Committee on Earth Observation Satellites

# GEO/LEO/SAR Flood Pilot

Guy Schumann, Remote Sensing Solutions

Mitch Goldberg, NOAA/NESDIS

Andrew Molthan, NASA

Dave Borges, NASA

WGDisasters-15 Meeting

Virtual Meeting

9 – 11 March 2021

# Flood Pilot Co-Leads

- Dr. Guy Schumann, Remote Sensing Solutions

  o Principal Scientist at RSS Inc. Researches flood risk, from local to global scale, using flood modeling prediction and remote sensing.

- Dr. Mitch Goldberg, NOAA/NESDIS

  o NOAA/NESDIS Chief Scientist; led the NESDIS Satellite Proving Ground to improve NOAA services.

- Dr. Andrew Molthan, NASA Marshall

  o Research Meteorologist, collaborates with NASA Disasters Program to help the disasters community use NASA data and tools.

- Dave Borges, NASA Langley

  o Physical Scientist, GEO DRR WG Co-Chair, CEOS WGDisasters Secretariat, supports DRR and flood-focused efforts across GEO and CEOS communities.
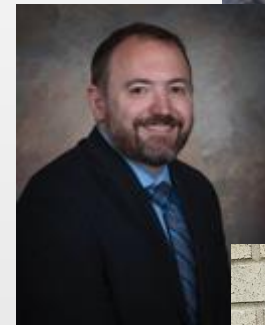
- SG1: Red River of the North
  - Vince Decker, Natural Resources Canada
- SG2: Bermejo and Picomayo Basins
  - Marcelo Uriburu Quirno, CONAE
- SG3: Brahmaputra River and Mahanadi Delta
  - G S Rao, ISRO
- SG4: Pearl River Basin
  - Weiyuan Yao, CAS
- SG5: Balkans
  - Issaak Parcharidis, Harokopio University of Athens
- SG6: Myanmar
  - Patrick Matgen, LIST

- WGDisasters Flood Pilot Implementation Plan was endorsed during the CEOS 2020 Plenary

- Key Milestones:
  - 2020-21
    - Begin regional studies; collect data; establish relationships
  - 2021-22
    - Provide derived products to users for feedback and explore refinement of monitoring strategies.  Initial evaluation of pilot results to GFP and international conferences.
  - 2022+
    - Develop reports from users on derived products, best practices, and evaluate results from study sites.  Explore whether broader EO strategies can be developed.

- Objective A
  - Solicit input from CEOS partnering agencies and participants on current and upcoming efforts to map water and flood extent from diversity of LEO/GEO and SAR contributions.
- Objective B
  - Capture underlying requirements and future needs to sustain and improve upon these capabilities.
- Objective C
  - Explore ideal combination of LEO/GEO/SAR flood mapping outputs, using representative regional events of interest to partners.
  - Develop and document best practices for combining and sharing flood information from multiple platforms with diversity in sensor, spatial/temporal resolution, etc.

- CEOS Chair (NASA) 2021 Theme / Implementation Plan
  - Space-based EO Data for Open Science and Decision Support
    - Develop a demonstration of a repository of data, methodologies and capacity building resources for open science and decision support for flood research and applications, ensuring relevance of outputs that can inform choices, support decisions, and guide actions using open science principles for disaster risk reduction through partnership efforts with CEOS WGCapD and stakeholder engagement. (DIS-20-06)

**Implementation Plan for the 2021 CEOS Chair Theme:**
**"Space- based Earth Observation Data for Open Science and Decision Support"**

At the 2020 CEOS Plenary, the CEOS community welcomed NASA's proposed theme for the 2021 CEOS Chair term: *"Space-based Earth Observation Data for Open Science and Decision Support".* This document summarizes an implementation plan that will identify existing CEOS activities (in the 2020-2022 CEOS Work Plan) and other CEOS activities (not in the Work Plan) that directly align with this theme and advance the concepts of "Open Science".

- Monthly meetings ongoing
- Flood Pilot Data Call Form
- Methodology / Algorithm Collection
- Licensed Data Offers to Pilot Team
  - CONAE SAOCOM
  - CSA RSAT-2
- Continued collaboration with CEOS COAST Ad Hoc Team to identify and leverage shared objectives, data call methodology and leveraging EAIL.
- Exploring collaboration with CEOS WGCapD regarding EAIL training

### CEOS WGDisasters GEO/LEO/SAR Flood Pilot

DATA CALL FORM

Last Updated: 2 March 2021

Intent: Document relevant data and methodology requests / requirements for each Flood Pilot Subgroup.

**Subgroup #1: Red River of the North**

Subgroup Lead: Vince Decker

| Satellite | Sensor Type | Public | Volume (Scenes) | Scene ID or Date(s) | Data Format | Spatial Resolution (m) | Temporal Resolution (days) |
|---|---|---|---|---|---|---|---|
| RCM | SAR | No | 77 | | Tentative ARD in GTiff | Various (5, 30) | Various (b/w 20200407 & 20200510) |
| RSAT-2 | SAR | No | 9 | | Tentative ARD in GTiff | Various (4.6 – 2.0 x 2.8, 5.2 x 7.6 , 16.5 – 6.8 x 7.6, 26.8 – 17.3 x 24.7) | Various (b/w 20200411 & 20200508) |
| Sentinel-1 | SAR | Yes | 8 | | SAFE | 20 x 22 | 12 |
| Sentinel-2 | Optical | Yes | 11 | | SAFE | 10 - 60 | 10 |
| Landsat-8 | Optical | Yes | 3 | | L1TP GTiff | 15 - 100 | 16 |
| Planet | Optical | No | 17 | | 3B Surface Reflectance | 3 | Various (b/w 20200415 & 20200506) |
| VIIRS | Optical | Yes | 2 files/day | | GTiff | 375 | Daily |
| GOES | Optical | Yes | 2 files/day | | GTiff | 1000 | Daily |
| Joint Leo/GEO | Optical | Yes | 2 files/day | | GTiff | 375 (LEO) 1000(LEO) | Daily |

- CEOS Earth Analytics Interoperability Lab (WGISS, SEO)
- First EAIL deployed, initial access will be rolling out to Pilot Team soon
- Will serve as centralized sandbox environment where entire Pilot team can share methodologies and data.

