Earth Observations for Informing Disaster Risk and Response to Drought, Wildfire, and Flooding in Mexico

Overview of Flood Monitoring Tools

May 9, 2023

Objectives

By the end of this presentation, you will be familiar with remote sensing-based web-tools useful for flood monitoring and management.

For details see:
https://appliedsciences.nasa.gov/join-mission/training/english/arset-monitoring-and-modeling-floods-using-earth-observations

Outline

- Overview of flood monitoring and modeling techniques
- Flood monitoring tools based on remote sensing
- Demonstration of the flood monitoring tools

Overview of Flood Monitoring and Modeling Techniques

About Floods

https://www.ready.gov/floods

- Flooding is a temporary overflow of water onto land that is normally dry.
  - The most common disaster affecting human lives
  - Can cause infrastructure damage & power outages
  - Disrupts transportation
  - Creates landslides

  About six inches (15 cm) of moving water can knock a person down, and one foot (30 cm) of moving water can sweep a vehicle away!

Flood Monitoring and Management

- Requires geophysical and socioeconomic data:
  - Floodplain map: terrain, Digital Elevation Model, low-lying areas
  - Precipitation intensity, frequency
  - River stage, streamflow, inundation
  - Coastal surges and inundation
  - Land use change: exposed soil versus built-up areas, soil moisture
  - Population, infrastructure, drainage, and storm water system capacity (for urban floods)
  - Flood return period
  - Hydrology and routing model

https://appliedsciences.nasa.gov/join-mission/training/english/arset-monitoring-urban-floods-using-remote-sensing

Remote Sensing-Based Flood Detection

There are several approaches to using remote sensing observations for flood monitoring:

- Detecting flood water on previously dry land surfaces using satellite-derived land cover observations
- Hydrology models that derive streamflow and runoff using precipitation and weather data from satellites and models
- Inferring flooding conditions using satellite-derived precipitation rate and amount and soil moisture conditions using statistical methodology

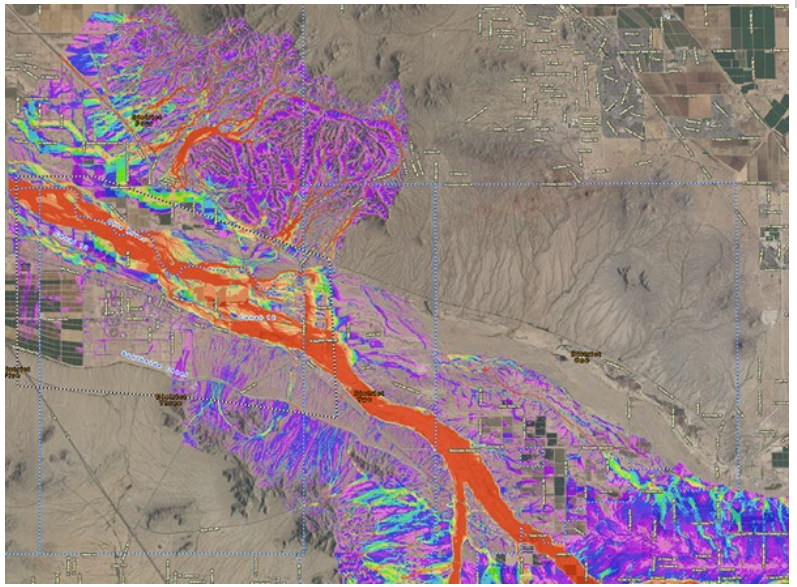
Note: Each flooding approach also uses model and/or surface-based data in addition to satellite data.

