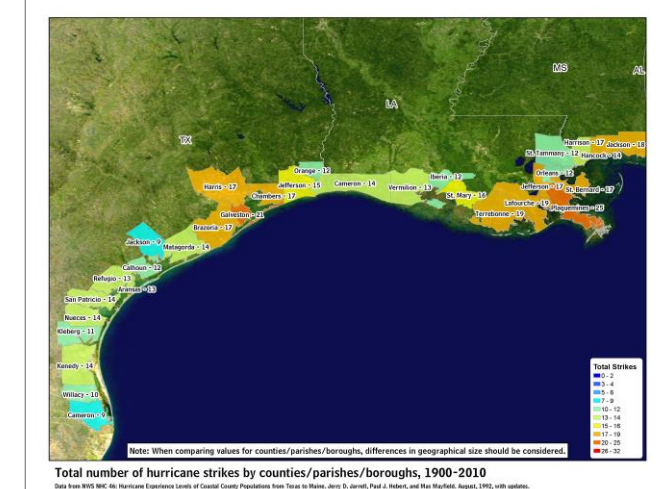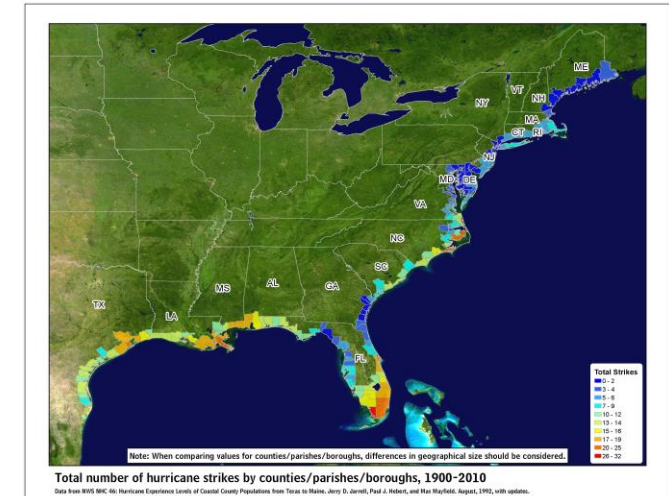
# Hazard Assessment from Past Data: Tropical Cyclones

The locations of lifetime maximum intensities (LMI) of tropical cyclones for the period 1985 – 2014. LMI is color-coded according to category on the Saffir-Simpson Hurricane Wind Scale.

Hazard Assessment from Past Data: Flooding

Global Flood Hazard Distribution

Flood Hazard
Deciles
1st – 4th
5th – 7th
8th – 10th

Projection: Robinson
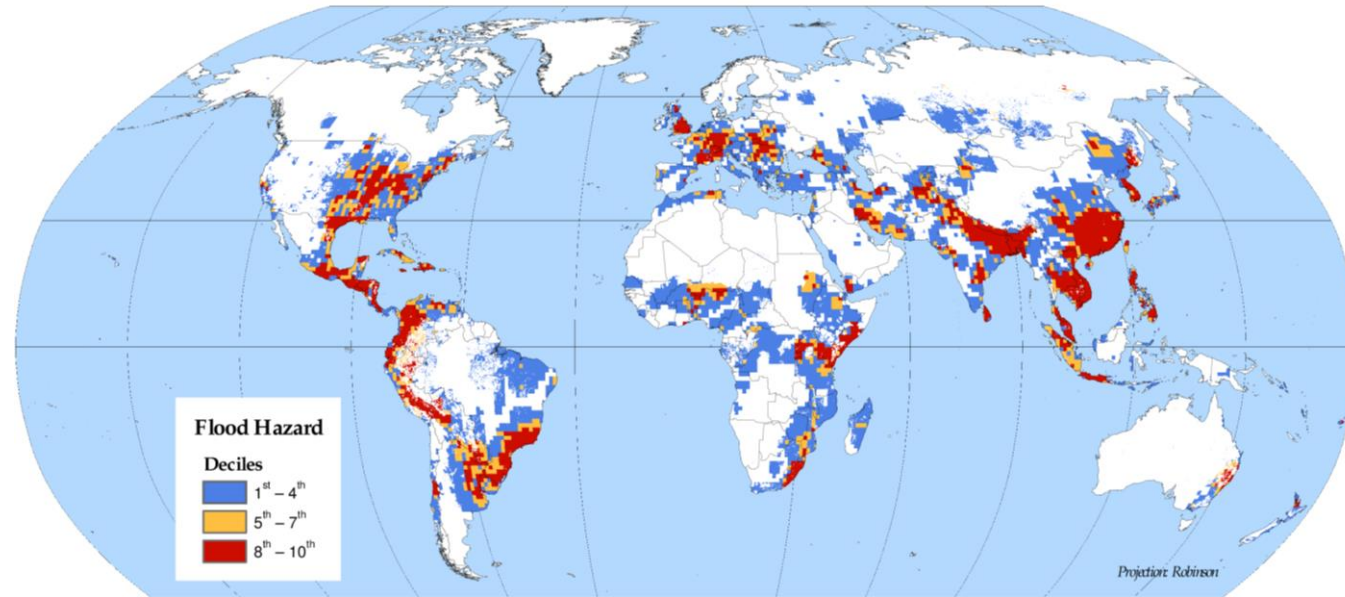
The data set comes from the Dartmouth Flood Observatory's global listing of extreme flood events compiled from various sources for the 19-year period from 1985 – 2003. Some flooding is evident in more than one-third of the world's land area.

