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CopernicusLAC –Service Development

Flood Extent Mapping for Preparedness

MASTER PRESENTATION

Copernicus LAC Panamá

Users and Stakeholders

REGIONAL

- Caribbean Institute for Meteorology and hydrology (**CIMH**)
- Caribbean Disaster Emergency Management Agency (**CDEMA**)

GUYANA

- Hydro-Meteorological Service of Guyana (**HMS**)
- Civil Defence Department (**CDC**)

BELIZE

- National Meteorological service of Belize (**NMS**)
- Hydrolgy Dept. – Ministry of Natural Resources (**MNR**)
- National Emergency Management Organization (**NEMO**)

JAMAICA

- Meteorological Service of Jamaica (**MSJ**)
- Water Resources Authority (**WRA**)
- Office of Disaster Preparedness and Emergency Management (**OPDEM**)

Efforts executed by the users/stakeholders

- The ToR signatories generally attended regularly to the socialization and sprint demo meetings and provided feedback when were questioned.
- CDEMA (technical partner) hosted the Caribbean Conference on Comprehensive Disaster Management (CDM13), where the CopernicusLAC initiative and the flood theme services were presented, and a stakeholder engagement event took place.
- CIMH (technical partner) selected dates and locations of past flood events to be analyzed. During the service development phase, CIMH identified key personnel in stakeholder institutions and supported their engagement, ensuring they remained actively involved.
- CIMH, in collaboration with WASDI, has successfully installed an instance of the CopernicusLAC platform- specialized for flood mapping and monitoring- on its premises.
- All the involved stakeholders accessed the data through the dedicated workspaces in the CopernicusLAC dedicated Processing Environment for floods and have started providing feedback and requested information.
- Representatives of HMS (Guyana), MNR and NEMO (Belize), MSJ and WRA (Jamaica) attended dedicated meetings per country with live session on how to use the platform and how to provide the necessary feedback and assisted in the design of the operational implementation.
- MNR and NEMO (Belize) filled and submitted the forms for the operational implementation design and for validation of the current results.
- The ToR signatories and potentially more institutions will attend the capacity building sessions to learn about the services processing chains and their operational exploitation.

Geoinformation Needs Addressed

📍 **Flooded Area Extent**

•Need for an **accurate and efficient** system to detect and report flooded areas capable of detecting floods in also urban environments

•Building and historical dataset of Flooded Areas to be used as reference also in forecast mode

📍 **Water Depth estimates**

•Demand for **geospatial data** on flood intensity measure.

📍 **Flood Catalog/Frequency**

•Capability of a complete analysis of flood events in specific areas

•Empirical frequency estimates for planning purposes

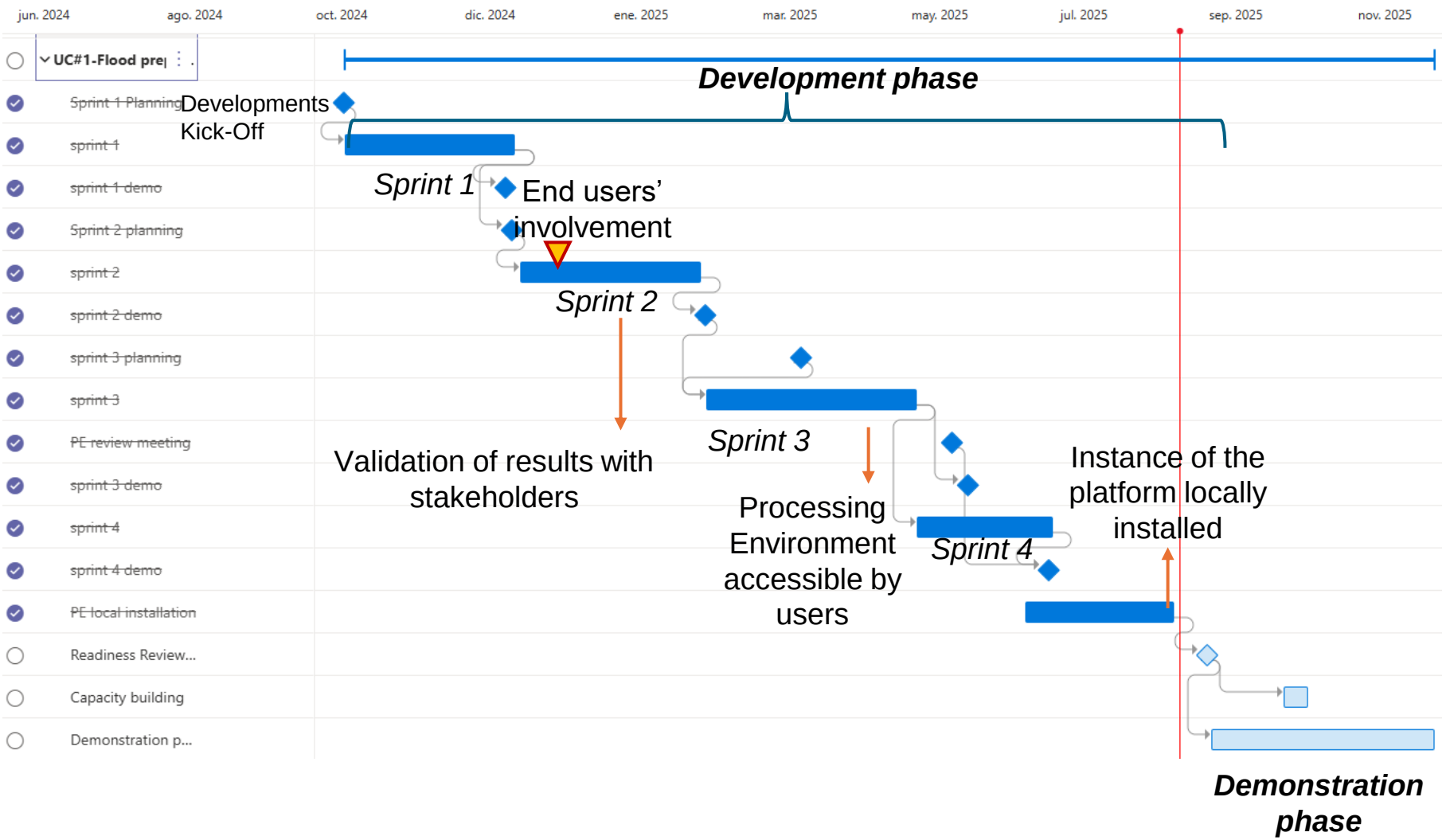
•Strengthened collaboration between **scientific and disaster risk institutions** for better decision-making.

📍 **Flood Hazard**

•Merging of model and observations to overcome limitations in the respective datasets..

Timeline

Agile approach: development phase divided into 4 incremental development sprints based on continuous interactions



The Services

Specifications and benefits

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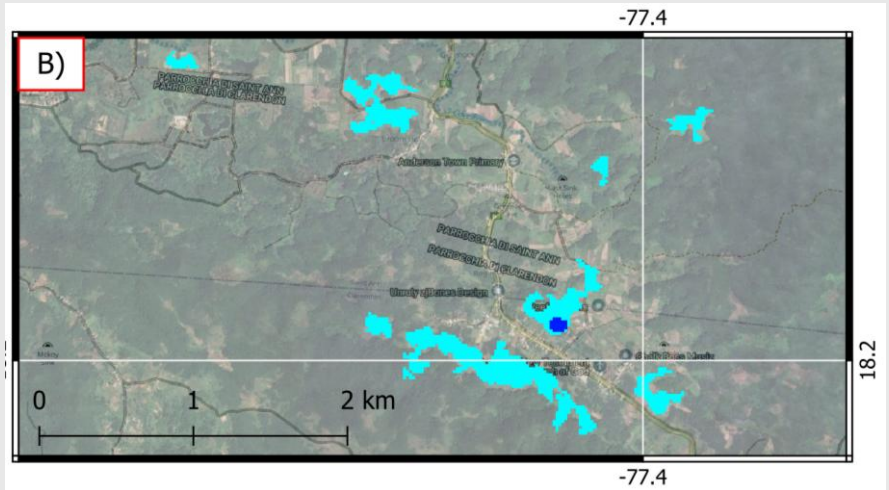
Flood Extent Mapping

The **Flood Extent Mapping (FEM)** service provides an Estimate of the cumulative extent of flood traces using both Sentinel-1 and Sentinel-2 for observation times over a period around the event start date, provided in the form of classified GeoTIFF (flooded, not flooded, permanent water bodes)



Frequency of production – Flood extent estimates for a specific observation time using EO data acquired before and after that time.

Spatial coverage - over a defined Area of Interest (AOI)

Temporal coverage - NA

Constraints - availability of S1 and S2 acquisitions

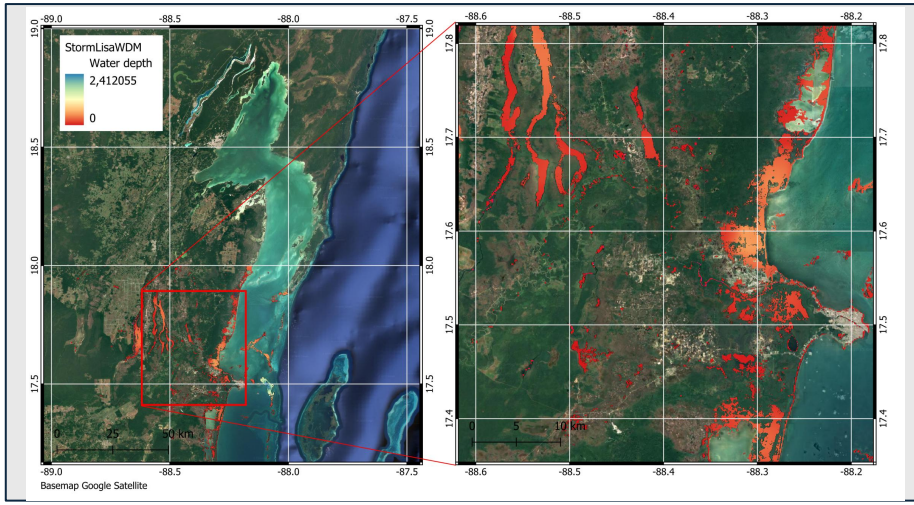
The **FEM** service tracks the extent of a flood both during an event and outside of emergency situations for prevention and risk assessment. It also provides critical input for the flood depth mapping service.