Flood Modeling Techniques

Two broad groups of flood modeling approaches:

- Empirical and statistical models based on observations, including remote sensing.
- Hydrodynamic models with 1-, 2-, or 3-dimensional representation of water flow in an open or closed channel.
  - Hydrologic and Hydraulic models

Tenh et al., 2017: https://doi.org/10.1016/j.envsoft.2017.01.006

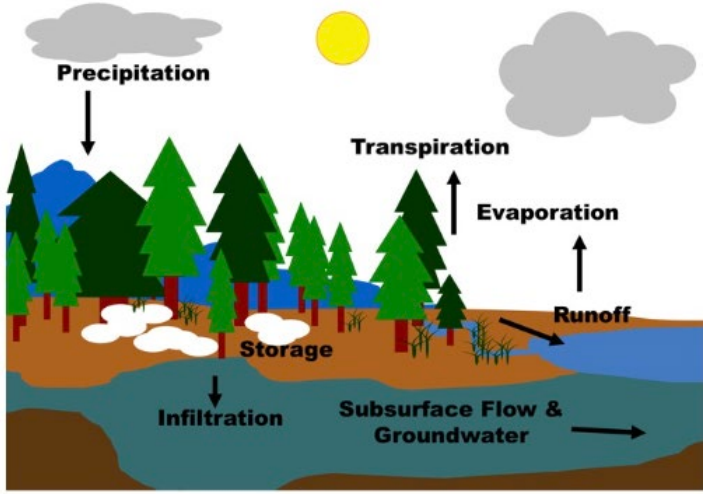


Flood modeling and management use hydrologic, hydraulic, and sediment transport modeling and analyses.

http://www.helm.world/hydrology-hydraulics.html

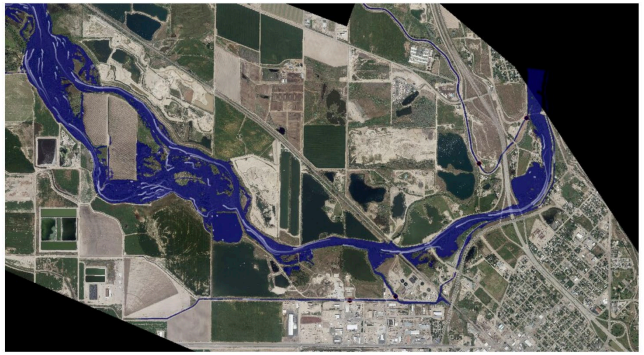
Hydrologic and Hydraulic Flood Modeling

- **Hydrologic Models**: Circulation of water through the hydrologic cycle and quantification of runoff flow produced by precipitation. It deals with precipitation, evaporation, infiltration, groundwater flow, surface runoff, and streamflow.



https://ncar.github.io/hydrology/projects/hydrologic_modeling

- **Hydraulics Models**: The mechanical behavior of water in open or closed channels. It provides water flow and depth as water moves from one point to the next in a channel.