## CEOS Earth Analytics Interoperability Lab

Working Group on Information Systems and Services and Systems Engineering Office

20 April 2020

*Robert Woodcock, CSIRO, WGISS Chair*
*Brian Killough, NASA, SEO Director*

### Situation

A significant number of CEOS activities are now engaged in the CEOS ARD and FDA strategies and in Integrated Earth observation data analysis (COAST, SDG, WGClimate, LSI-VC, WGDisasters, GEO Aquawatch and GEOGLAM). There is strong collaboration between groups with both WGISS and SEO being sought for technical advice and coordination on issues related to interoperability of all kinds including data standards, formats, analytics and discovery services.

From the Natural Resources Canada/Red River of the North team:

- 77 RCM scenes used to create 20 flood maps between April 14th and May 10th
- Preliminary plans on algorithm sharing for community use and development
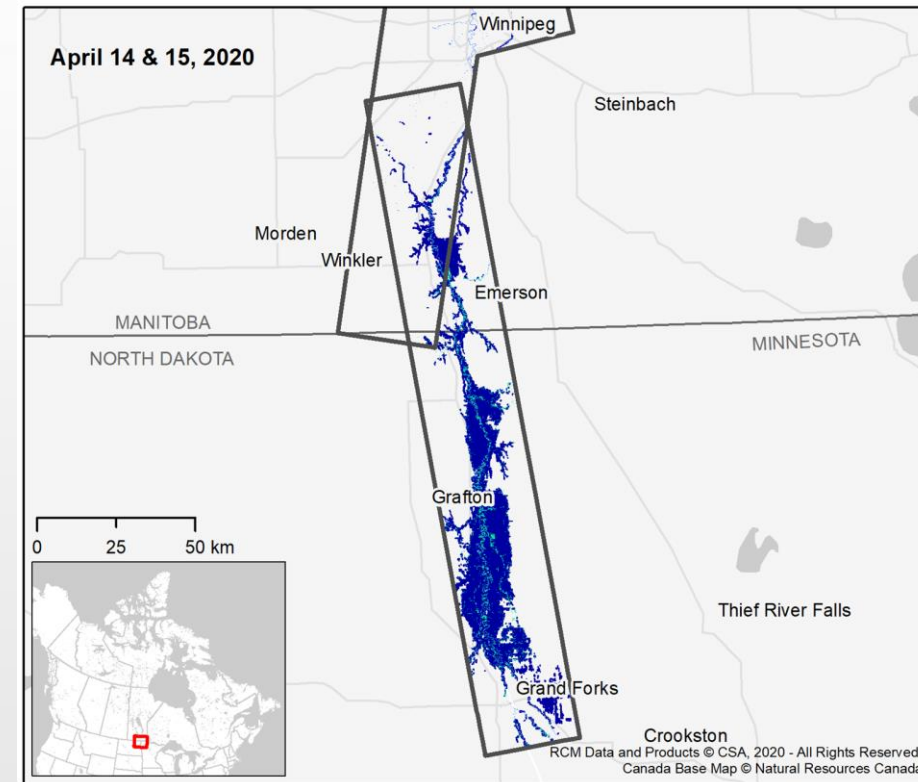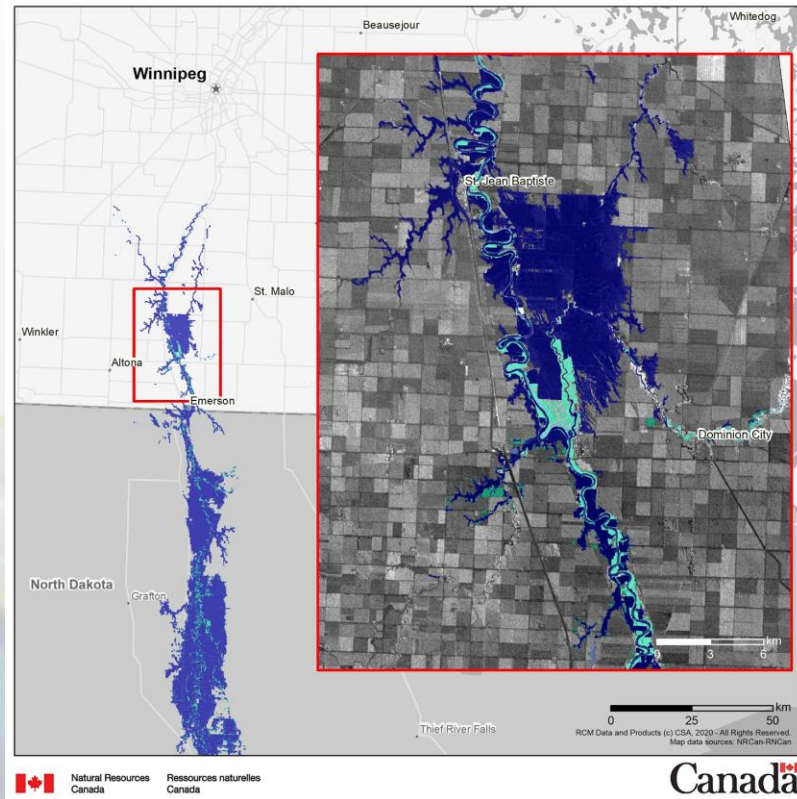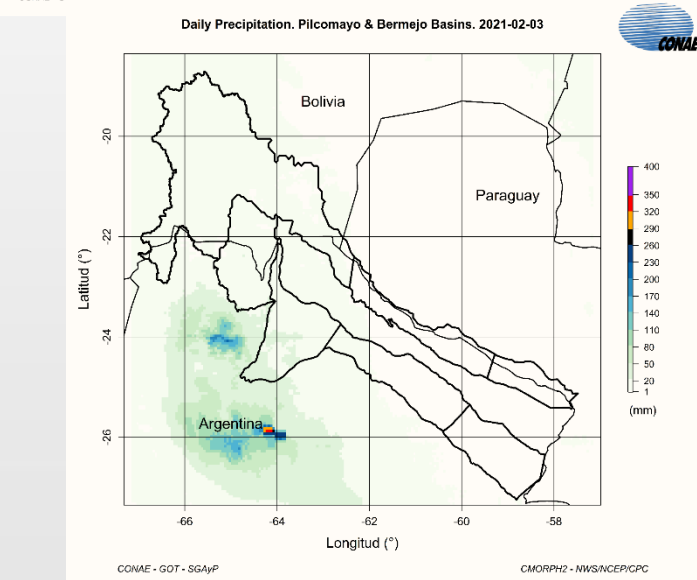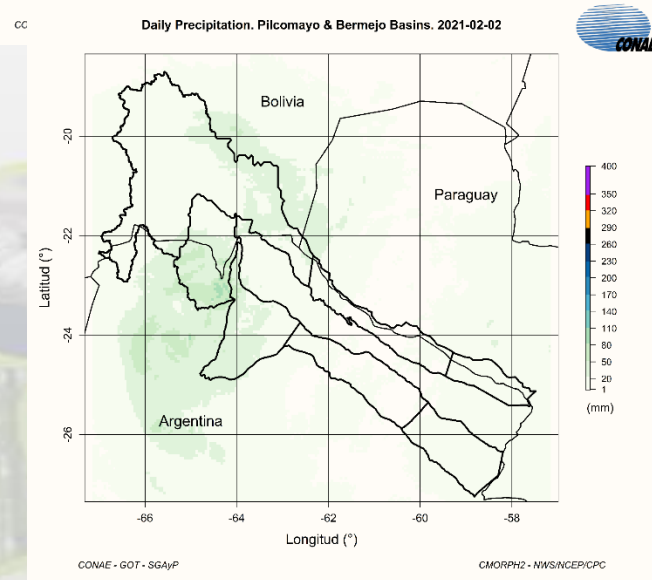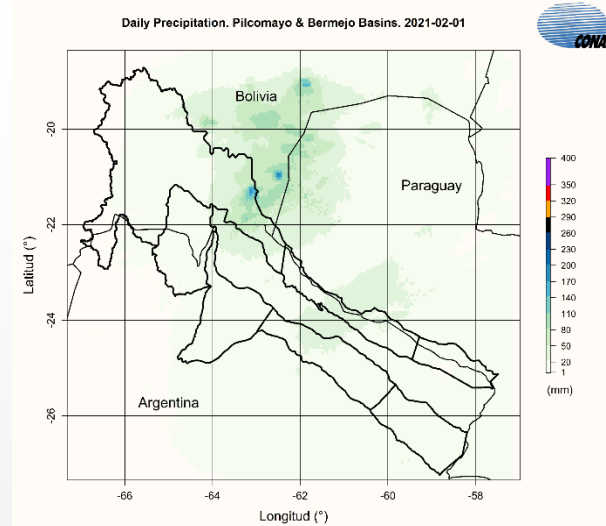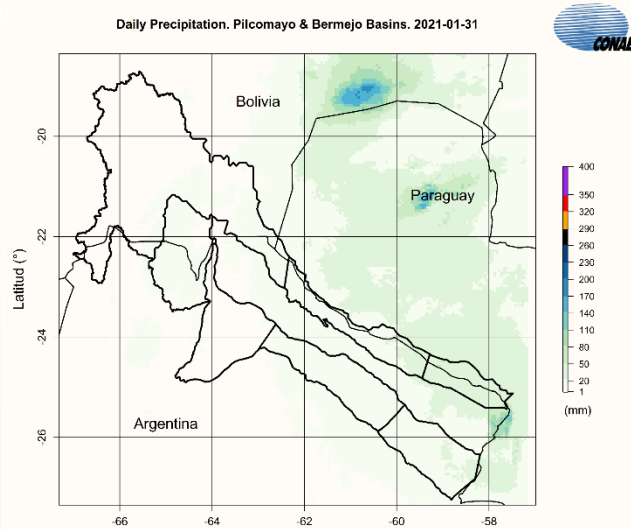
# Red River: Data Plan

