



Committee on Earth Observation Satellites

CEOS – Working Group on Disasters

GEO/LEO/SAR Flood Pilot Projects

Marcelo Uriburu Quirno (CONAE) - Presenter
Guy Schumann (RSS Hydro)
Mitch Goldberg (NOAA)

WGDisasters-18 Meeting

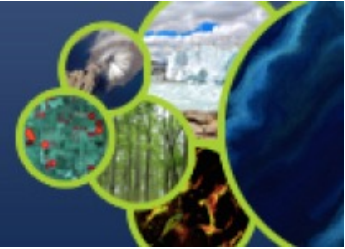
Nice, France

4 – 6 October 2022





Background



Initial Objective

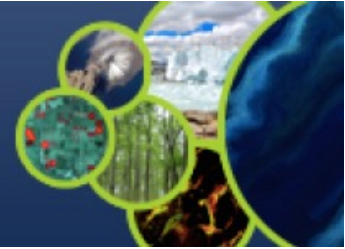
Flood Pilot Projects would explore and demonstrate best practices for combining diverse optical and SAR data to map floods

Report on best practices developed through integration of LEO-GEO and SAR.

Although this objective is still **relevant** and the motivations behind, fully **valid**, the plan for the Flood Pilot Projects is to **gradually** transition into exploring the use of satellite EO for **other aspects** of Flood Risk Assessment and Management



Permanent activities



Since March 2022

- 5 monthly meetings with members of the “Sub-groups”
- 2 coordination meetings
- Permanent e-mail exchange among the co-leads, for project coordination
- Interactions with other initiatives and WGs



Active Sub-groups (projects)