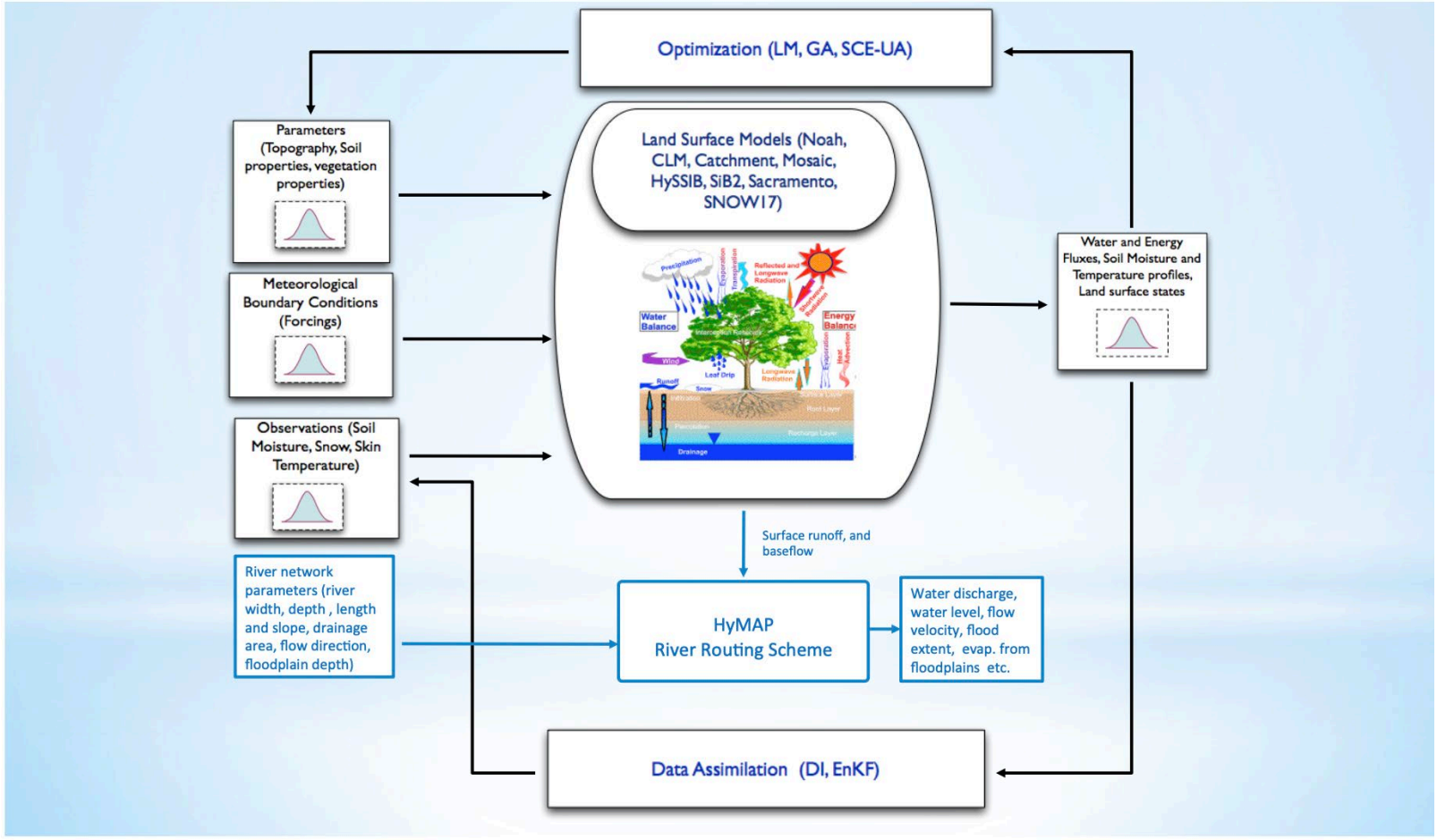
boise river 2d modelling software

https://dudek.com/do-you-know-the-difference-between-hydrology-and-hydraulics/

https://www.nww.usace.army.mil/Media/Images/igphoto/2002565818/

NASA Land Information System and HyMAP Routing Model

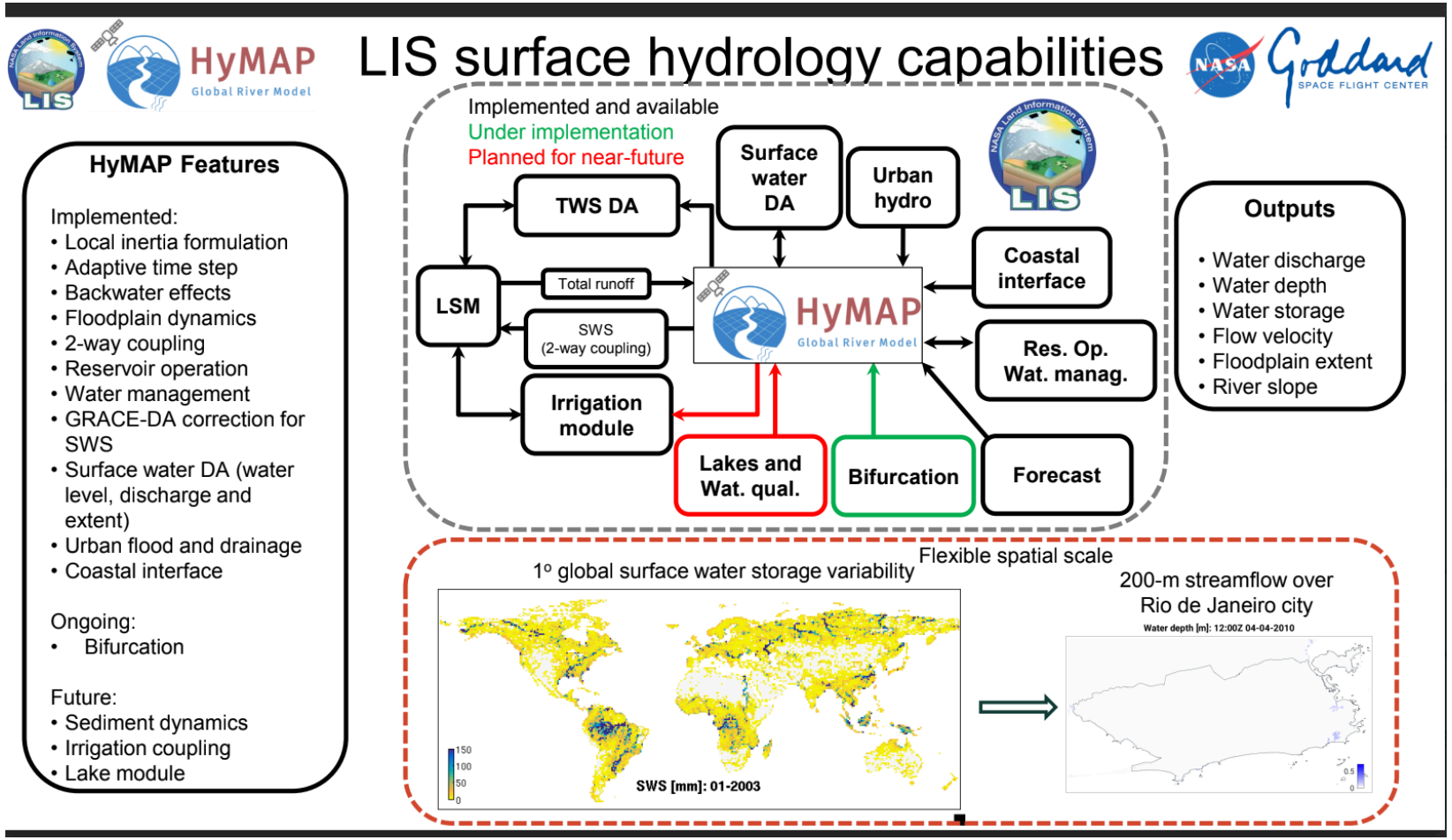
https://lis.gsfc.nasa.gov/software/lis



https://ldas.gsfc.nasa.gov/sites/default/files/ldas/nldas/presentations/Getirana_NLDAS_HyMAP_10Nov2016.pdf

NASA Land Information System and HyMAP Routing Model

https://lis.gsfc.nasa.gov/software/lis



From A. Getirana, SAIC, NASA-GSFC

Flood Modeling

- Both hydrologic and hydraulic modeling are required for flood mapping and flood risk mapping at watershed level.
- Remote sensing observations are routinely used for inputs:
  - Weather and precipitation data
  - Digital elevation
  - Land cover
- Calibration of flood model parameters is necessary and is performed using historic floods on stream reaches where discharge, flood flow, and elevation data are available.

- NASA Earth observations used for flood monitoring, mapping, and modeling from:
  - MODIS
  - Landsat
  - GPM
  - SRTM
  - SMAP
  - Sentinel-1and -2 (ESA)

Munawar et al. 2022: Remote Sensing Methods for Flood Prediction: A Review, Sensors (Basel). 2022 Jan 26;22(3):960. doi: 10.3390/s22030960. PMID: 35161706; PMCID: PMC8838435.

Flood Monitoring Tools Based on Remote Sensing

In this training we will focus on observation-based flood monitoring.