Reference: Dilley, M., R.S. Chen, U. Deichmann, A.L. Lerner-Lam, M. Arnold, J. Agwe, P. Buys, O. Kjekstad, B. Lyon, and G. Yetman. 2005. *Natural Disaster Hotspots: A Global Risk Analysis*. Washington, D.C.: World Bank. https://doi.org/10.1596/0-8213-5930-4.

DRA Based on Hazard and Exposure & Vulnerability Data

- Disaster Risk Assessment (DRA) depends on disaster type, geographical area, and socioeconomic conditions

- There is no unique methodology to derive local and regional disaster risk, various data sources and statistical/empirical techniques are generally used

- This session provides a possible methodology to assess hazard frequency and intensity together with exposure data for Disaster Risk Assessment (DRA) to plan for Disaster Risk Reduction (DRR)

- Additional data and quantitative analysis may be required for more accurate DRA

Past Earth Observations for Hazard Assessment

Cyclone Risk Assessment

- Information useful for hazard assessment:
  - Frequency
  - Magnitude (Intensity, Category): Winds, Rain, Sea Level Pressure
- Cyclone/Hurricane frequency :
  - https://coast.noaa.gov/hurricanes/
  - https://www.metoc.navy.mil/jtwc/jtwc.html?best-tracks
- NASA data useful for cyclone intensity assessment:
  - Tropical Rainfall Measuring Mission (TRMM) Multi-satellite Precipitation Analysis (TMPA)
  - Integrated Multi-satellitE Retrievals for GPM (Global Precipitation Measurement) (IMERG)
  - MERRA-2: Modern-Era Retrospective Analysis for Research and Applications, Version 2
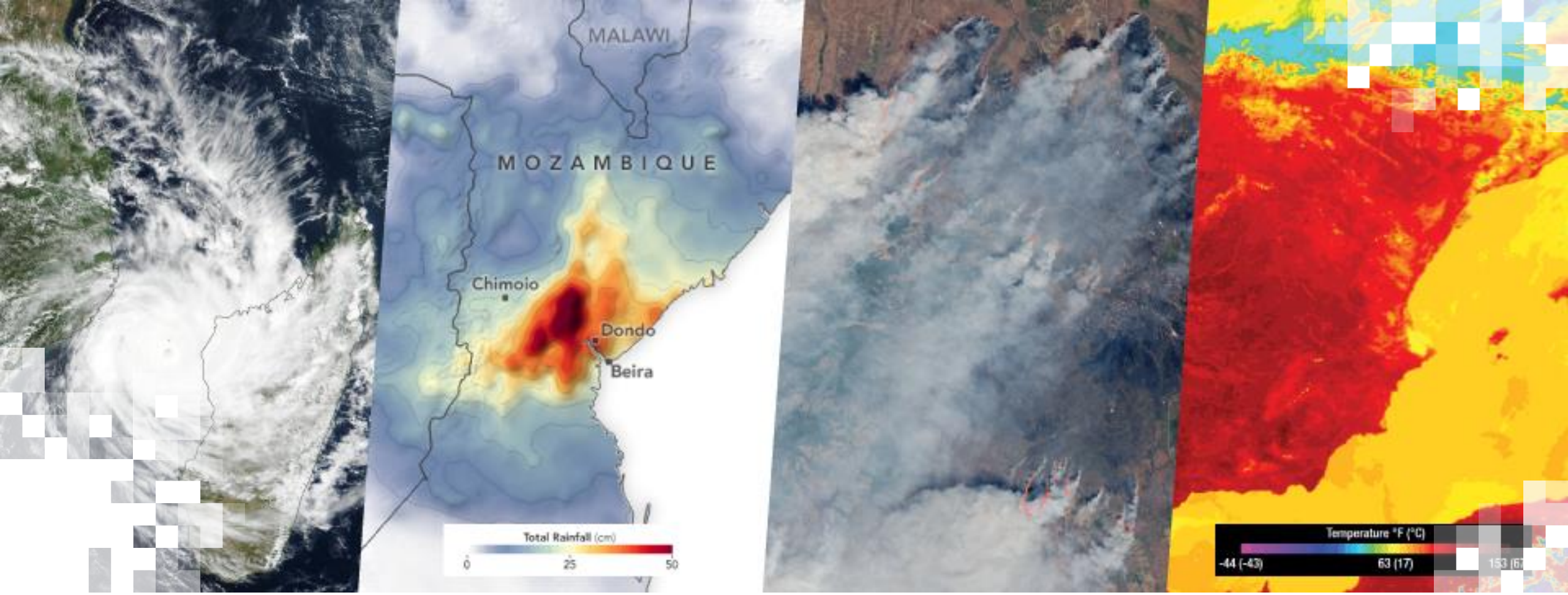
Extreme Rain Risk Assessment