SG1: Red River of the North

Vince Decker, Natural Resources Canada

SG2: Bermejo and Pilcomayo Basins

Marcelo Uriburu Quirno, CONAE

SG3: Brahmaputra River and Mahanadi Delta

G S Rao, ISRO

SG4: Pearl River Basin

Weiyuan Yao, CAS

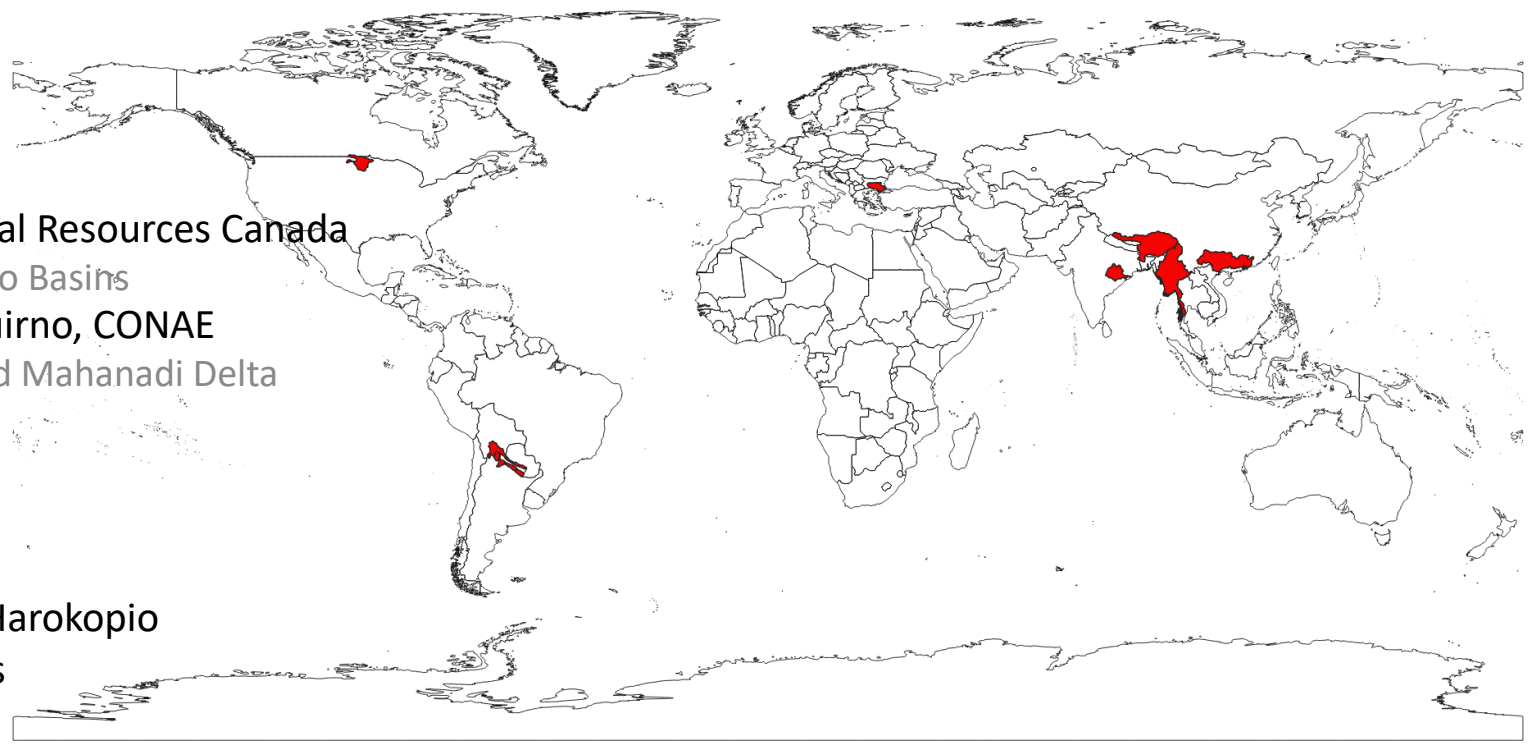
SG5: Balkans

Issaak Parcharidis, Harokopio

University of Athens

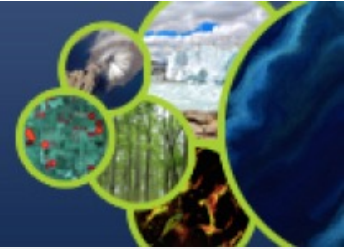
SG6: Myanmar

Patrick Matgen, LIST



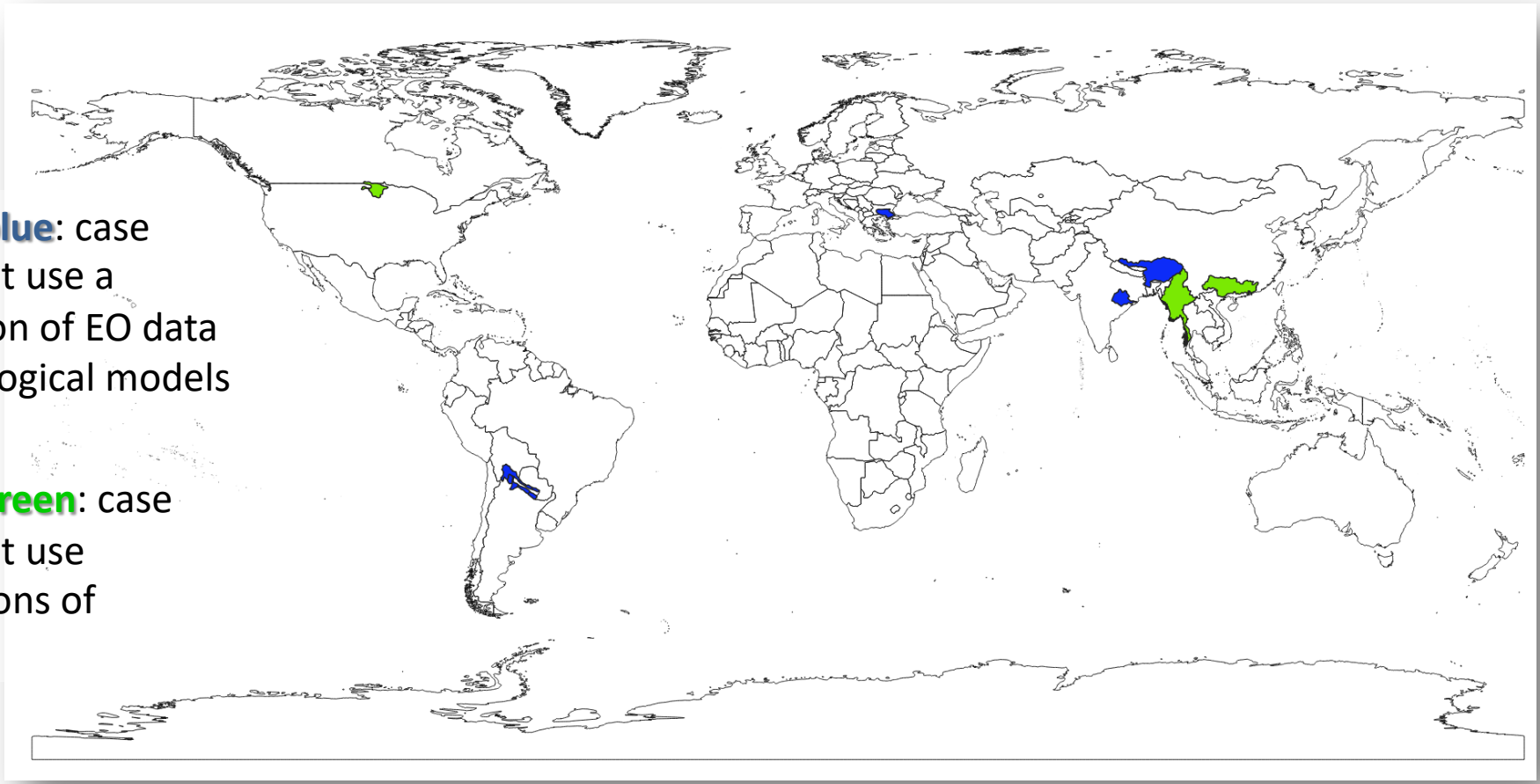


Active Sub-groups (projects) (2)