Flood Monitoring Tools

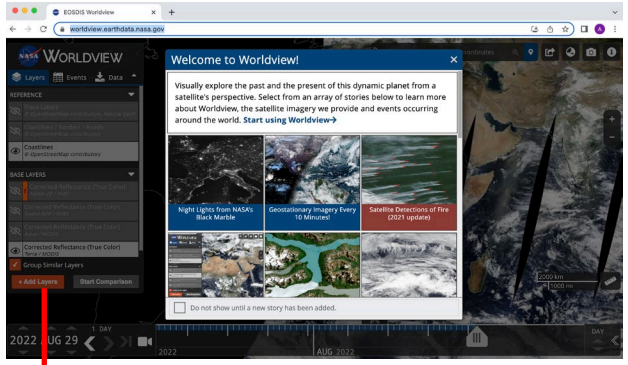
- [1]MODIS-Based Flood Mapping (NASA Worldview)
- [1]The Flood Observatory River Watch (DFO River Watch)
- [2]Global Disaster Alert and Coordination System (GDACS)

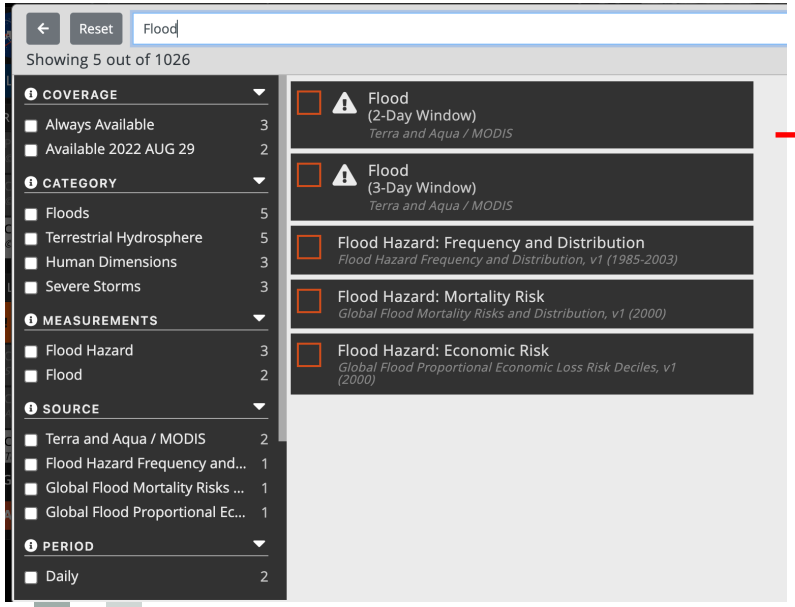
[1]https://appliedsciences.nasa.gov/join-mission/training/satellite-remote-sensing-flood-monitoring-and-management

[2]https://appliedsciences.nasa.gov/join-mission/training/english/arset-overview-global-disaster-alert-and-coordination-system-gdacs