Red River of the North Team / NRCan have demonstrated their need and goals for multi-platform and partner data supporting analysis in the 2020 event and year
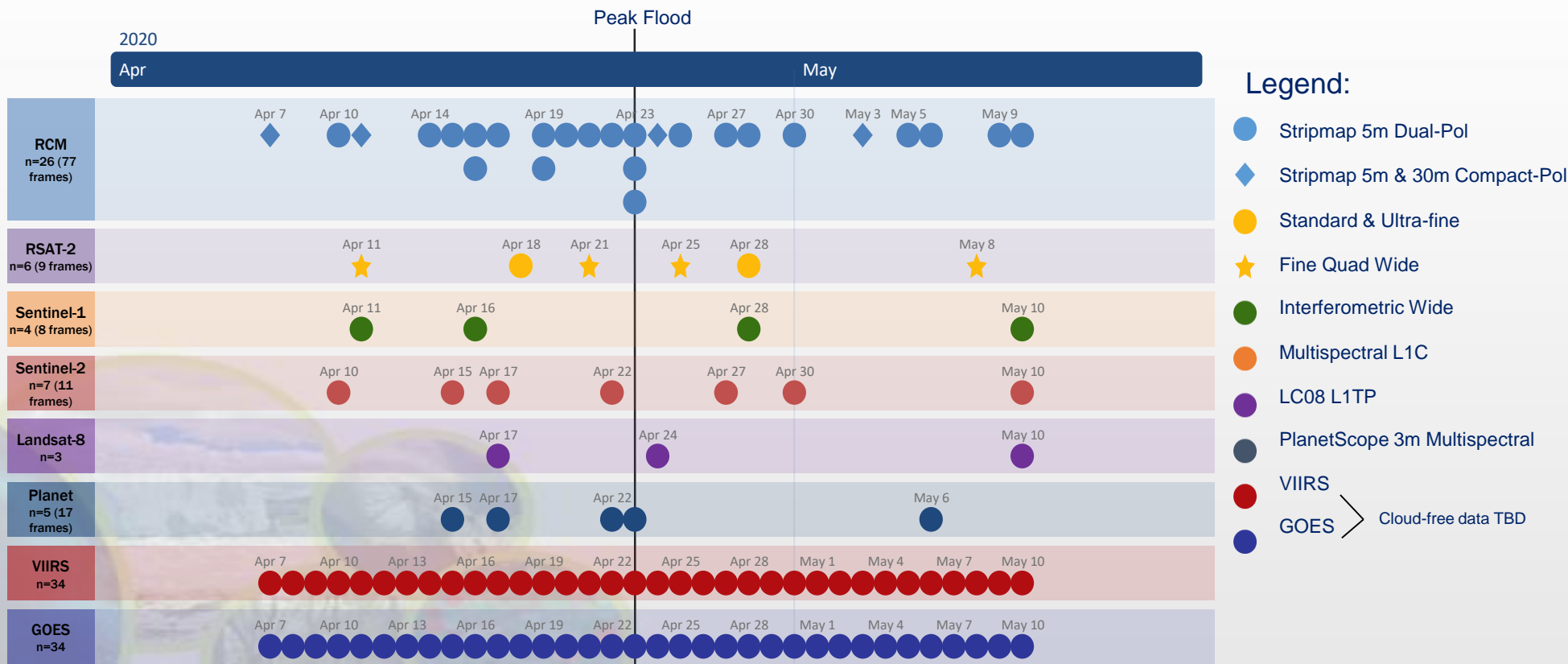
- Leverage the CEOS data interoperability/sharing platform with all relevant available Red River data.
  - Bring code to the infrastructure & collaborate towards improving existing mapping tools: open water, flooded vegetation, urban and critical infrastructure, multi-platform downscaling, identify gaps, etc…