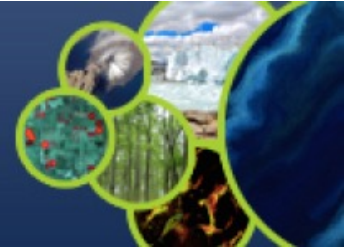
Basins in blue: case studies that use a combination of EO data and hydrological models

Basins in green: case studies that use constellations of satellites



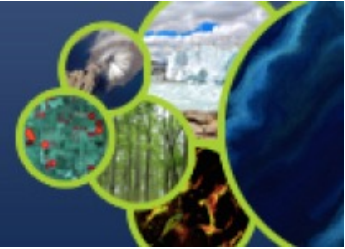


Summary of Sub-groups approaches



A broad variety of aspects have been covered, including:

- ML techniques for merging water fraction products,
- Downscaling DEMs to a finer detail,
- Merging GEO-LEO and SAR sources,
- Monitoring antecedent moisture conditions at basin level with satellite rainfall estimates,
- The infusion of satellite data to flood monitoring and warning systems, automated flood extent mapping systems.



- Probabilistic inundation maps, combining the results of hydrologic modelling with the inundation statistics based on a library of SAR imagery of events.
- SAR-based flood mapping methodology for flood extent, flood frequency, evolution, etc.
- Other effects that share the same forcing as floods have been covered: erosion and soil loss, landslide risks, etc.

Red River Flood

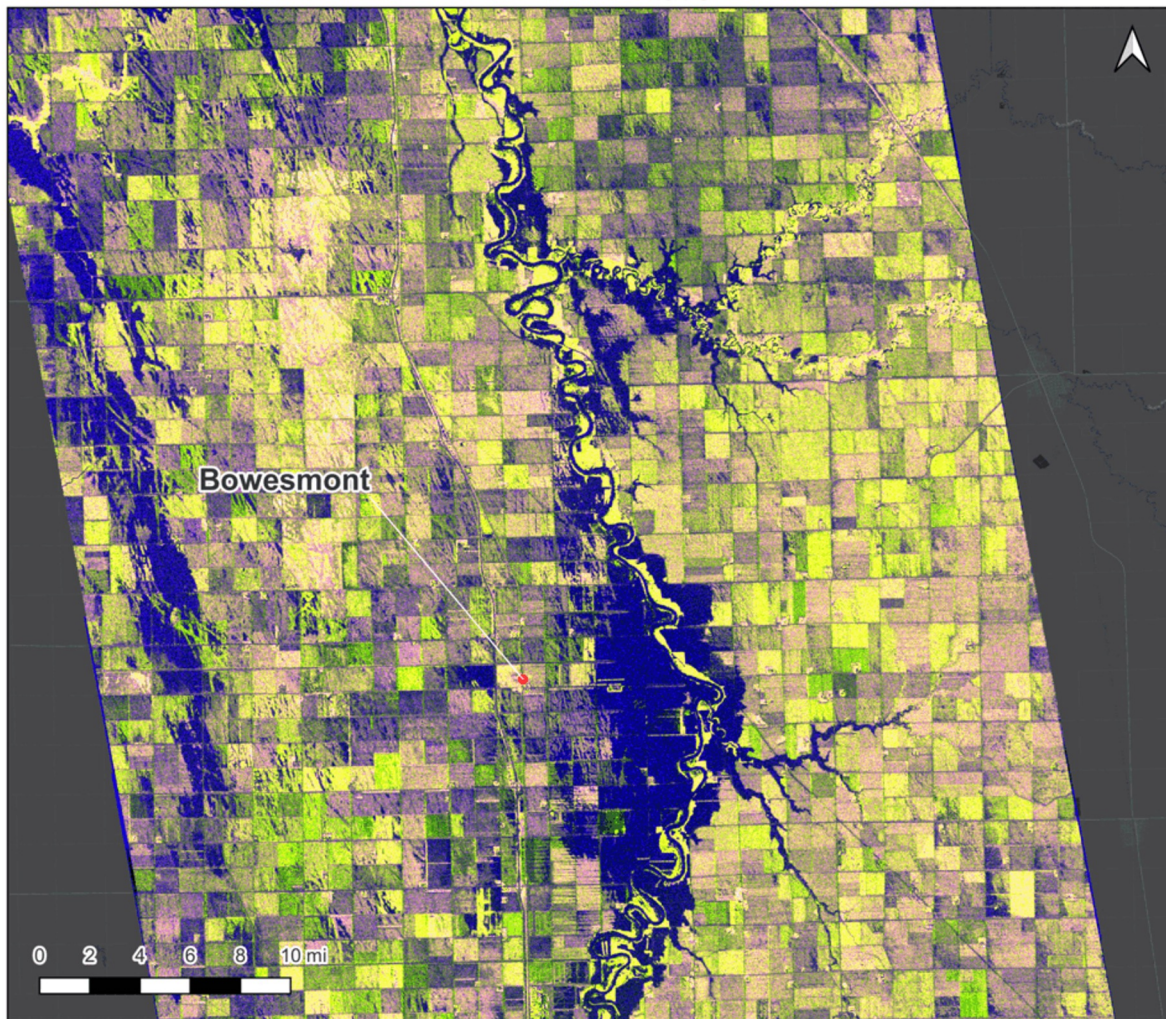
The Water Surface Quality (SAR) team has undertaken a major effort to develop a SAR inundation product