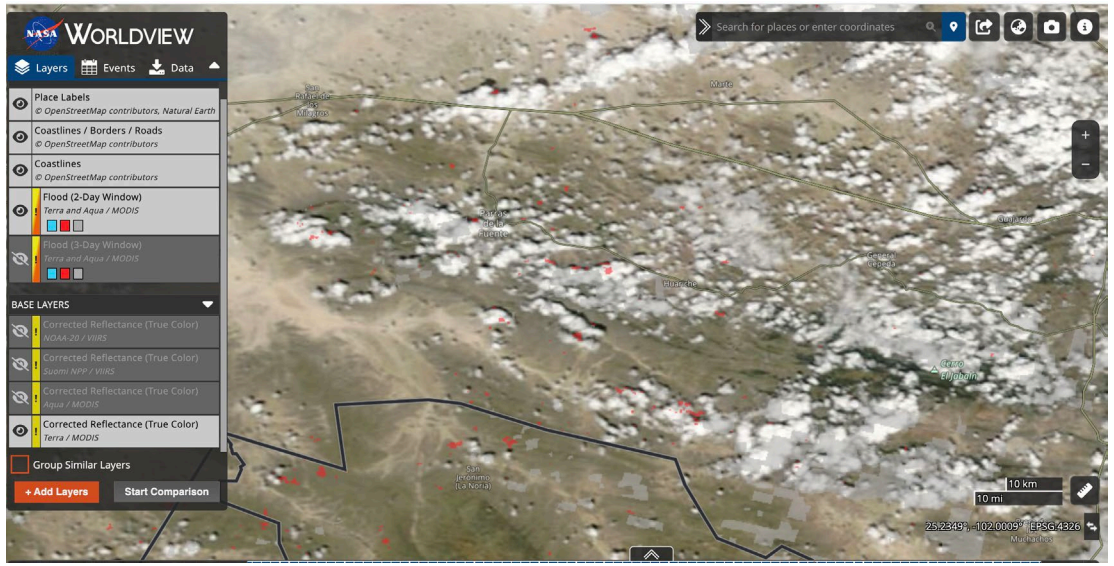
NASA Worldview

https://worldview.earthdata.nasa.gov/





2-Day Composite Flooding from MODIS



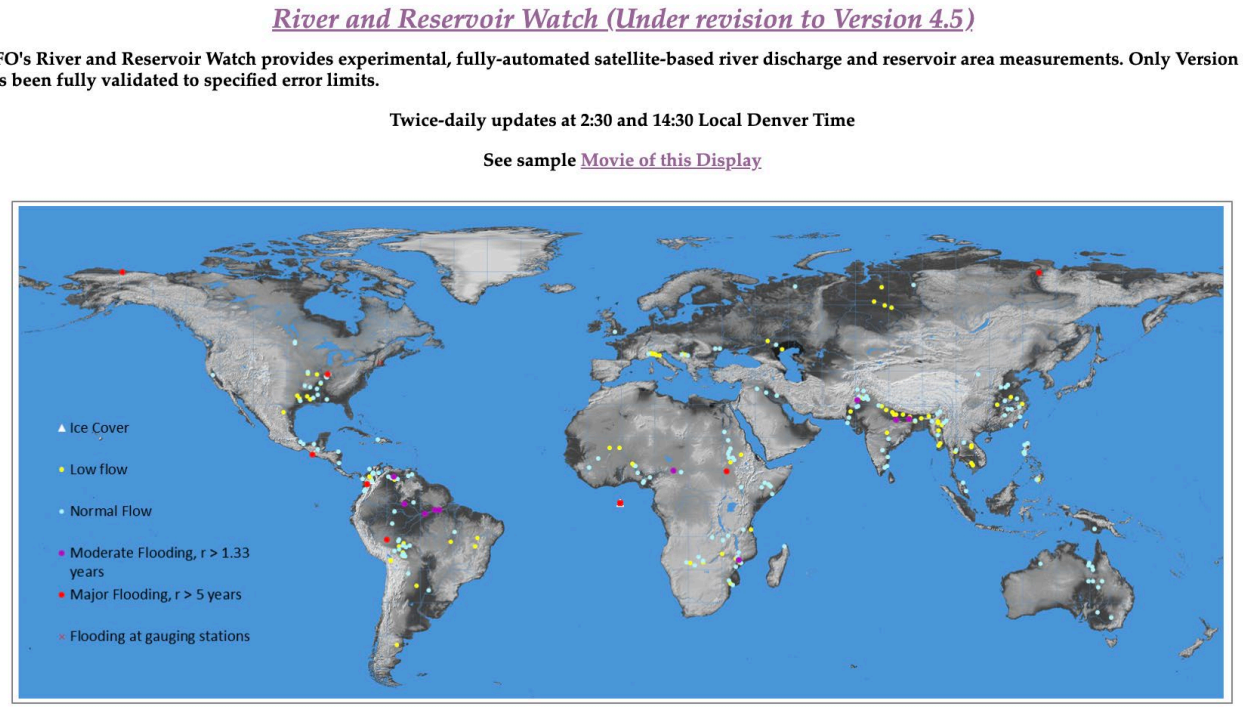
Replacing the MODIS NRT Flood Map Portal