Service owner:

cima RESEARCH FOUNDATION

Flood Depth Estimation

The **Flood Depth Estimation (FDE)** service provides high-resolution maps detailing the maximum water depth per pixel for specific flood extents, using as ancillary layer a Height Above Nearest Drainage (HAND) re-elaboration of the Copernicus Digital Elevation Model.



Frequency of production – provides flood depth estimates for a specific flood extent map

Spatial coverage – extent of the input flood extent map.

Temporal coverage - NA.

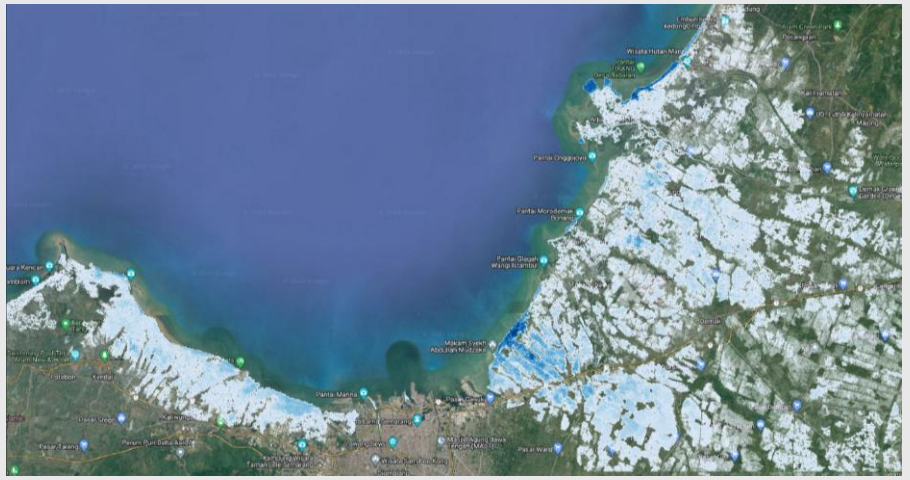
Constraints – Availability of Flood extent and HAND elaboration of a DEM over the area covered by the flood extent map

The **FDE** service computes the maximum depth of flood water in each pixel. It can be used during a flood event and outside an emergency basis for prevention and risk assessment. Combined with vulnerability data provides a critical input for infering the flood impact.

Service owner: LIST

Flood Frequency Mapping service

The **Flood Frequency Mapping (FFM)** service provides estimates of a series of flood records for a user defined period, typically a season or multiple years, providing flood extent maps and the frequency map associated to these records.



Frequency of production – Can be updated every 6 months or on demand if a large event has been experienced.

Spatial coverage – over a specified AOI

Temporal coverage – Scans the full catalog of Sentinel-1 & Sentinel-2 acquisitions

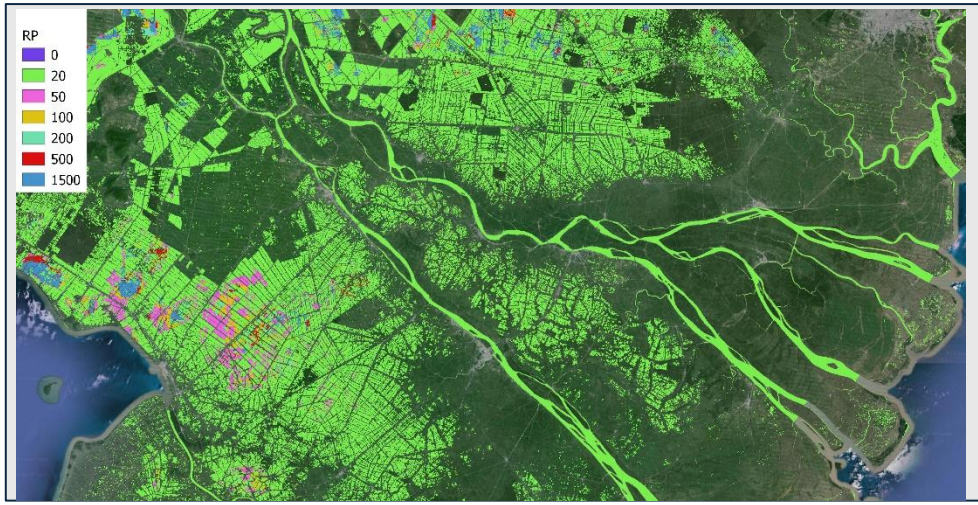
Constraints - availability of Sentinel-1 and Sentinel-2 data from the Copernicus Data Space Ecosystem.

The **FFM** service can be used in the risk reduction community in the broad sense to better understand the hazard, thus informing the risk assessment.

Service owner: cima RESEARCH FOUNDATION WASDI

Flood hazard Mapping

The **Flood Hazard Mapping (FHM)** service generates enhanced flood hazard maps by merging modelled hazard maps from the GloFAS model and the empirical flood frequency map derived from the Flood Frequency Mapping service based only Sentinel-1



Frequency of production - NA

Spatial coverage – over a specified AOI.

Temporal coverage – For different Return periods available from the model maps

Constraints - availability of Sentinel-1 data from the Copernicus Data Space Ecosystem. Availability of Modeled Flood Hazrd Maps.

The **FHM** service can be used in the risk reduction community in the broad sense to better characterise the hazard, thus informing the risk assessment.

Service owner: LIST

The Use Case

The operational implementation of the services

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Flood Preparedness in the Caribbean

2 operational implementations

Past events reconstruction & forecast (analogous events):

It consists in a reconstruction of past events identified by the user in the target areas. The objective is to **build a large enough set of possible flooded areas that can be used as analogous reference events** any time an event is feared to hit the target areas. Those events need to be **linked to clear triggers**.

Services:

- Service 1: Flood Extent Mapping
- Service 2: Flood Depth Mapping

On-demand event monitoring:

It allows an **on-demand activation** in case of a possible event. In this case the service can be activated in the immediate aftermath of the event to minimize time delays for the products availability.

Services:

- Service 1: Flood Extent Mapping
- Service 2: Flood Depth Mapping

Flood Preparedness in the Caribbean

Two additional services will be accessible through a specialized Processing Environment locally installed at CIMH.

Services:

- Service 3: Flood Frequency Mapping
- Service 4: Flood Hazard Mapping

Flood Preparedness: Past events reconstruction, forecast and monitoring

- **AOI**: The Caribbean and specifically the urban areas of Kingston (**Jamaica**) and Georgetown (**Guyana**) and Urban areas in **Belize** with a possibility of roll-out to other locations
- **Specific dates**: of past floods caused by hurricanes or other recurrent and predictable weather conditions in the AOI. Flood events of interest can also be used to support the forecast phase, and the monitored events will seamlessly enrich the past event database for future use.

General workflow – Past events rec.

User

(for each known past flood event)
- Area of Interest
- Date range
- Trigger information

User data insertion, engine selection

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USER'S WORKSPACE

launches engine

Images that match insertion

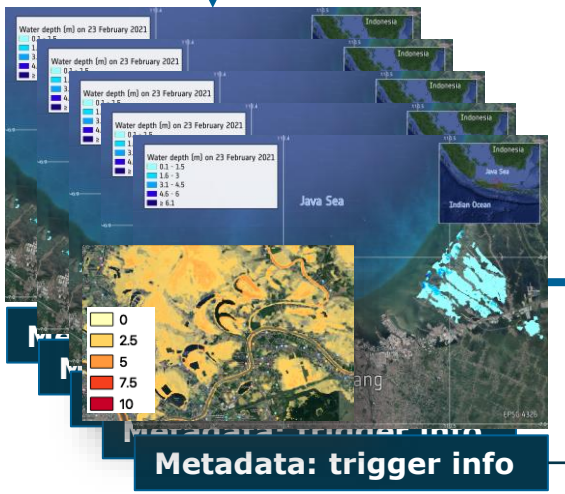
SENTINEL IMAGERY CATALOGUE

FLOOD DELINEATION ENGINE

Water Depth Estimation ENGINE

Past Events Catalogue

A series of maps of past flooding depicting the maximum flood extent and associated max wáter depths
(metadata include the attributes of the causing trigger)



Metadata: trigger info

Storage in workspace /catalogue

Hurricane
- Intensity 3
- Forecasted rainfall
- Maximum wind speed
- …

General workflow – Forecast

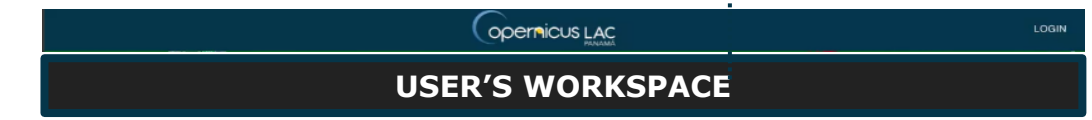
User

(for the forecasted flood trigger)
- Landfall date
- Area of interest
- Trigger information

Landfall date

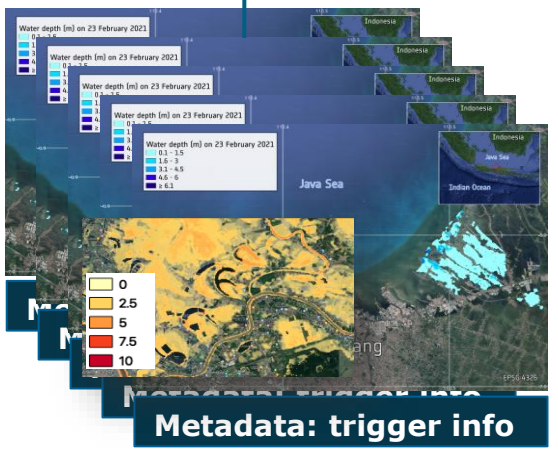
Forecasting system

User data insertion, monitoring activation



Past Flood events catalogue

Fetch past flood map that matches insertion



Metadata: trigger info

Metadata: trigger info

Visualization

Past Events Catalogue

A series of maps of past flooding depicting the maximum flood extent and associated max wáter depths (metadata include the attributes of the causing trigger)