- The Red River has been getting 2x daily RCM coverage (5 meter resolution) since 4/30
- Best SAR coverage of any flooding event to date (ever)



Flood Inundation Mapping: National Water Center Remote Sensing

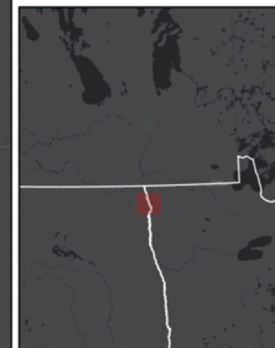
Radarsat Constellation Mission False Color RGB Image Valid: 2022-04-28 @ 00:29:12 UTC. (Red - HV; Green - HH; Blue - HV/HH Ratio)
NCRFC

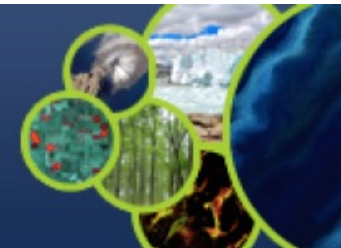


This loop contains false color RGB imagery created from Radarsat Constellation (RCM) imagery from April 28th, 2022 to corresponding RCM imagery from May 5th, 2022. The Blue/Darker Blue areas (depending on the image) depict areas of flooding advancing downstream on the Red River of the North near Bowsmont basins in Minnesota and North Dakota.

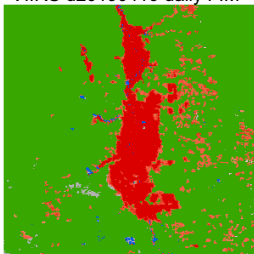


Radarsat Constellation imagery courtesy of the Government of Canada via cooperation with NOAA/NESDIS.





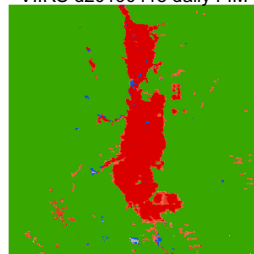
VIIRS d20190416 daily FIM



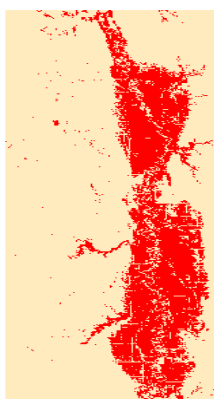
VIIRS d20190417 daily FIM



VIIRS d20190418 daily FIM



Landsat d20190422 FIM



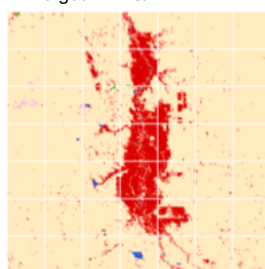
S1 d20190417 RAPID FIM



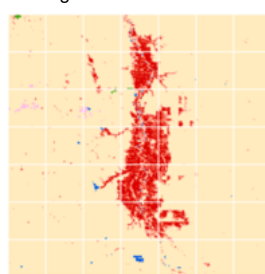
S1 d20190417 UNET FIM



Merged VIIRS/RAPID FIM



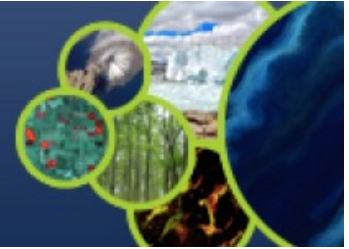
Merged VIIRS/UNET FIM



- NOAA is testing performance of 2 Machine Learning algorithms (Liu et al UNET, Shen et al RAPID) for flood detection in the Red River.
- UNET excludes “permanent” water from the flood prediction, while RAPID includes “permanent” water.
- The Sentinel 1b overpass on April 17 was cloudy preventing VIIRS observations, but VIIRS flood observations on April 16 & 18 were collected allowing for a general comparison. VIIRS is 375m resolution, while the SAR products are 30m resolution.
- The 30m Landsat observation on April 22, is the closest date to the SAR overpass. Conditions by that date show the migration of the water downstream (north) and may not be suitable for direct validation, but can be applied to understand ML algorithm differences.
- **More testing is needed, but for April 17, the RAPID algorithm appears better aligned with VIIRS and LandSat.**



Deliverable for Q4 2024 CEOS Work Plan 2022 – 2024

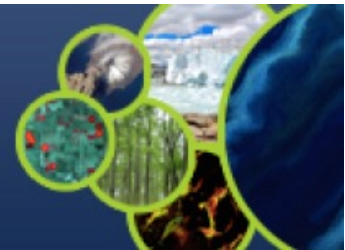


“Understanding Flood Risk from Space” (DIS - 22 - 01): Deliverable for Q4 2024

- Given the maturity achieved in applying flood mapping techniques with optical, SAR or their combination, next steps will include different aspects of flood risk (not just hazard but also exposure and vulnerability) to support flood risk management
- Report on best practices developed through integration of LEO-GEO and SAR
- Learn from organizations that use satellites for flood response/management (National Disaster Management Agencies, i.e., FEMA equivalent from different countries)
- Format TBD