- RSAT-2 availability with an open license being discussed.
- Have a ready to use conditioned trans-boundary high resolution DEM.
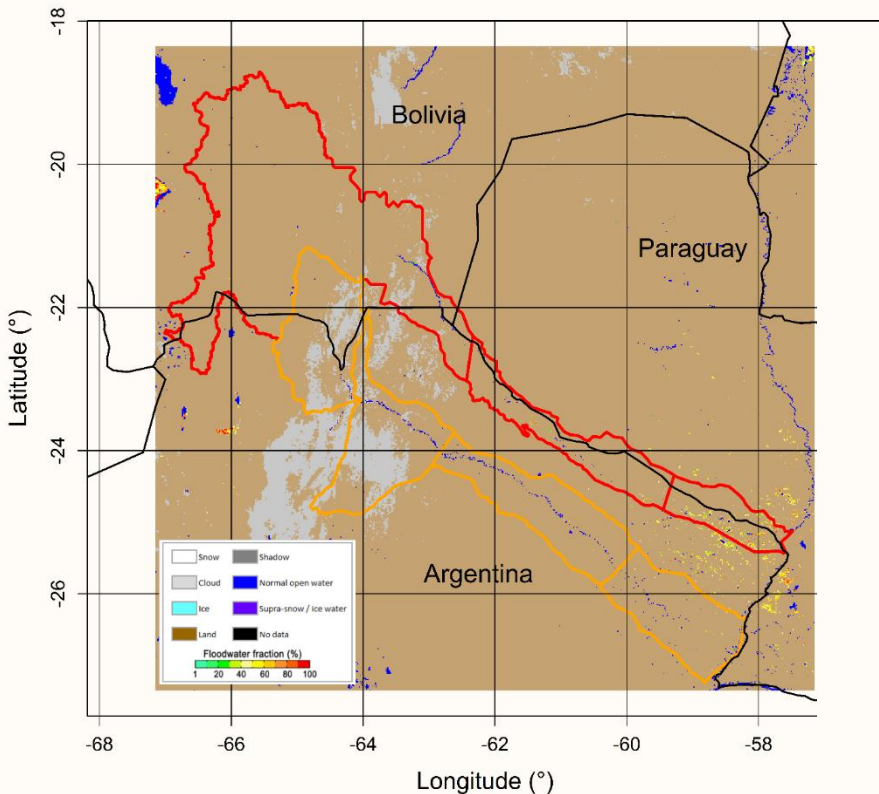- Fill data gaps and promote cross sensor validation with other LEO platforms.
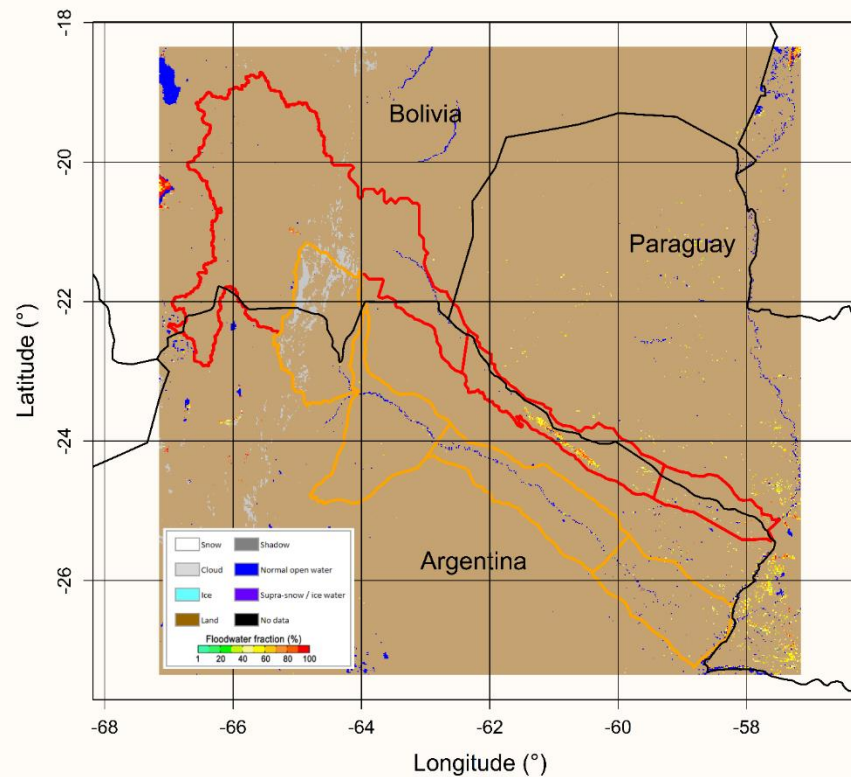
- Rain event on the Pilcomayo Basin: CMORPH2