General workflow – Monitoring

User

(for the forecasted flood trigger)
- Landfall date
- Area of interest
- Trigger information

User data insertion, monitoring activation

Landfall date

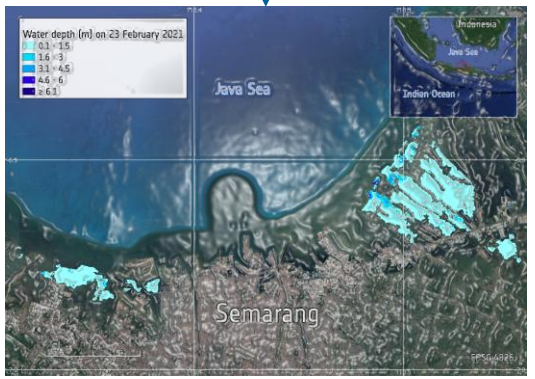
opernicus LAC — LOGIN

USER'S WORKSPACE

New Sentinel images

Verify new images over AOI after landfall time

FLOOD DELINEATION ENGINE



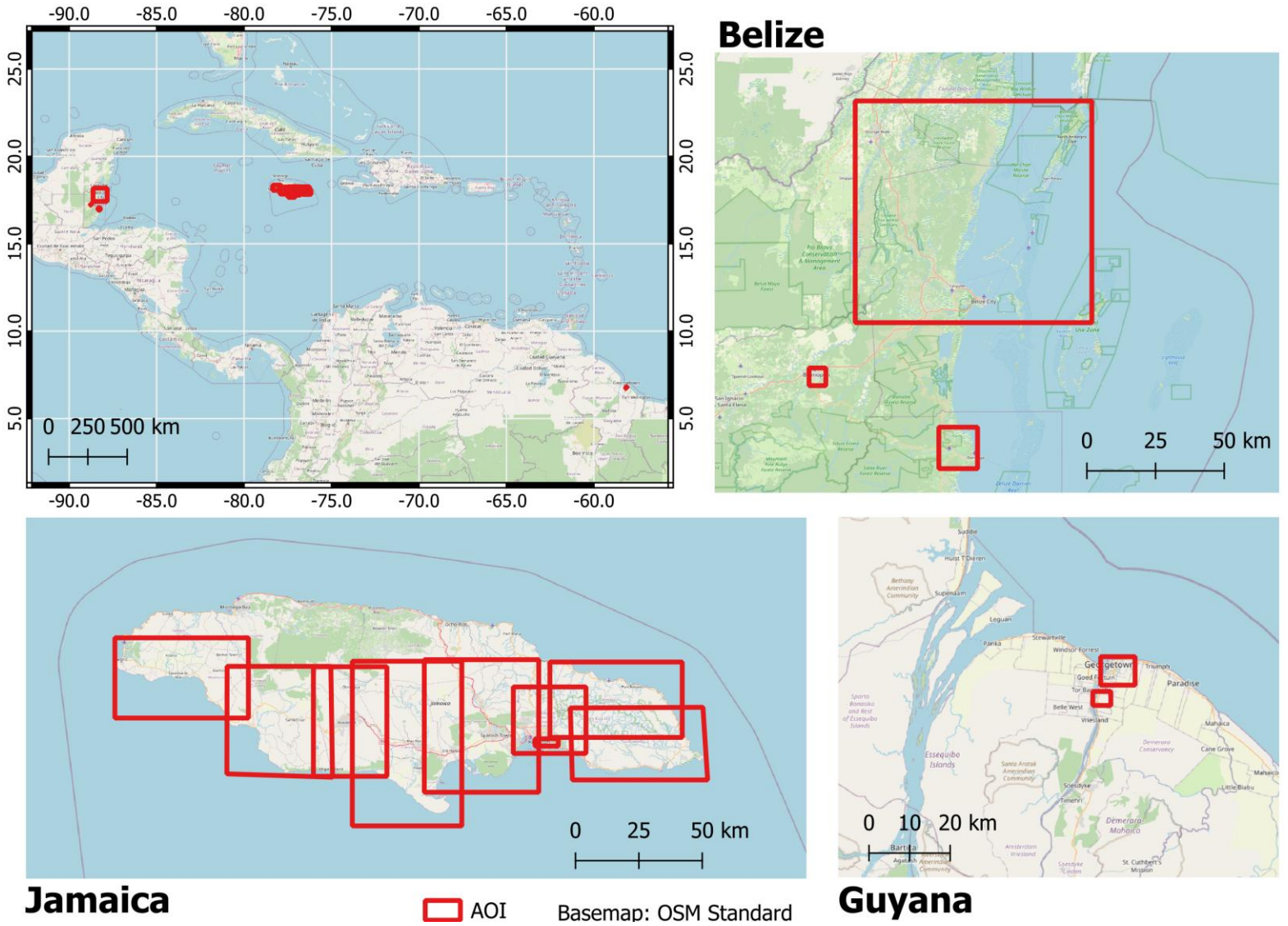