https://floodmap.modaps.eosdis.nasa.gov/

Dartmouth Flood Observatory (DFO River Watch)

http://floodobservatory.colorado.edu/

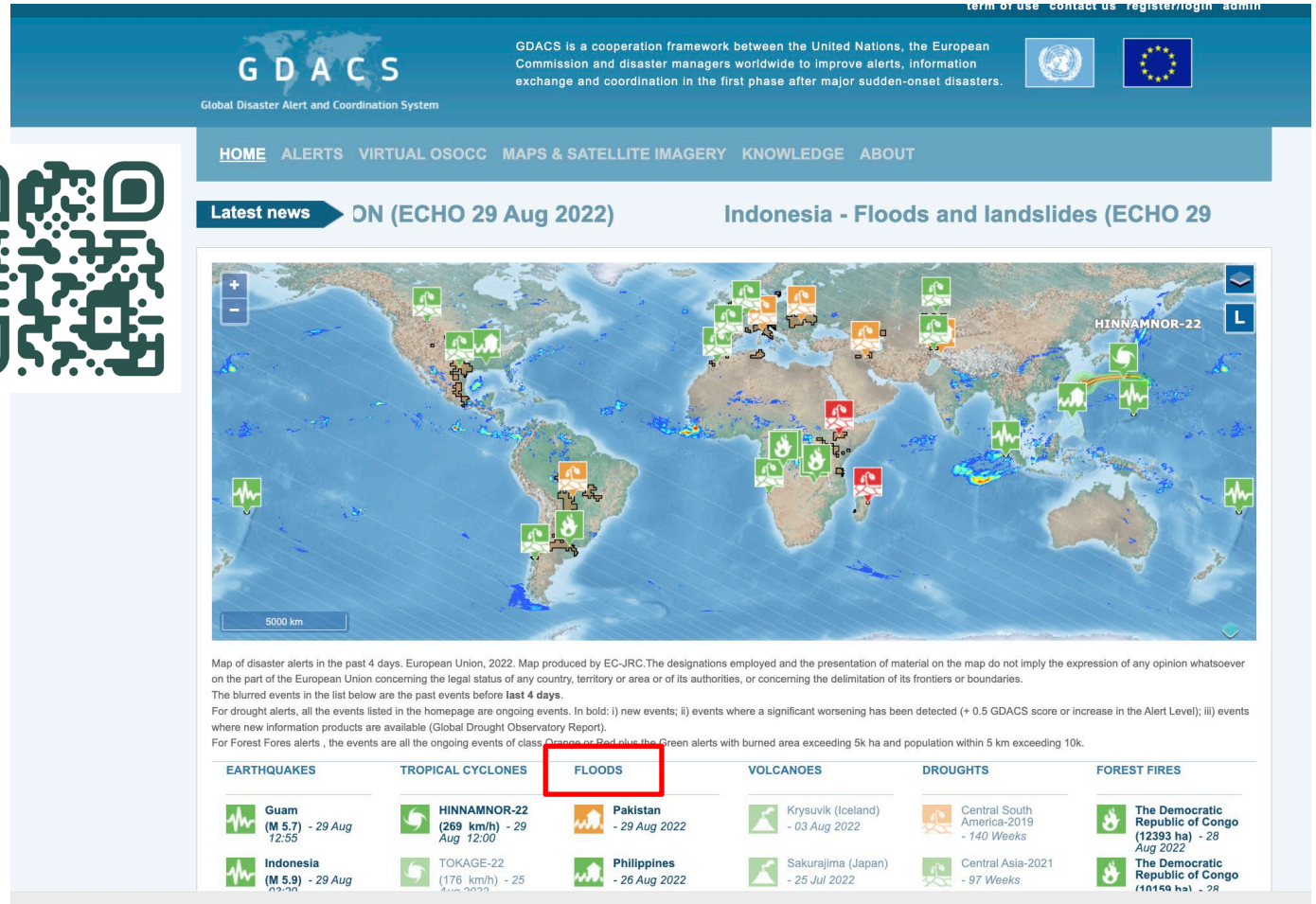
- Based on passive microwave observations and river gauge measurements.
- Currently, a new version and validation of river discharge methodology is underway.