Joint ABI/VIIRS flood product. Pilcomayo & Bermejo Basins. 2021-01-01

Joint ABI/VIIRS flood product. Pilcomayo & Bermejo Basins. 2021-02-06

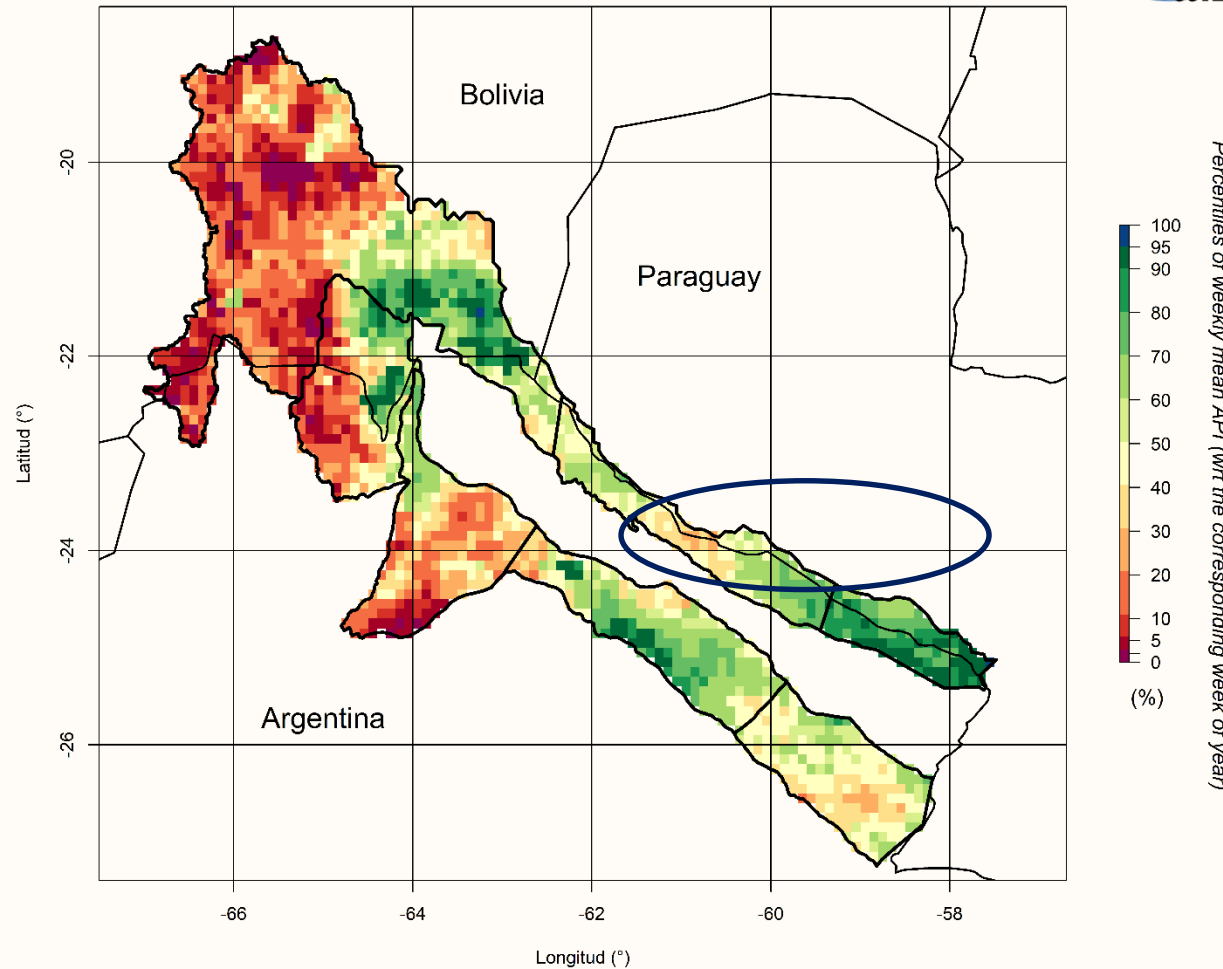Tendency to normality of hydrological condition in central part of the Pilcomayo Basin