New Event

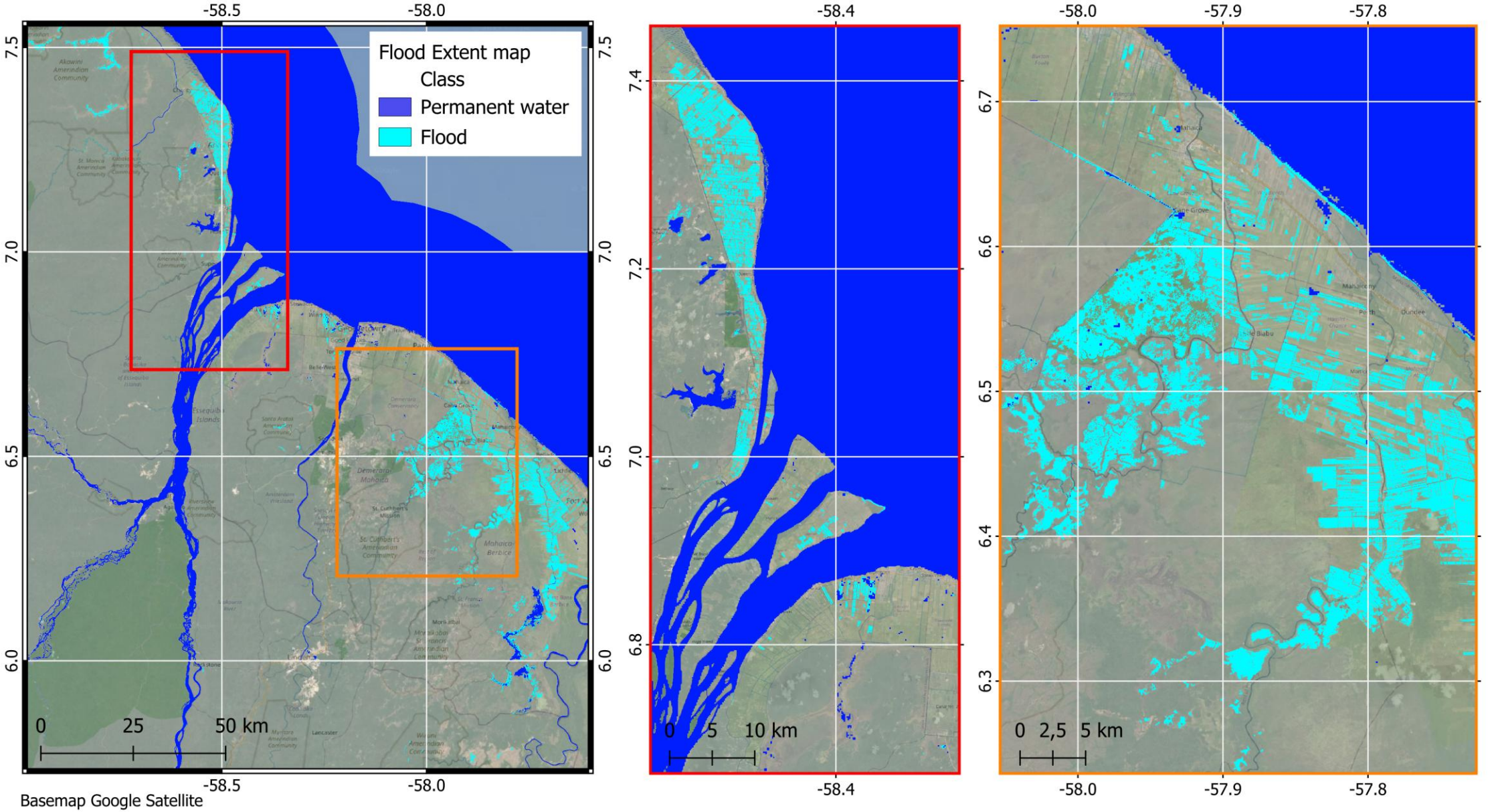
SPRINT DEMOS

Case study : Events in Jamaica, Guyana and Belize

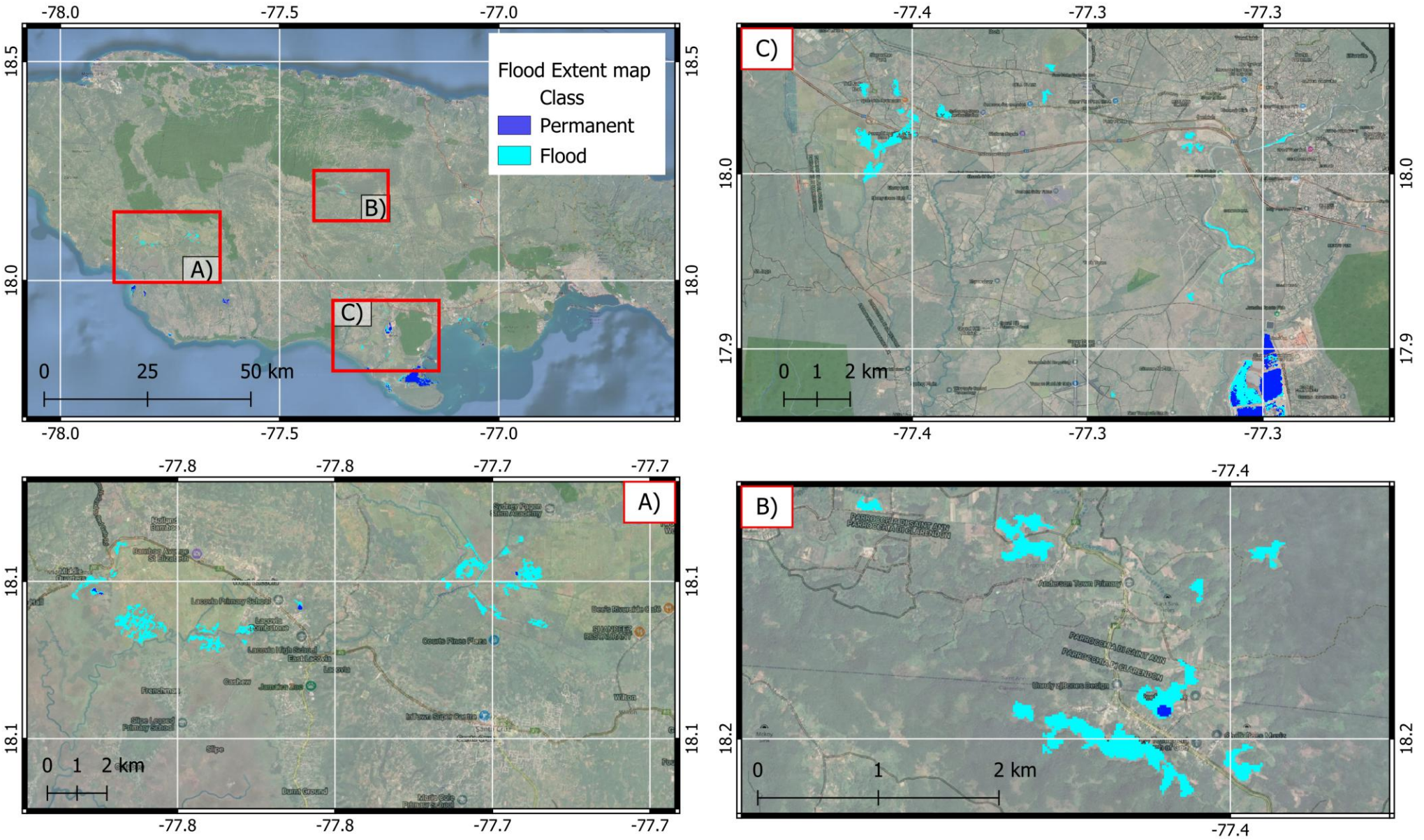
Copernicus LAC PANAMÁ

UC1 – Areas of Interest

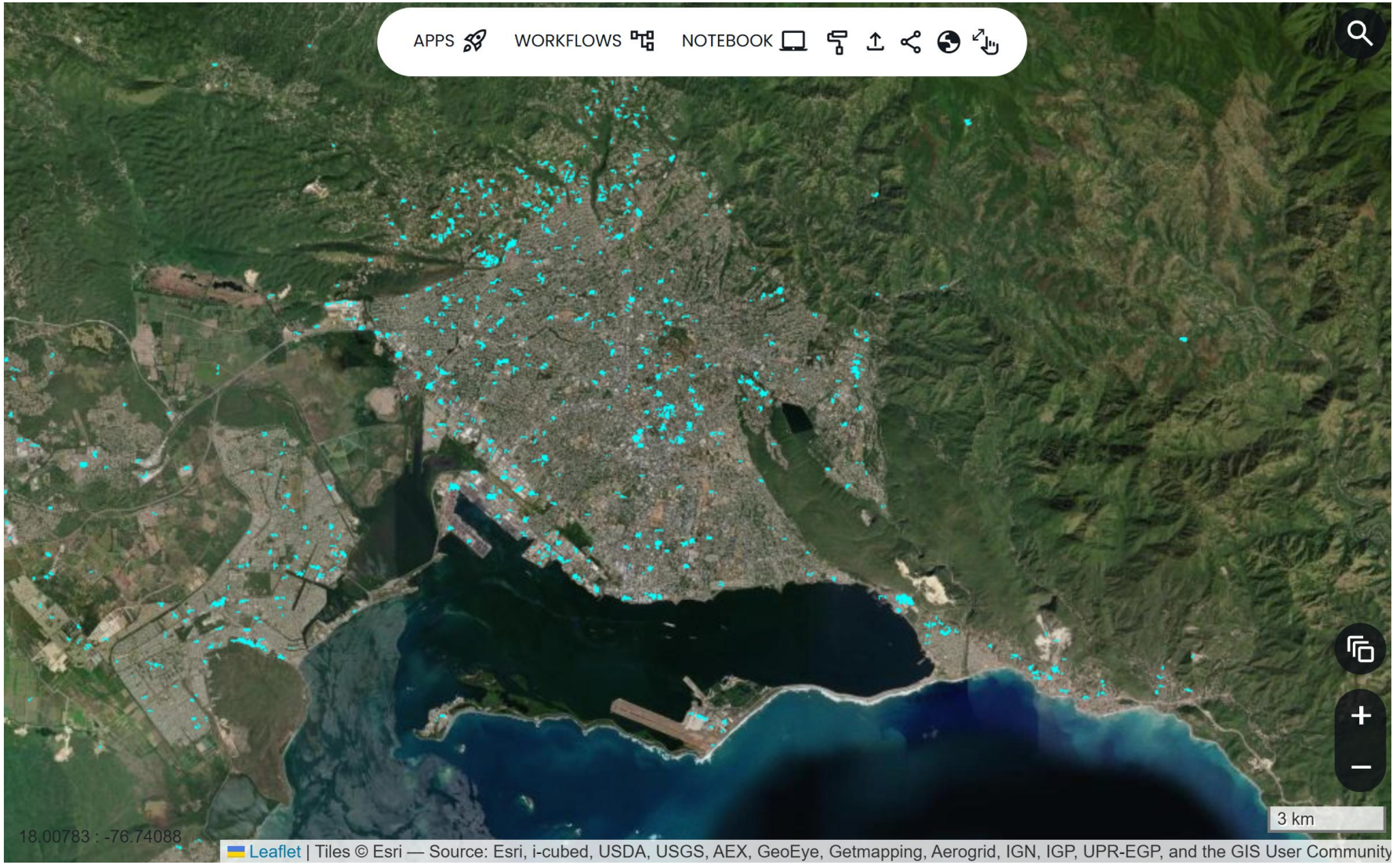




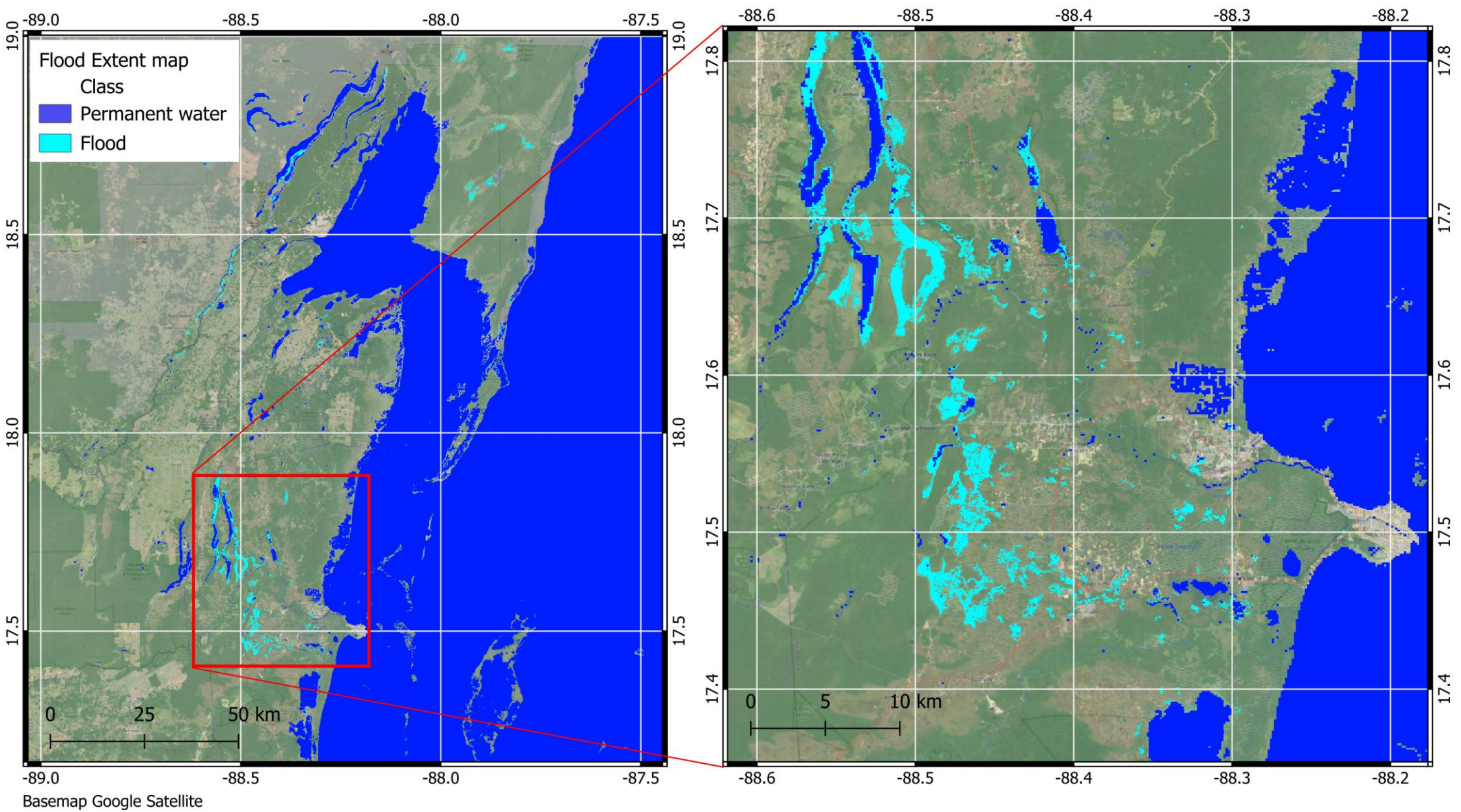
Flood in Guyana -Flood maps based on Sentinel-1 data acquired on the 06/06/2021