Examples of recent uses of GEO/LEO/SAR

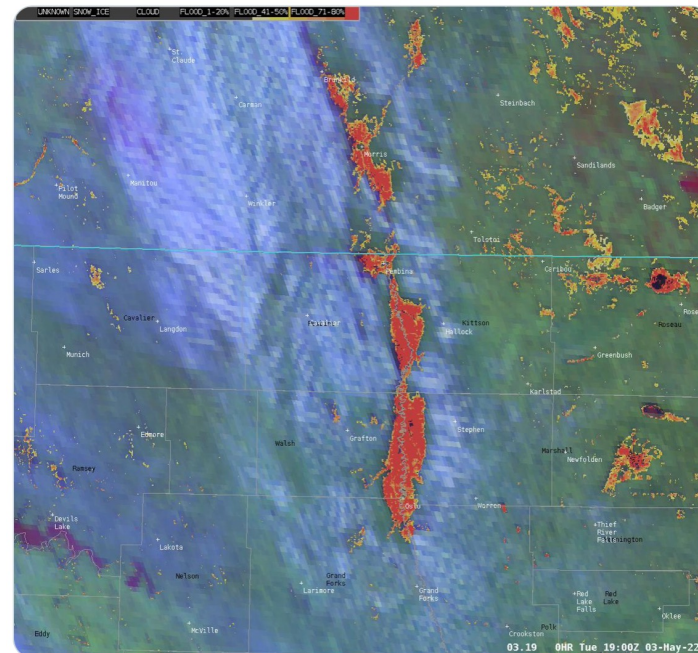


Lessons learned and interagency collaboration fostered by the flood pilots are benefiting services.

US National Weather Service used NOAA VIIRS flood maps to inform emergency managers

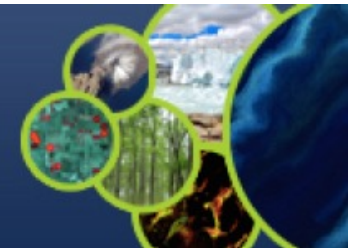


The yellow/orange coloring in this image denotes flood water detected by the VIIRS satellite instrument, in some locations around 8 miles wide!