Hydrological Status. Pilcomayo & Bermejo Basins. Week through 2021-02-02
Comparison with the most recent 20-year record

copyright CONAE, 2021

*Non-Validated Product*

CONAE-led team for Pilcomayo and Bermejo Transboundary Basins area of interest continues progress in line with expected contributions. Data requests submitted.
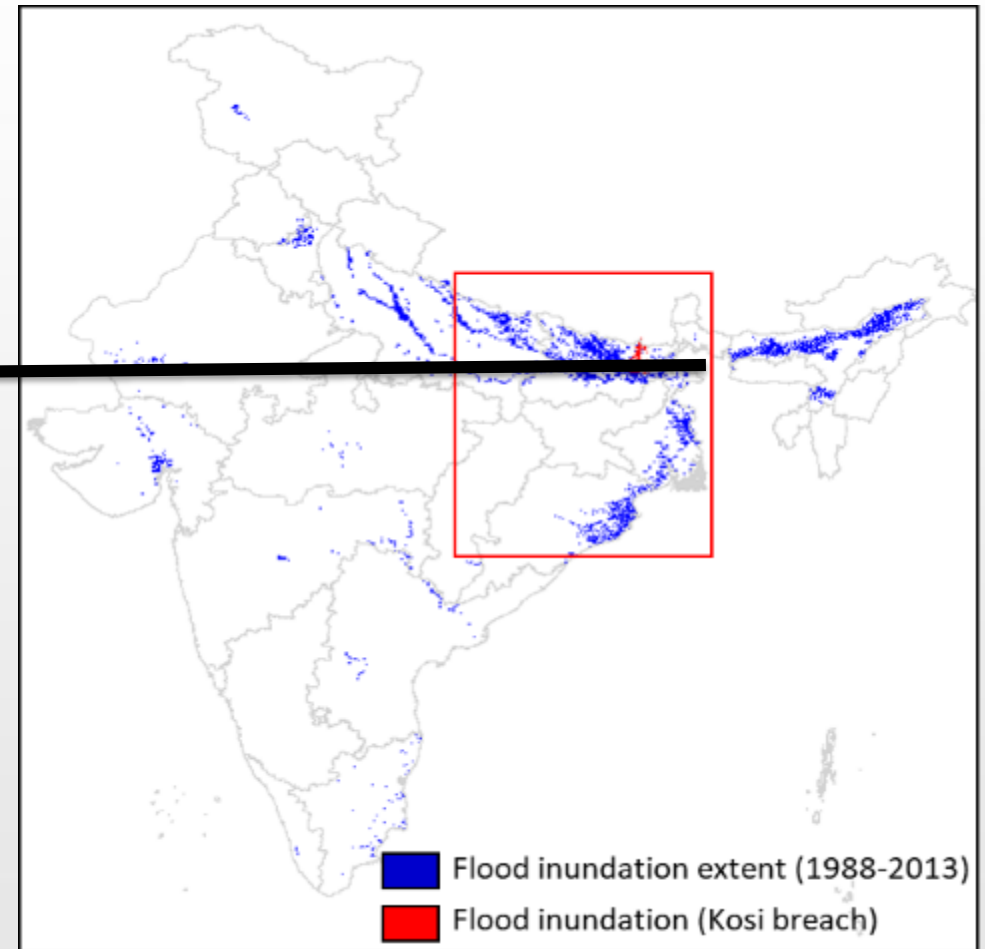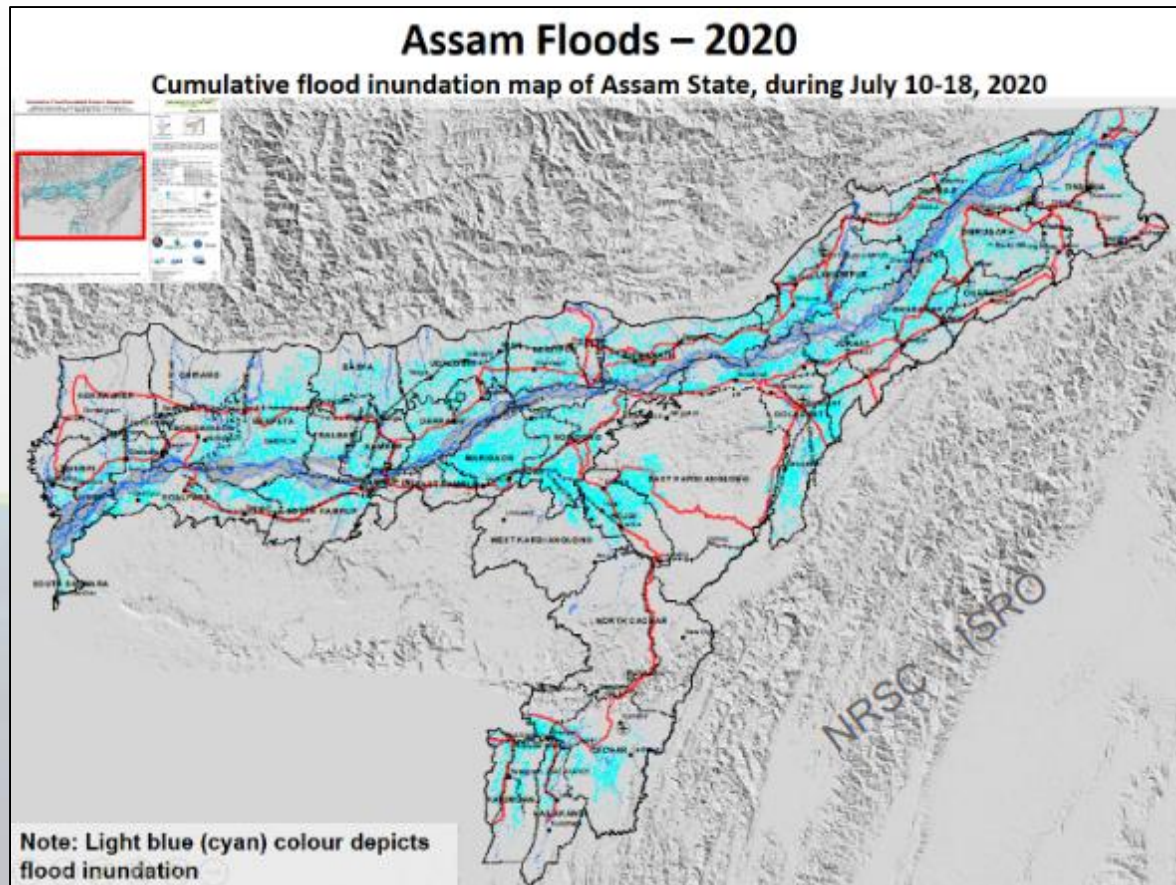
| DELIVERABLES | QUARTERS | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 | Q12 |
| **Pre – event monitoring of basin antecedent conditions** | | | | | | | | | | | | |
| Hydrological status. Percentiles of weekly mean API (GPM and TRMM) | # | | | | | | | | | | | |
| Daily API, as a proxy of soil moisture (GPM) | # | | | | | | | | | | | |
| Satellite rainfall estimates (GEO Hydro-estimator, LEO GPM) | | | # | | | | | | | | | |
| | | | | | | | | | | | | |
| **Post – event assessments** | | | | | | | | | | | | |
| Flood extent maps with SAR (SAOCOM, COSMO-SkyMed, Sentinel-1) | | | | | | | | # | | | | |
| Flood extent mapping with GEO + LEO (Joint ABI/VIIRS Flood Product) | | | | # | | | | | | | | |
| Impact of flood waves on bridges | | | | | | | | | | | # | |
| Inundation depths | | | | | | | | | | | | # |
| | | | | | | | | | | | | |
| **Flood Risk Analysis** | | | | | | | | | | | | |
| Flood extent frequency maps (LEO, optical and SAR) | | | | | # | | | | | | | |
| Land use / land cover (NDVI, EVI, RVI, optical classification) | | | | | | | # | | | | | |
| Digital elevation models for specific reaches | | | | | | | | | # | | | |
| Support to vulnerability and exposure assessments | | | | | | | | | | | | # |