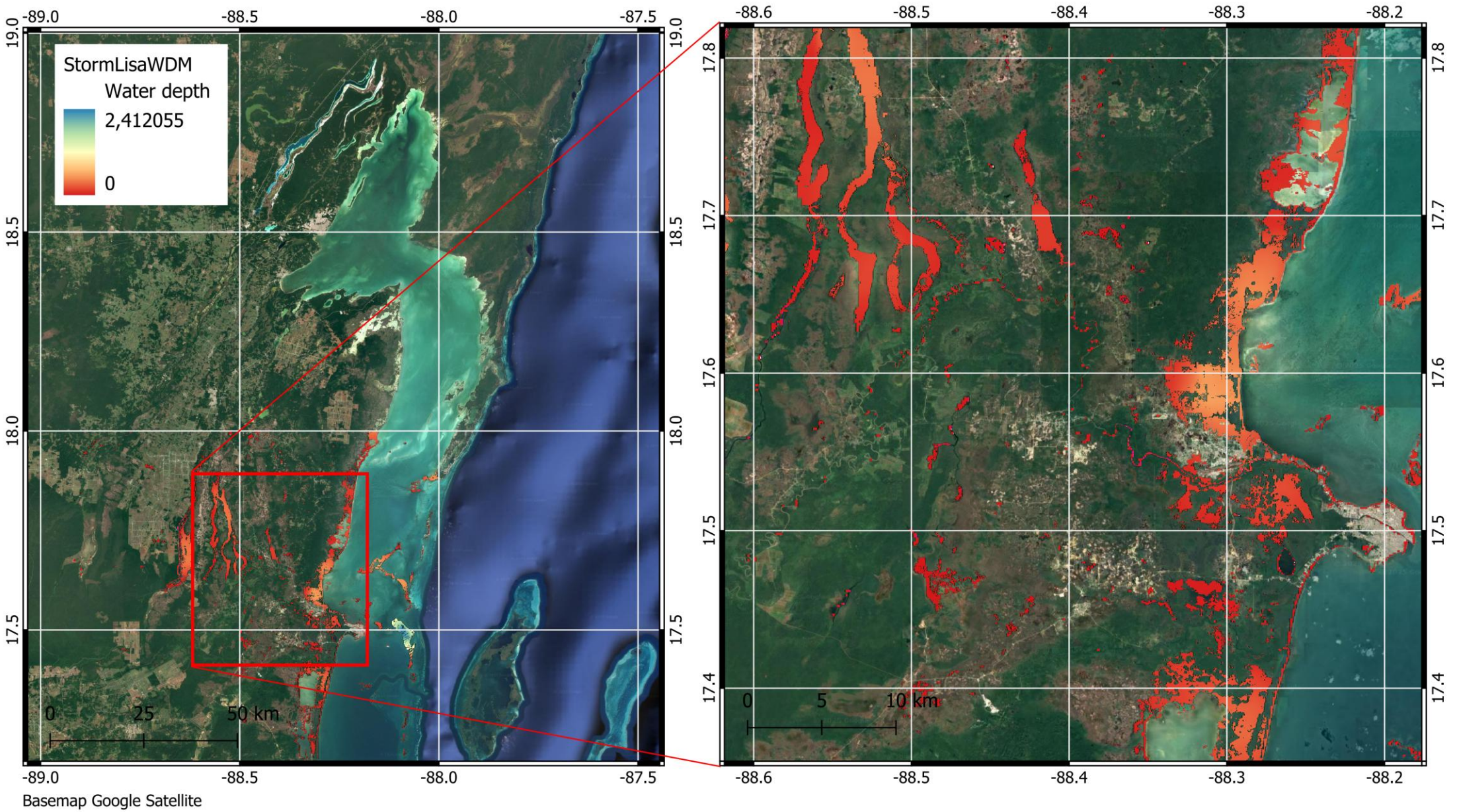
Storm Grace in Jamaica - Flood maps based on Sentinel-1 data aquired on the 27/08/2021



Urban Flooding in Kingston - - Greater Antilles Floods Nov 2023



Storm Liza in Belize - Flood maps based on Sentinel-1 data acquired on the 3/11/2022



Storm Liza in Belize – Water depth maps based on Sentinel-1 data acquired on the 3/11/2022

THE PRE-OPERATIONAL DEMONSTRATION PHASE

Set-up and challenges

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The pre-operational demonstration phase

Info on the demo phase:

- **Start date**: mid-end September 2025
- **End date**: mid-end December 2025
- ROI: Belize, Guyana and Jamaica

- Users will be able to produce new flood maps on their own by using the following services on the Specialized Processing Environment:
  - Flood Extent Mapping (FEM) Service URL: Copernicus LAC. Full tutorial of the FEM service accessible via this LINK.
  - Flood Depth Mapping (FlDM) Service URL: Copernicus LAC. Full tutorial of the FDM service accessible via this LINK

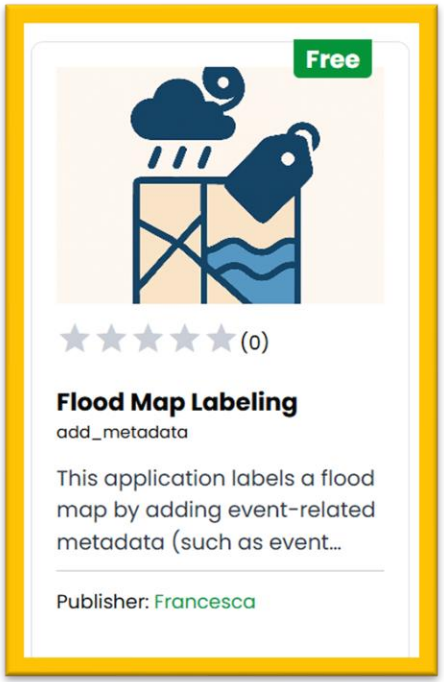
The pre-operational demonstration phase

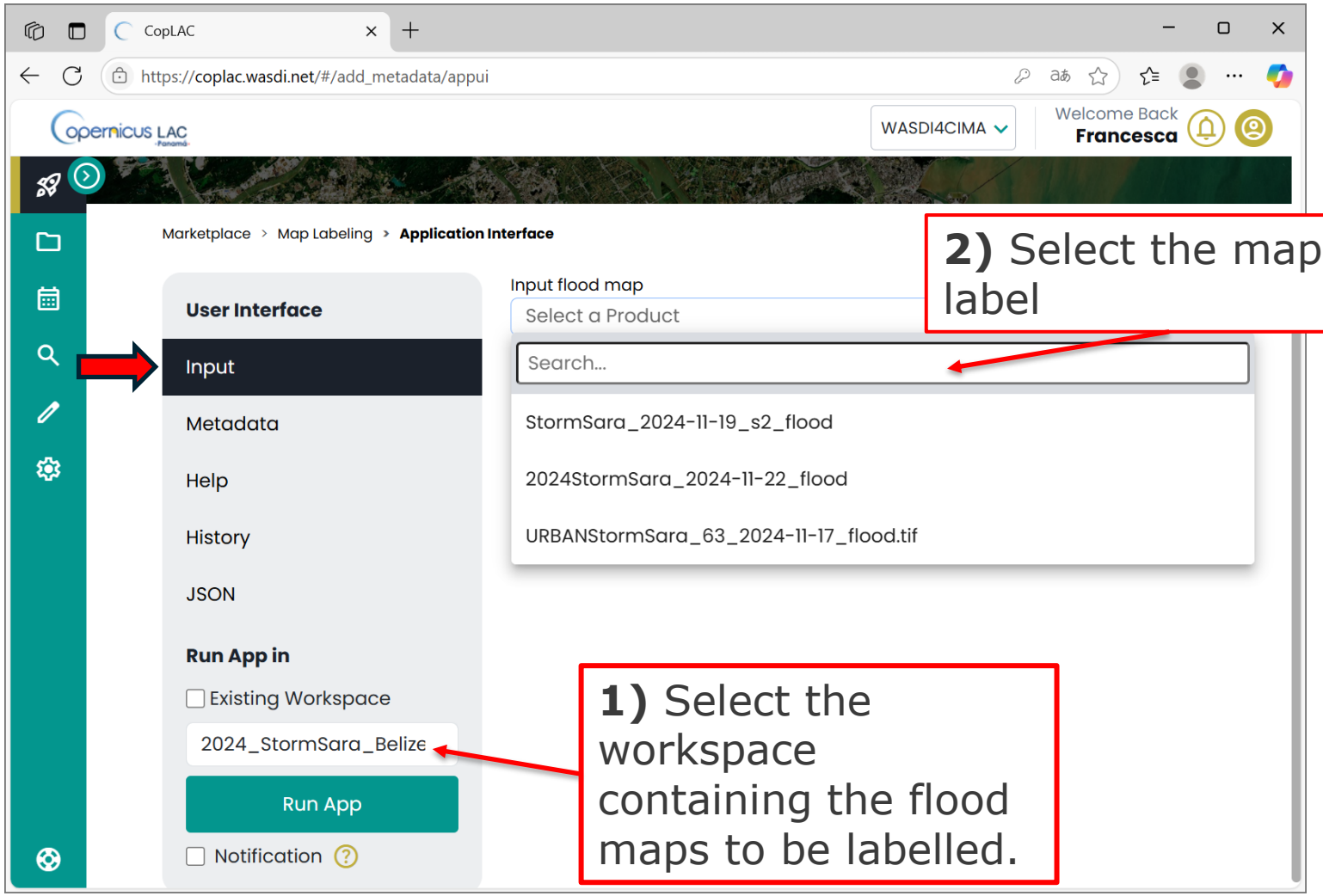
The services developed for the Use Case 1 – Flood Preparedness in the Carribean - support both the reconstruction of past flood events and the forecasting of analogous events. The core idea is to use historical flood data, identified by the user within the target areas, to build a comprehensive set of possible flooded areas. This collection of reference events can then serve as analogous scenarios whenever a new flood event is expected to impact the region.