- Information useful for hazard assessment:
  - Frequency
  - Magnitude
  - Rain Rate Distribution
  - Spatial Extent
- NASA data useful for extreme rain assessment:
  - Tropical Rainfall Measuring Mission (TRMM) Multi-satellite Precipitation Analysis (TMPA)
  - Integrated Multi-satellitE Retrievals for GPM (Global Precipitation Measurement) (IMERG)

Cyclone and Extreme Rain Exposure Data for DRA

Exposure Data from SEDAC (https://sedac.ciesin.columbia.edu/):

- Human Population
  - https://sedac.ciesin.columbia.edu/data/collection/gpw-v4
  - https://sedac.ciesin.columbia.edu/data/set/gpw-v4-basic-demographic-characteristics-rev11
  - https://sedac.ciesin.columbia.edu/data/set/povmap-global-subnational-infant-mortality-rates-v2

- Roads and Infrastructure
  - https://sedac.ciesin.columbia.edu/data/set/groads-global-roads-open-access-v1

- Coastal Zones
  - https://sedac.ciesin.columbia.edu/data/set/gpw-v3-coastlines

- Human Settlement and Urban Impermeable Surface
  - https://sedac.ciesin.columbia.edu/data/set/ulandsat-gmis-v1/data-download

Application of Past Hazard Information for Near Real-Time and Future Disaster Risk Assessment

Near Real-Time and Future Disaster Risk Assessment

- Cyclone Forecast:
  - National Hurricane Center (https://www.nhc.noaa.gov/)
  - Joint Typhoon Warning Center (https://www.metoc.navy.mil/jtwc/jtwc.html)
  - Global Disaster Alert and Coordination System (http://www.gdacs.org/)
- NASA Near Real-Time Rainfall
  - https://pmm.nasa.gov/gpm/imerg-global-image
- NASA Rainfall and Wind 10-day Forecast
  - Goddard Earth Observing System Version 5 (GEOS-5)
  - https://gmao.gsfc.nasa.gov/GEOS/

Demonstration: Past, Near Real-Time, and Forecast DRA

We will use the following data and open source software:

- TMPA, IMERG, and MERRA-2: https://giovanni.gsfc.nasa.gov/giovanni/

  https://disc.gsfc.nasa.gov/

- GEOS-5: https://fluid.nccs.nasa.gov/weather/

- Exposure: https://sedac.ciesin.columbia.edu/

- QGIS: https://qgis.org/en/site/

- Microsoft Excel or Open Office: https://www.openoffice.org/

Coming Up Next Week:

Disaster Risk Assessment Case Studies Using Remote Sensing Data:

1. Heat wave risk assessment using Earth observations in New York state

2. Web-based DRA tools from World Resources Institute (WRI)

Thank You!