**#: MILESTONES FOR DELIVERABLES**

**Progress of these products in good agreement with Gantt chart**

**Recent Floods in India**

**Aggregate Flood Maps**



Assam Floods – 2020
Cumulative flood inundation map of Assam State, during July 10-18, 2020

Note: Light blue (cyan) colour depicts flood inundation



Flood inundation extent (1988-2013)
Flood inundation (Kosi breach)

- **Difficulties in providing daily updates, complete updates**

- LEO Satellites
  - Optical – Multi-Spectral- NDWI
  - Optical – Cloud Cover, Limited Coverage
- GEO Satellites
  - Optical – Highly temporal
  - Optical – Cloud Cover, Low resolution,
- Synthetic Aperture Radar (SAR)
  - SAR – All weather-Backscatter Threshold
  - SAR – Hill shadows, Winds, Protruding vegetation, Problems due to thick clouds, …
- Passive Microwave – Very Low Resolution
- Digital Elevation Models – Less utilized
- Others – Alti-meter, River Gauges

1. **Feasibility of integrating LEO-GEO-SAR-DEM-Other Datasets**
2. **Indian Case Study: Brahmaputra River (Assam State)**
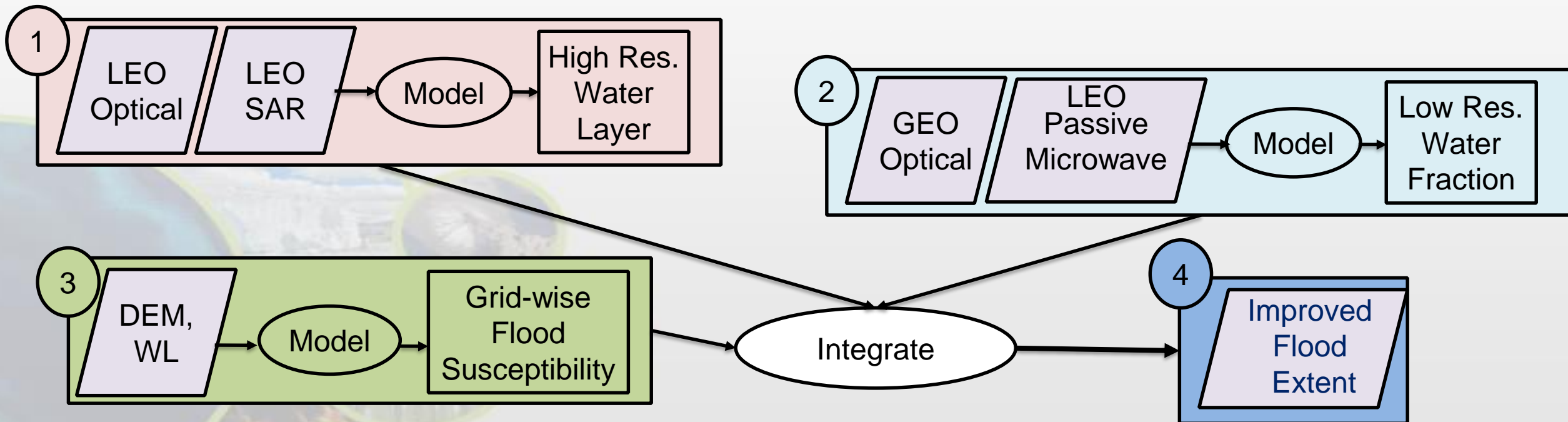
- Daily / Sub-daily Flood Inundation
- Inundation for complete State / District
- Flood depth maps
- Pending Actions
  - o Methodology Finalization
  - o Action Plan Preparation
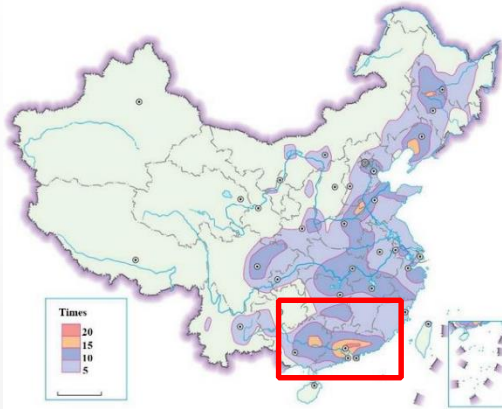
NASA MODIS via Worldview