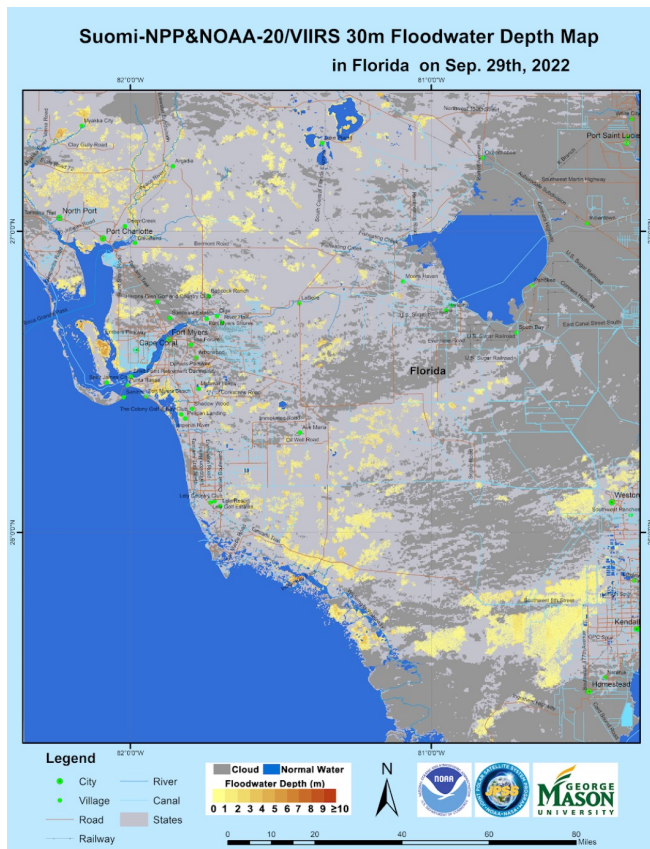




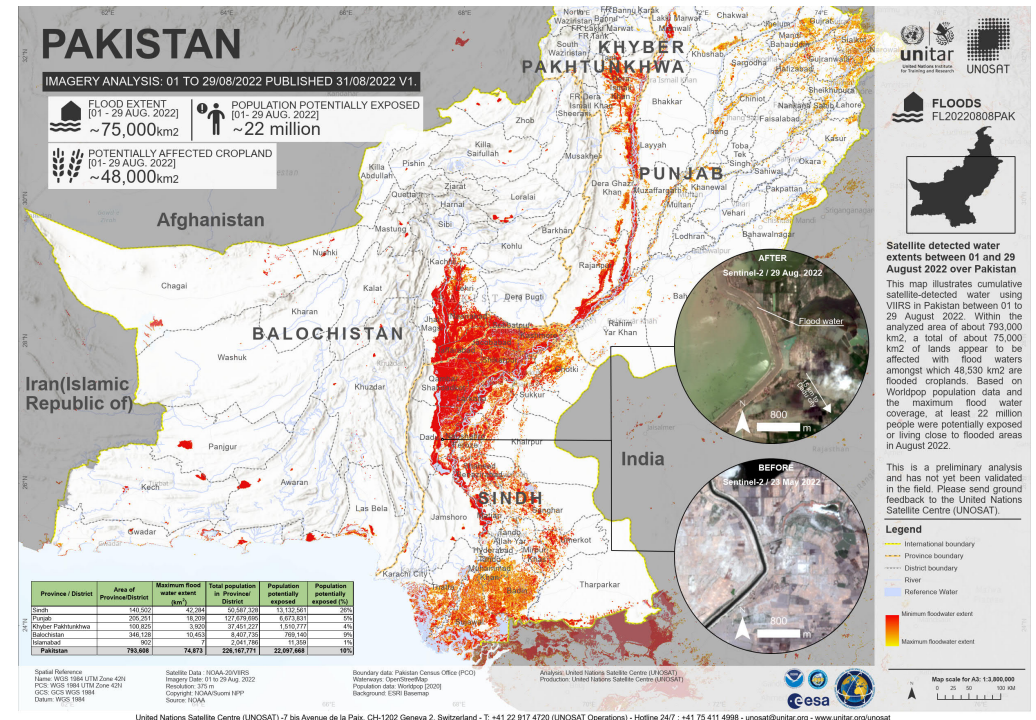
Examples of recent uses of GEO/LEO/SAR



Hurricane Ian - NOAA VIIRS Flood Depth Product Used by USA Federal Emergency Management Agency (FEMA)



UNITAR/UNOSAT translating VIIRS flood extent to impact populations

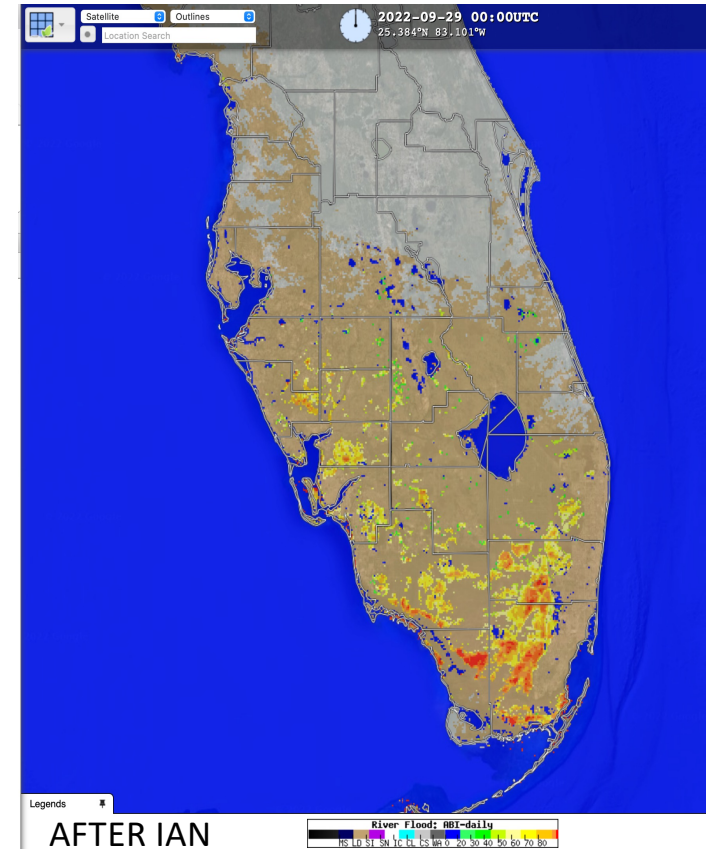
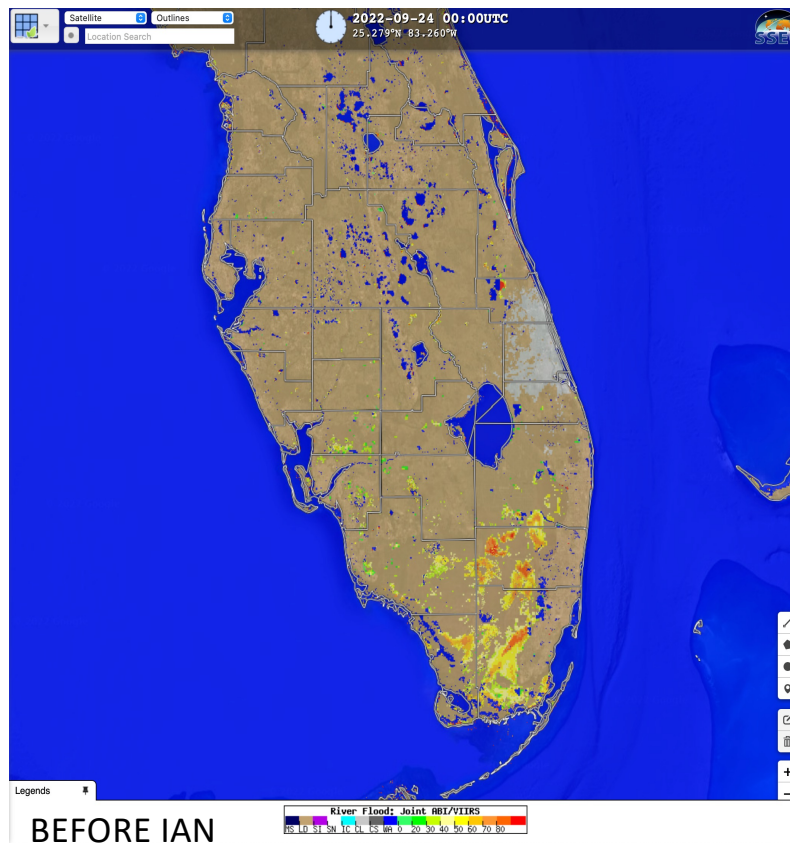