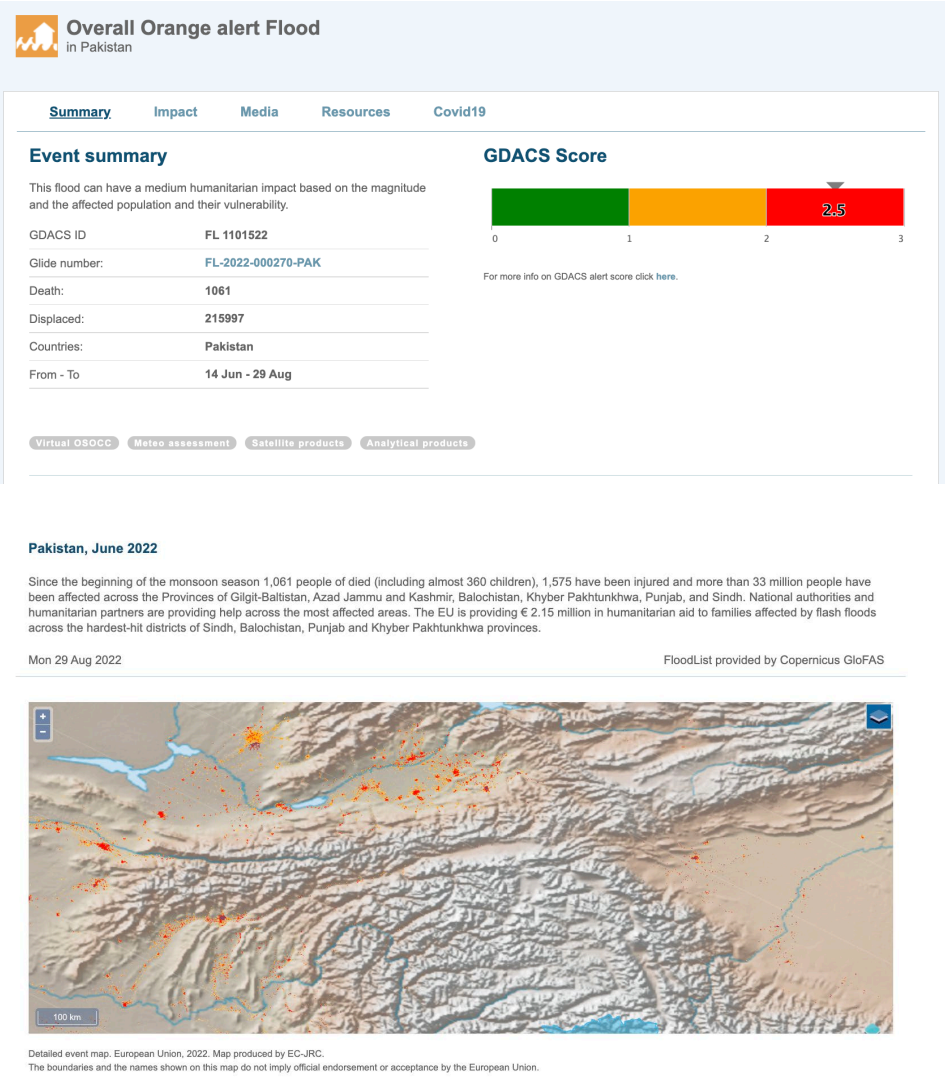


https://floodobservatory.colorado.edu/DischargeAccess.html

Global Disaster Alert and Coordination System (GDACS)

https://gdacs.org/





Demonstration: Flood Monitoring Tools


APPLIED REMOTE SENSING TRAINING PROGRAM
TRAIN - EMPOWER - ADVANCE

Thank You!