- The Pearl River Basin experiences heavy rainfall from coastal storms (cyclones, typhoons) and heavy interior rainfall events
- Events have included Typhoon Rumbia and other major storms in the region
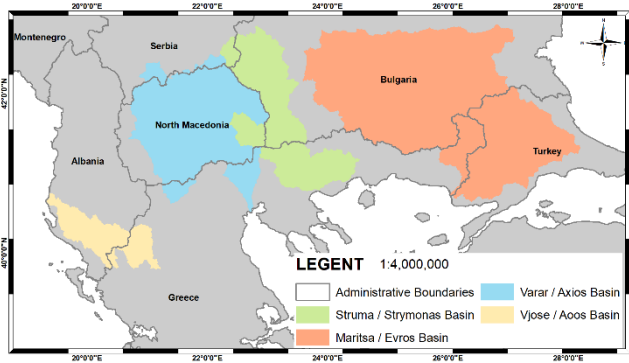
## Expected Outcomes

- Leverage imagery from Chinese optical remote sensing satellites
- GF4, HJ, ZY, each providing resolutions of 5-30 m and multispectral bands of VIS-MWIR
- Explore benefits of using GF3, a multi-polarized C-band SAR sensor offering resolutions of 5-50 m

## Status and Level of Effort

- Leads: Chinese Academy of Sciences (CAS)
- Regions of interest and some preliminary events have been identified in 2018, may also be able to use most recent flooding event in 2020.

## Data Needs, Challenges, and Risks

- Collaborations with other data partners on any available in situ data for validation, imagery collections through partners and/or the Charter
- Expecting heavy use of Chinese / China Academy of Space Technology assets for optical and including SAR imaging capabilities

# Subgroup 5: Balkan Basins -- Transboundary



LEGENT   1:4,000,000

Administrative Boundaries
Struma / Strymonas Basin
Maritsa / Evros Basin
Varar / Axios Basin
Vjose / Aoos Basin

- Major basins spanning political boundaries benefit from routine Earth observations and flood mapping

## Expected Outcomes

- Improved integration of LEO, GEO and SAR with an emphasis on water and flood mapping in these transboundary basins
- Capture underlying physical processes and causes contributing to major regional flood events.
- Demonstrate operational utility of EO specific to hazards and risks in the region

## Status and Level of Effort

- Leads: Harokopio University (Greece) Earth Observation Team (HUA EO Team)
- Previous work in the region has examined SAR analysis and multi-temporal approaches to extract features of interest

## Data Needs, Challenges, and Risks

- Multi-temporal optical and SAR images, SAR amplitude imagery to assist with mapping of permanent water versus floods.
- Interferometric coherence based upon SAR (InSAR) and additional polarimetry processing, wavelength diversity.

# Subgroup 6: Myanmar
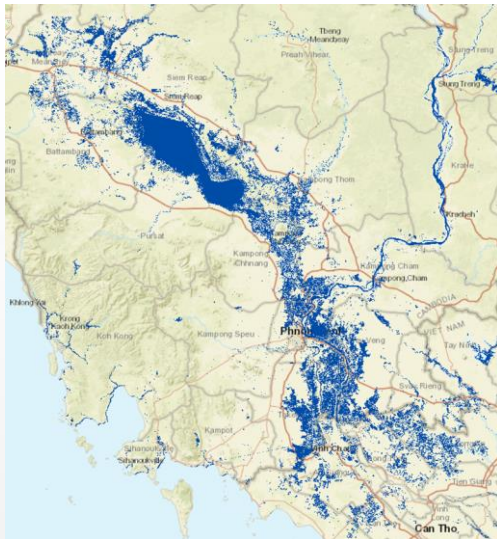


- Seeking to understand flood risk at large scales and establish risk profiles via satellite archive.
- Strengthen emergency response efforts.

## Expected Outcomes

- Partner with the World Bank to enhance use of satellite-derived information in the disaster risk financing sector for SE Asia
- Strengthen emergency response through parametric insurance modeling that looks to expedite pay-out based upon clear and transparent rule sets
- Use multi-temporal SAR and other complementary images to improve water mapping

## Status and Level of Effort

- Leads: Luxembourg Institute of Science and Technology (LIST)
- Past work has examined mapping the extent of permanent water bodies, separating permanent water from flood extent, and relating flood events to impacts via population and other human settlement information

## Data Needs, Challenges, and Risks

- Adapting InSAR coherence imagery to improve the performance of flood detections in urban areas and the urban-suburban-rural interfaces, also for regions with extensive vegetation
- Increased sampling rate of imagery over the region through a multi-sensor approach (e.g. incorporate Radarsat-2, Sentinel, others) as well as combined radar and optical data
- Explore additional L-band wavelengths to improve detections within vegetated regions and to prep for ESA's ROSE-L mission

- Finalize Flood Pilot Data Call Form to include data formats and temporal/scene details.
- Address outstanding licensed data sharing opportunities with CSA & CONAE.
- Continue collaboration with CEOS WGISS & SEO to roll out Flood Pilot EAIL.
- Pilot data and algorithm aggregation within EAIL.
- Continue close collaboration with CEOS COAST Ad Hoc Team.
  - Specifically their 'Sea to Land' Subgroup focused on coastal inundation.
- Documentation of methodologies, successes, challenges to inform Pilot Deliverables to include GEO/LEO/SAR data fusion towards improved flood mapping.


- Questions / Discussion