Examples of recent uses of GEO/LEO/SAR

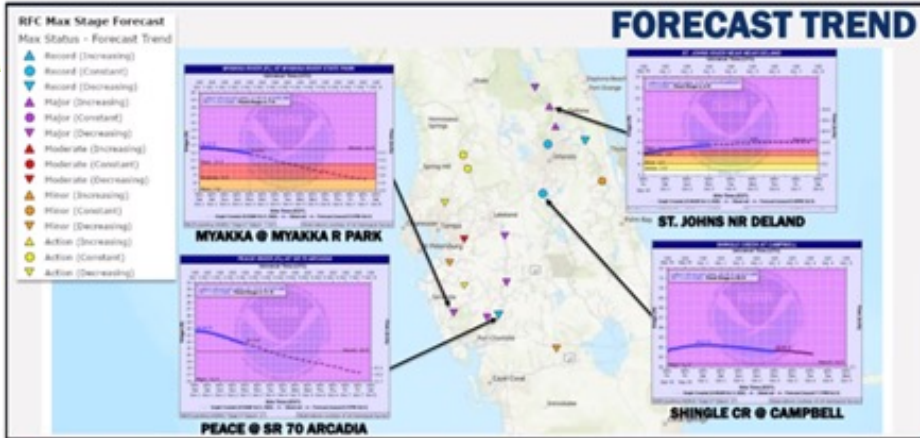


Geostationary (ABI)
flood mapping for Ian,
Advantage –
information available in
morning and wide
coverage for situational
awareness