During demo phase users will have access to the following data and tools:

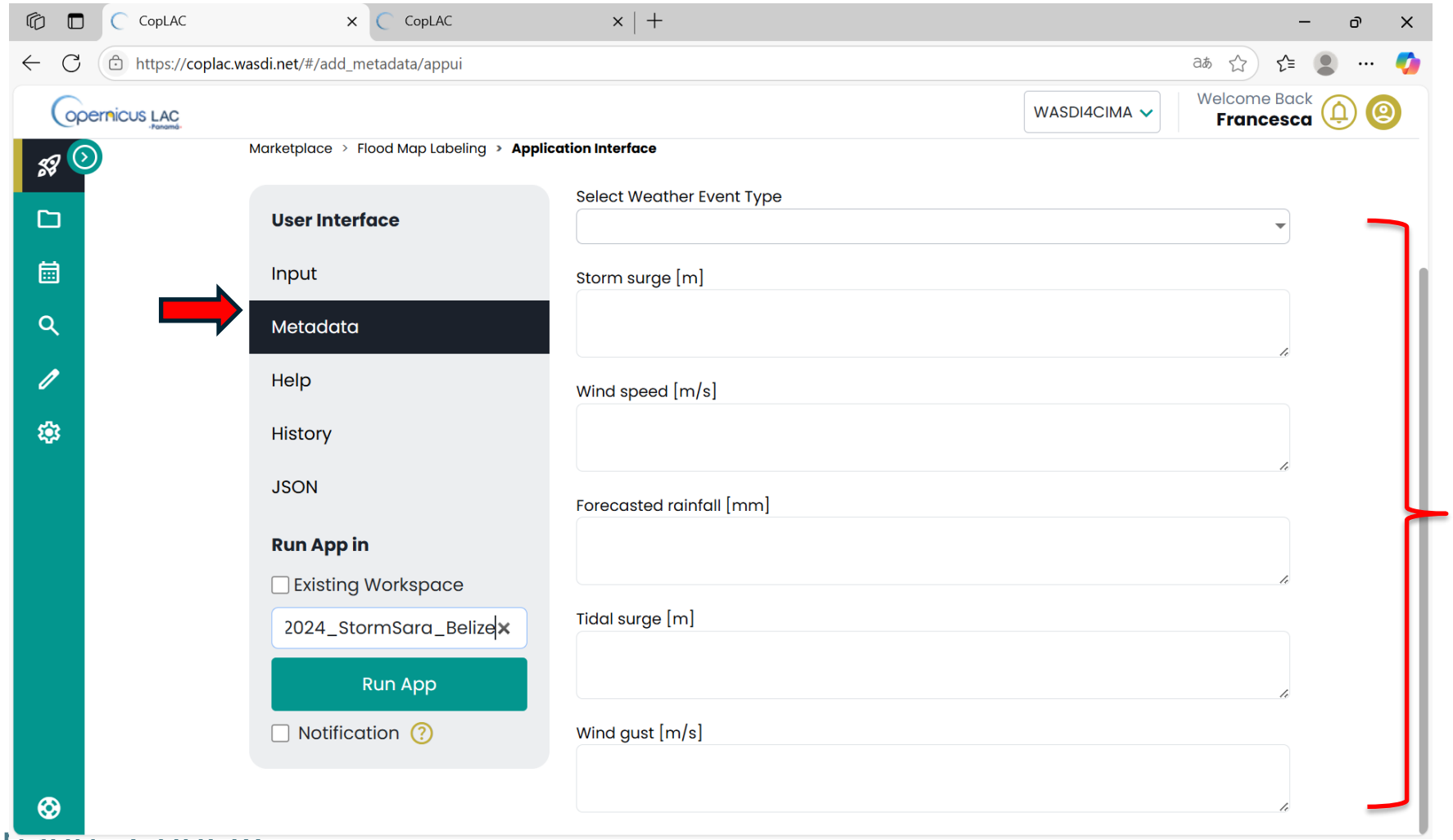
- **Past event archive workspace** containing all flood extent maps produced for individual dates, some of which are already labeled. For example, the archive for Belize users is available at the following link Copernicus LAC.
- **Flood Map Labeling** App (Available at Copernicus LAC): the application labels a flood map by adding event-related metadata (such as event type, storm surge, wind speeds, rainfall, and more) into the image file. The result is a new GeoTIFF with updated metadata, useful for cataloguing, filtering, and future automated processing.
- **Map Fetching By Metadata** App (Available at Copernicus LAC): the application searches through the catalogue of flood maps available in a workspace, filtering them based on user-defined metadata—such as storm surge, cyclonic wind speed, rainfall, tidal surge, or wind gust. All maps that match the selected criteria are automatically copied to a new workspace for easy access and further analysis. The search will retrieve flood maps with trigger values greater than or equal to the value you set. The search is currently designed to retrieve all maps that satisfy at least one of the search parameters.

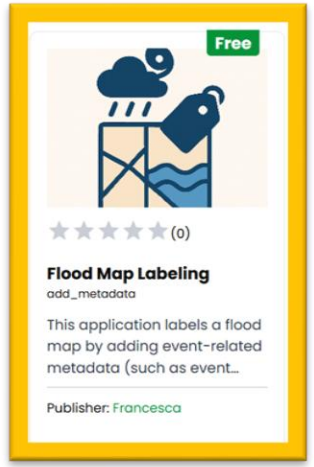
Adding triggers as metadata – Flood Map Labeling App on the Specialized PE





Adding triggers as metadata – Flood Map Labeling App on the Specialized PE



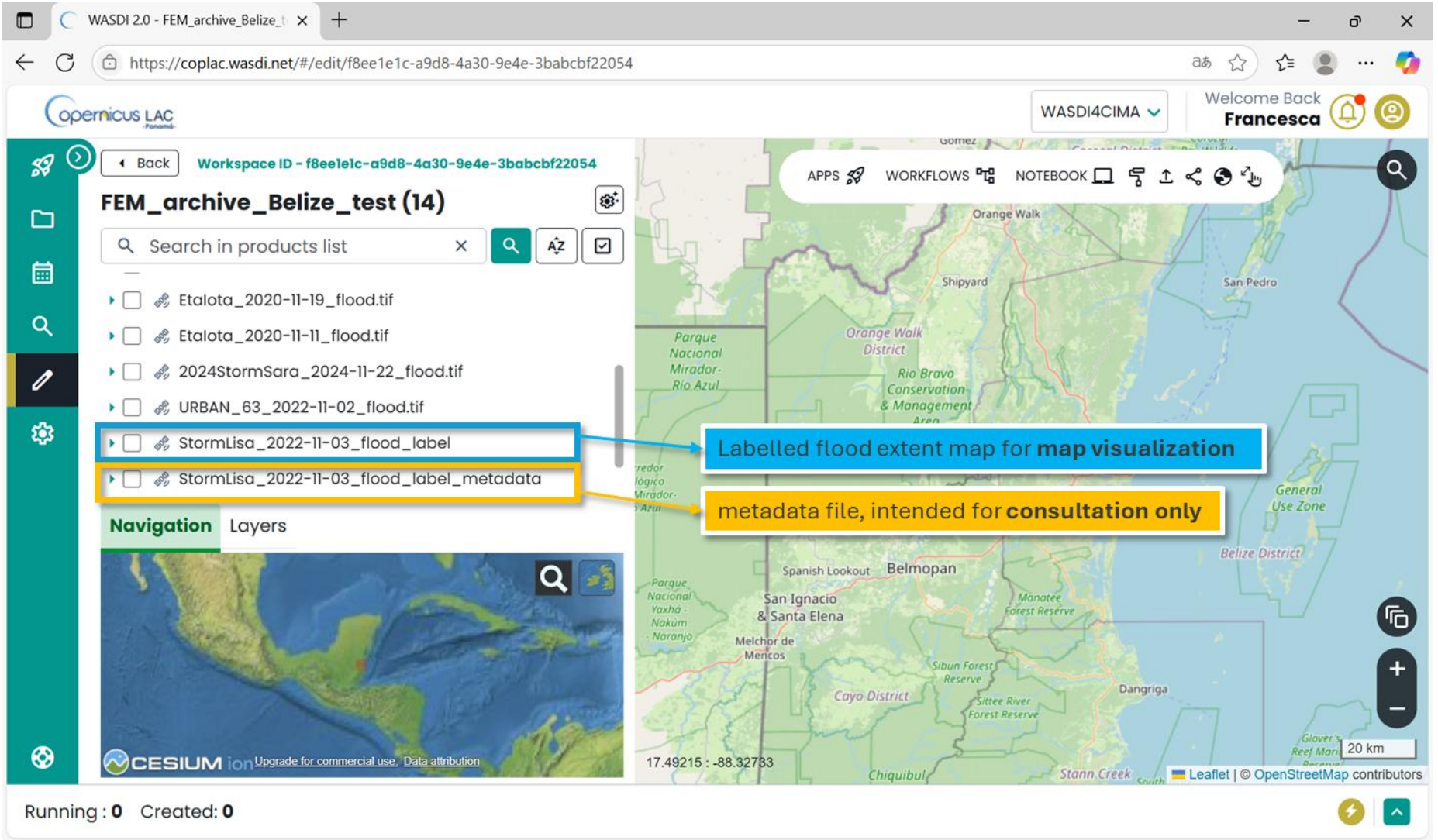


Form to be filled with the values associated with the identified variables.