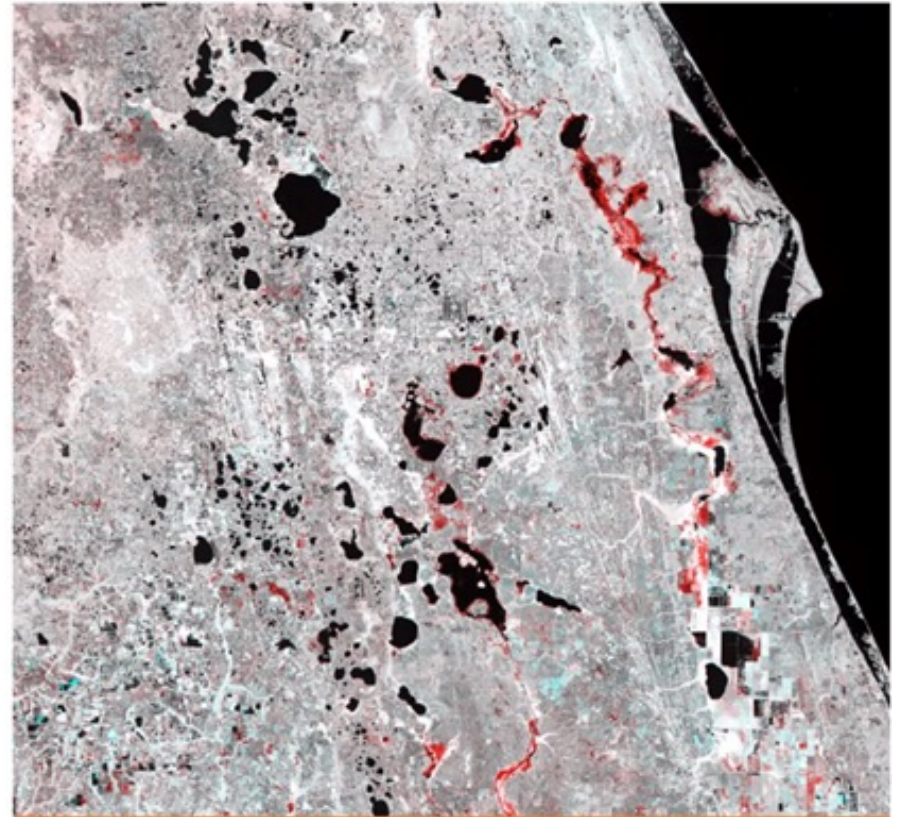




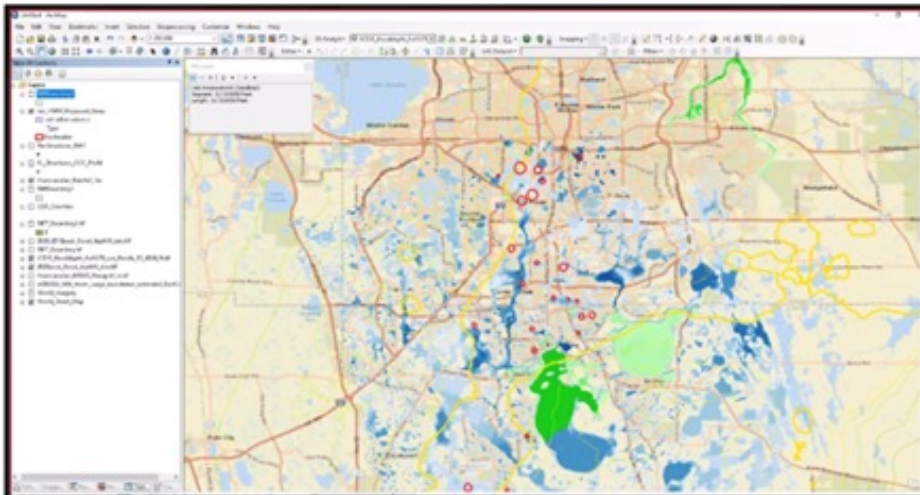
Hurricane Ian. Ongoing inland and riverine flooding in Florida Counties



Sentinel-1 SAR-based Flood Delineation, SAR of 2 OCT 2022

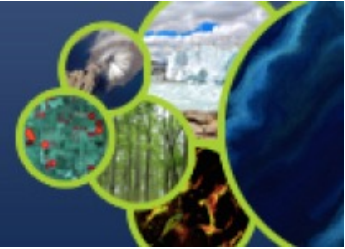


Attribution: Earth Big Data LLC under contract for and in collaboration with the NOAA Water Surface Conditions Program within NESDIS/STAR.





Action M17/2



Flood pilot: Present linkages between Flood Pilot activities and UN-SPIDER activities, as well as links to GEOGLOWS and GloFas; present map of areas considered in Flood Pilot.

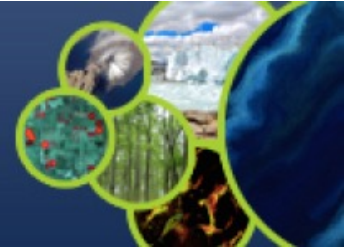
The Flood Pilot shares links with JRC and the Global Flood Partnership. There is a need to make these linkages more explicit and in some cases further develop them.

Action: present existing links to Copernicus and JRC and develop.

Gwendolyn presented the FloodDAM project (see PPT). The project works through test sites and is not global. There's a need to automate the hydrological models. The project does not aim to estimate flood damages.



Action M17/2: to remain open



Map of Flood Pilot basins and areas: shown before

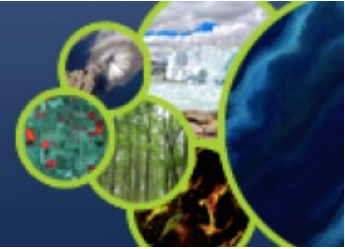
Some linkages to be developed or strengthened, particularly with JRC and the Global Flood Partnership, Copernicus.

Links between operational models as GEOGloWS and GloFAS of deterministic and ensemble hydrologic forecasts and flood pilot projects: the linkage seems to be unidirectional, from models to projects. Not yet used by any sub-group.

FloodDAM project: Gwendolyn Blanchet & Raquel Rodriguez Suquet (CNES) are currently in the FP distribution list. Interactions, yet to be explored.



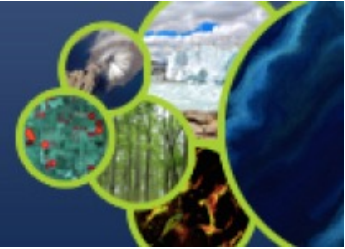
Strengths & Weaknesses



- Most sub-group work is unfunded/voluntary contributions → relatively slow to complete workload
- As a result, some groups are more active than others
- Participation in monthly meetings is uneven
- Increased interaction and synergies among sub-groups needed
- Flood Pilots represent a wide international span of sub-groups (US/CA, CONAE, CAS, India, Europe (Greece, Luxembourg))
- Pilot AOIs are diverse and have their own particular data/analysis challenges



Path Forward



- Continue the consolidation of flood mapping techniques with LEO-GEO-SAR integrated sources
- Gradually incorporate all aspects of flood risk into the analyses, in line with the DIS-22-01 deliverable
- Increase the knowledge of the use satellite data for flood response/management made by disaster managers
- Increase the impact of the Pilots on the decision making of disaster managers
- Increase interaction and synergies among sub-groups



Thank you for your attention