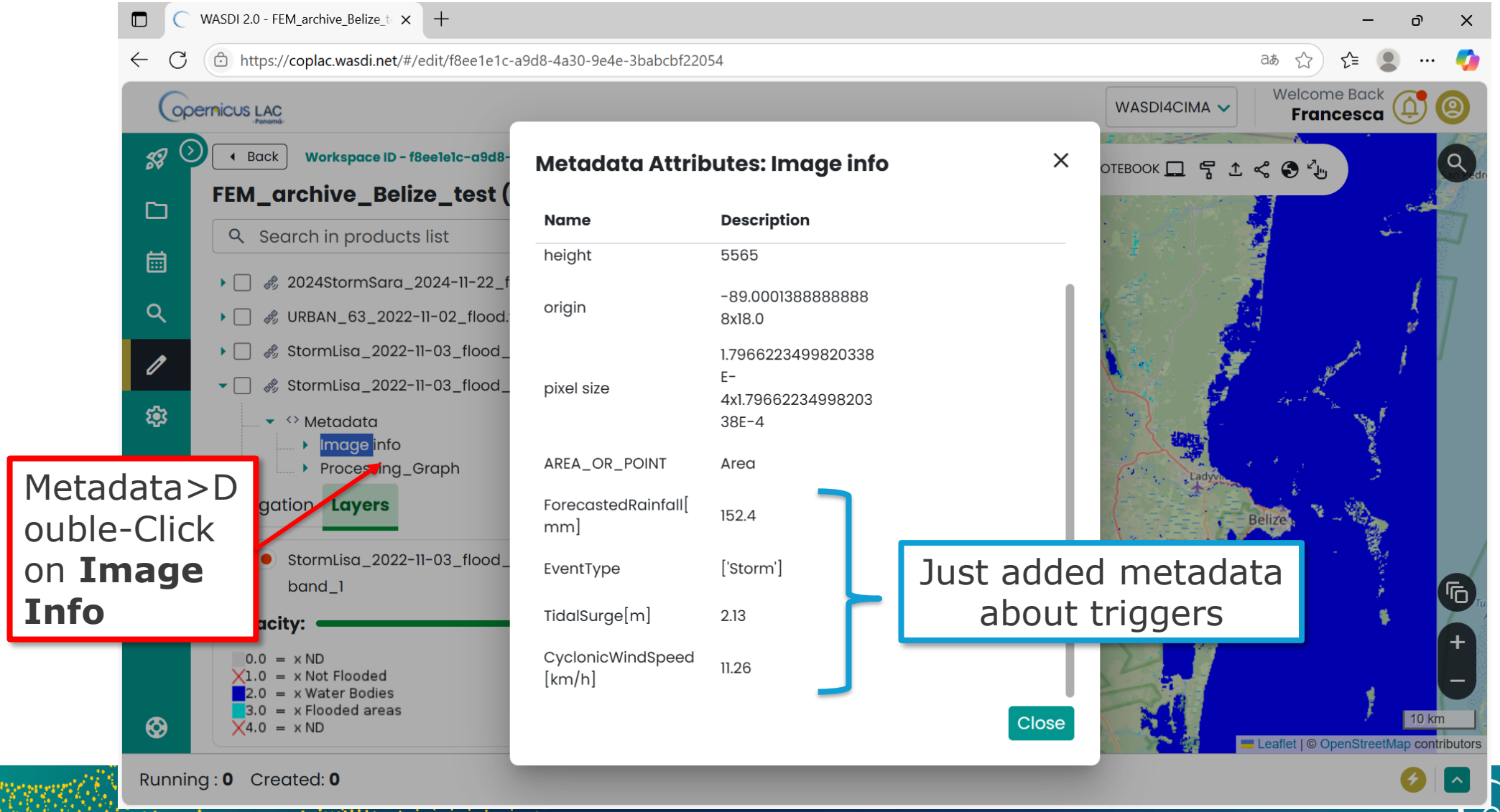
webpage: CopLAC

Flood Map Labeling App - output

- One file is used for map **visualization**, allowing you to display the flood extent layer on the map interface.
- The other is a **metadata** file, intended for **consultation** only, which contains detailed information about the corresponding flood map



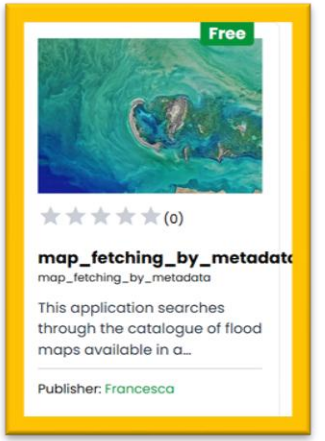
Flood Map Labeling App - output

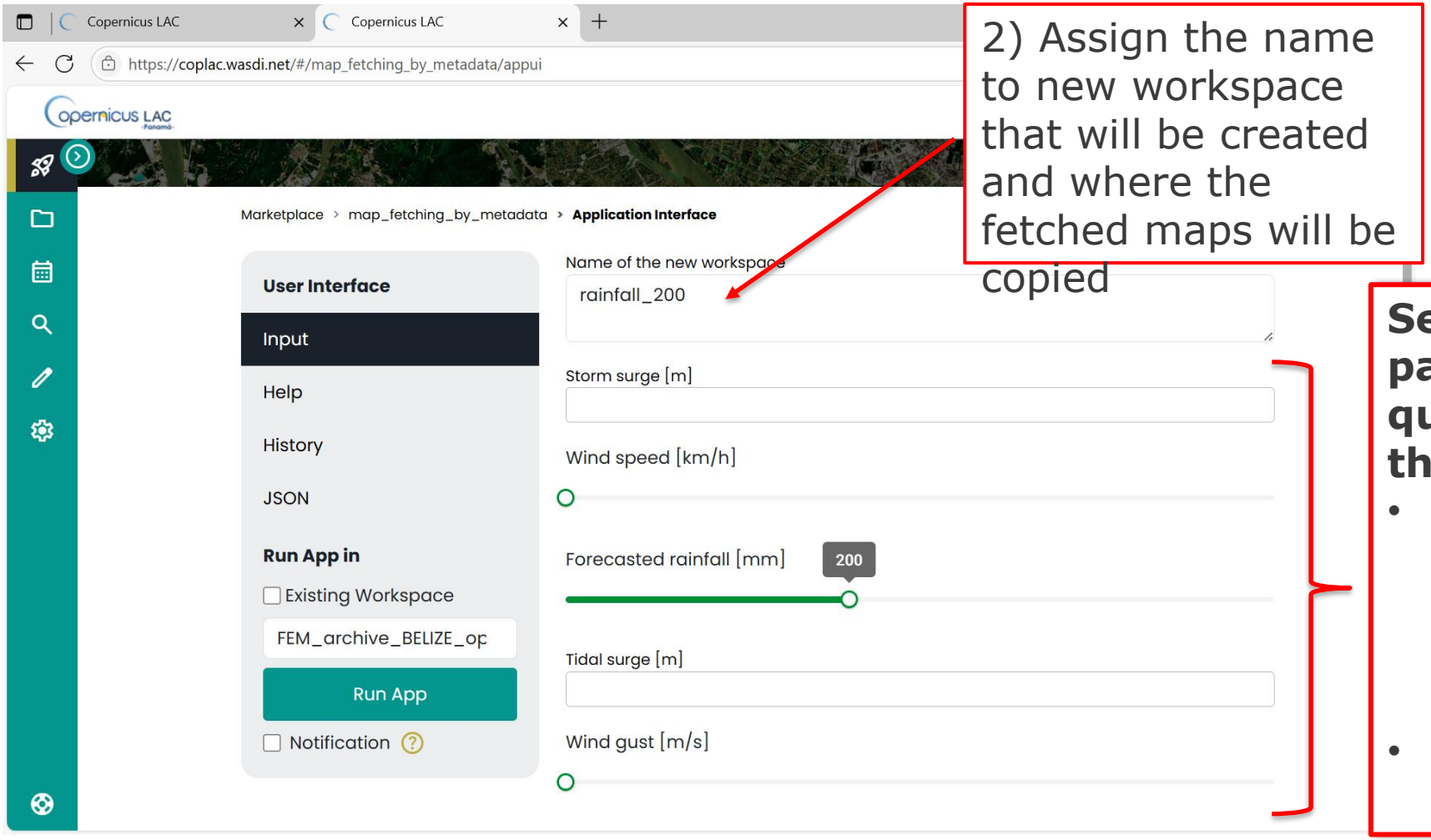


Metadata>Double-Click on **Image Info**

Just added metadata about triggers

Fetching Archive by Metadata – Map Fetching By Metadata App





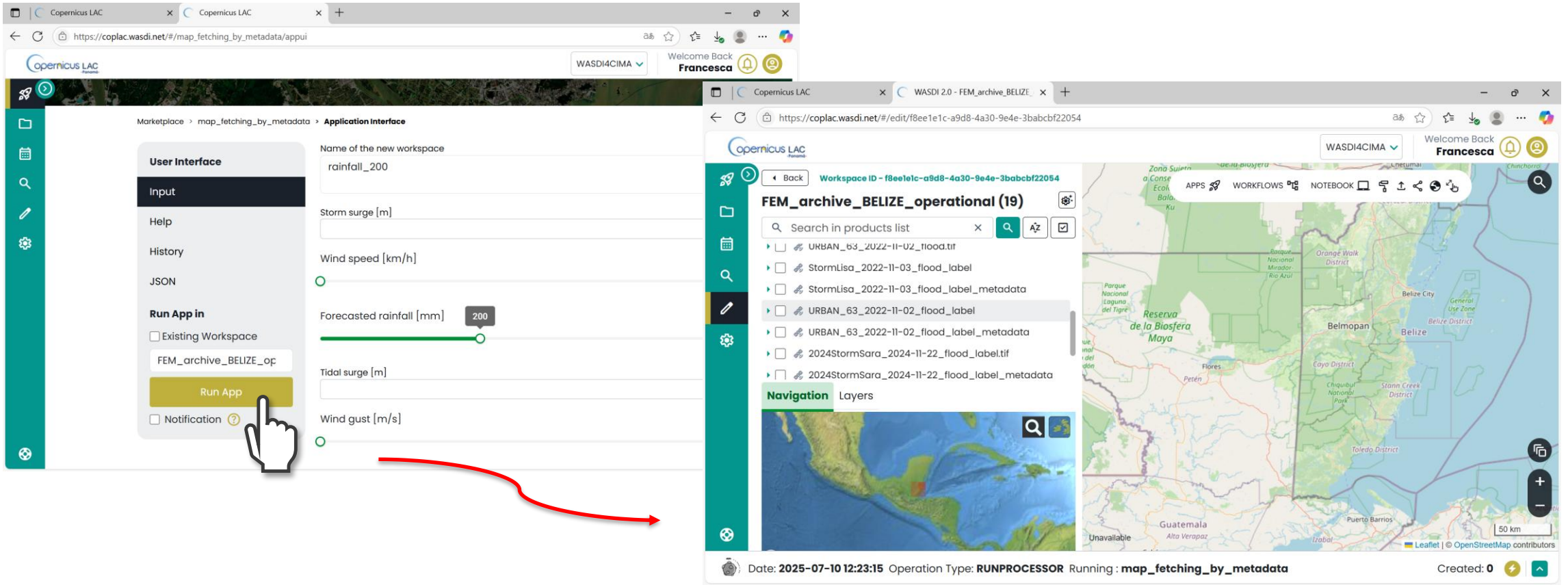
2) Assign the name to new workspace that will be created and where the fetched maps will be copied

Set the filters on the parameters for your query. Keep in mind that:

- The search will retrieve flood maps with trigger values **greater than or equal to** the value you set.
- The search is currently designed to retrieve **all maps that satisfy at least one** of the search parameters.

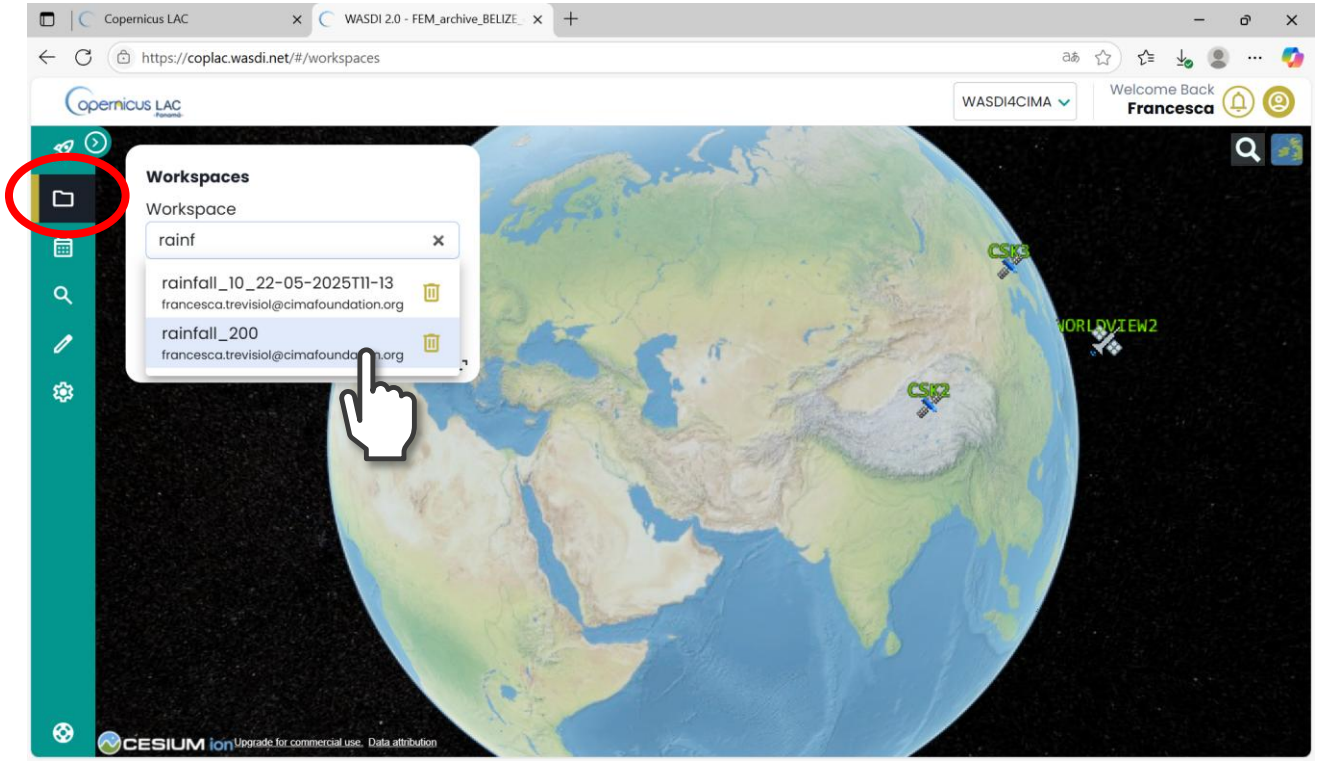
Fetching Archive by Metadata - Output

- Once all parameters are set, click the **"Run App"** button in the Main Menu. The platform will automatically redirect you to the workspace you selected (the archive).



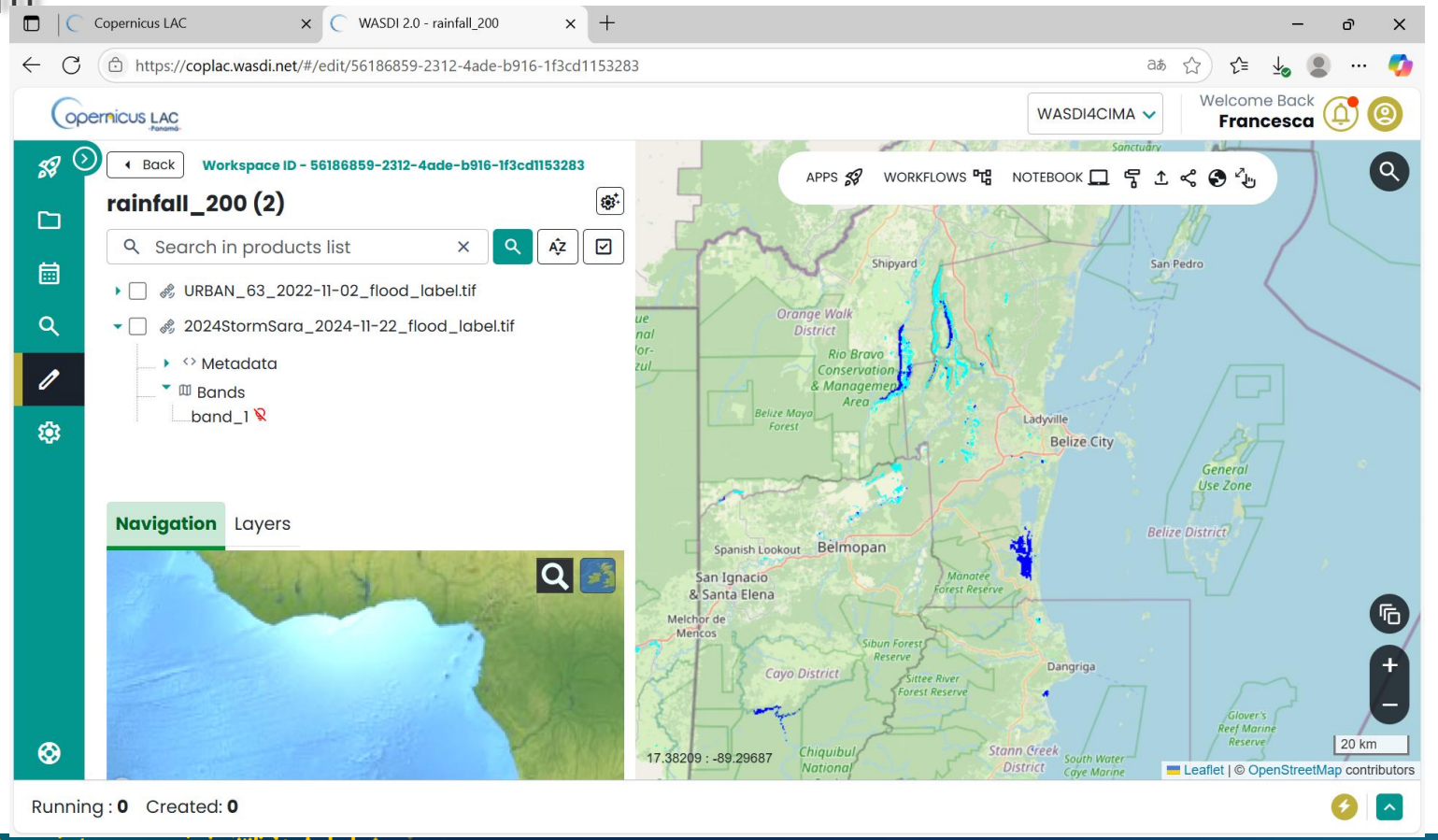
Fetching Archive by Metadata - Output

- After few seconds in the list of your workspace, in the workspace menu, you will find the new one, for this example "*rainfall_200*"
- **Open "rainfall_200"** and you will see the list of flood extent maps satisfying your query. In this example, you will retrieve the flood extent maps with associated forecasted rainfall > 200 mm



Fetching Archive by Metadata - Output

- **Open "rainfall_200"** and you will see the list of flood extent maps satisfying your query. In this example, you will retrieve the flood extent maps with associated forecasted rainfall > 200 mm



The pre-operational demonstration phase

Expectations and activities

- Completion of validation and metadata triggers
- Specialization of the User interface by countries for metadata insertion and data fetching: dedicated bilateral sessions
- SOP consolidation
  - Simple document description of the current SOP (per institution)
  - Bilateral meetings to agree on SOP modification with the developed services
  - DBX at the end of the demonstration period
- Capacity Building on the use of all applications including Flood Extent Mapping and Water Depth Estimation
- Final User Feedback
- Consolidation of the specialised PE with existing platforms at CIMH

Challenges for pre-operational demonstration phase

1. **Technical Performance & Service Maturity:** Robust flood extent/depth mapping but limited by e.g. satellite acquisitions and cloud coverage.
   Opportunity: modular system allows AI/EO integration & urban use cases

2. **Institutional Uptake & Engagement:** The flood map archive of past event relies on user feedback, validation and triggers assignment. Varying country involvement (strong in Belize & Guyana; limited in Jamaica). Need for structured capacity-building, Standard Operating Procedures & inter-agency coordination.
   Opportunity: CIMH leadership as regional champion, fostering collaboration.

3. **Technological Feasibility (On-Premises Deployment):** Hybrid model (local + cloud) offers autonomy & reduced latency. It is challenging due to infrastructure demands, security, IT expertise retention.
   Opportunity: scalable model, supports digital sovereignty in Small Island Developing States

4. **Operational Sustainability & Replicability:** Long-term success depends on integration into routine workflows. This requires shared standards, regional coordination, and platform integration (e.g., in IT platforms and forecasting tools already in use at CIMH)
   Opportunity: scalable to other hazards (droughts, wildfires, geo-hazards)