Copernicus LAC
Panamá

Overview of the CopernicusLAC EO Services Development & Transfer Activity

Appendix

Date: 13/10/2025

Global Gateway
PROGRAMME OF THE EUROPEAN UNION
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TERMS AND ACRONYMS

Acronym	Description
ABE	Agencia Boliviana Espacial (Bolivian Space Agency)
AEB	Agência Espacial Brasileira (Brazilian Space Agency)
AEP	Agencia Espacial del Paraguay
ALCE	Agencia Latinoamericana y Caribeña del Espacio (Latin American and Caribbean Space Agency)
ANA	Autoridad Nacional del Agua (National Water Authority) - Peru
AOI	Area of Interest
CCRIF	The Caribbean Catastrophe Risk Insurance Facility
CDC	Copernicus LAC Panama Centre
CDEMA	Caribbean Disaster Emergency Management Agency
CENAPRED	Centro Nacional de Prevención de Desastres (National Center for Disaster Prevention) - Mexico
CENEPRED	Centro Nacional de Estimación, Prevención y Reducción del Riesgo de Desastres (National Center for Disaster Risk Estimation, Prevention, and Reduction) - Peru
CEOS	Committee on Earth Observation Satellites
CEPREDENAC	Centro de Coordinación para la Prevención de los Desastres Naturales en América Central (Coordination Center for the Prevention of Natural Disasters in Central America)
CIMH	Caribbean Institute for Meteorology and Hydrology

CINCH	Centro de Información y Coordinación Hidrometeorológica (Center for Hydrometeorological Information and Coordination)
CITEC	Centro de Investigación y Tecnología del Clima (Center for Climate Research and Technology)
CNE	Comisión Nacional de Emergencias (National Emergency Commission) - Costa Rica
CONIDA	Comisión Nacional de Investigación y Desarrollo Aeroespacial (National Commission for Aerospace Research and Development) - Peru
CONRED	Coordinadora Nacional para la Reducción de Desastres (National Coordination for Disaster Reduction) - Guatemala
COPECO	Comisión Permanente de Contingencias (Permanent Contingency Commission) - Honduras
CRIS	Crisis Response Information System
DGPC	Dirección General de Protección Civil (General Directorate of Civil Protection) - El Salvador
DMH	Dirección Meteorológica de Honduras (Meteorological Directorate of Honduras)
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DTM	Digital Terrain Model
EMS	Emergency Management Services
ENSO	El Niño-Southern Oscillation
EO	Earth Observation
EO Services Development	Earth Observation Services Development project
ESA	European Space Agency
ESRIN	European Space Research Institute (part of ESA)
FAN	Fondo de Adaptación Nacional (National Adaptation Fund) - Colombia
FAO	The Food and Agriculture Organization – United Nations
FIRMS	Fire Information for Resource Management System (by NASA)
GDP	Gross Domestic Product
GEP	Global Earthquake Model Program
GFDRR	Global Facility for Disaster Reduction and Recovery
GloFAS	Global Flood Awareness System
GRD	Ground Range Detected
HMS	Hydro-Meteorological Service of Guyana
IADB	Inter-American Development Bank
IDEAM	Instituto de Hidrología, Meteorología y Estudios Ambientales (Institute of Hydrology, Meteorology, and Environmental Studies) - Colombia
IFI	International Flood Initiative
IGP	Instituto Geofísico del Perú (Geophysical Institute of Peru)
IMHPA	Instituto Meteorológico e Hidrológico de Panamá (Meteorological and Hydrological Institute of Panama)
INDECI	Instituto Nacional de Defensa Civil (National Institute of Civil Defense) - Peru
INFONA	Instituto Forestal Nacional (National Forestry Institute) - Paraguay
INGEMMET	Instituto Geológico Minero y Metalúrgico (Geological, Mining, and Metallurgical Institute) - Peru
INRE	Instituto Nacional de Reforma Agraria (National Institute of Agrarian Reform) - Bolivia
INTPA	International Partnership for the Development of Agrometeorology
JRC	Joint Research Centre
LAC	Latin America and the Caribbean

MNR	Hydrolgy Dept. – Ministry of Natural Resources
MSJ	Meteorological Service of Jamaica
NBR	Normalized Burn Ratio
NEMO	National Emergency Management Organization
NMS	National Meteorological Service
NOAA	National Oceanic and Atmospheric Administration - USA
OPDEM	Office of Disaster Preparedness and Emergency Management
PMI	Project Management Institute
SAR	Synthetic Aperture Radar
SAT	System of Alert and Response
SEN	Secretaría de Emergencia Nacional (National Emergency Secretariat) - Paraguay
SENAMHI	Servicio Nacional de Meteorología e Hidrología (National Meteorology and Hydrology Service) – Peru and Bolivia
SINAGER	Sistema Nacional de Gestión del Riesgo (National Risk Management System) - Honduras
SINAPROC	Sistema Nacional de Protección Civil (National Civil Protection System) - Mexico
SINCH	Sistema Nacional de Información y Coordinación Hidrometeorológica (National Hydrometeorological Information and Coordination System)
SNGR	Secretaría Nacional de Gestión de Riesgos (National Risk Management Secretariat) - Ecuador
TBD	To Be Defined
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction
UNEP	United Nations Environment Programme
UNGRD	Unidad Nacional para la Gestión del Riesgo de Desastres (National Unit for Disaster Risk Management) - Colombia
URD	Unidad de Respuesta a Desastres (Disaster Response Unit)
VIDECI	Viceministerio de Defensa Civil (Vice Ministry of Civil Defense) - Bolivia
WB	World Bank
WRA	Water Resources Authority

COUNTRY ABBREVIATIONS

Acronym	Description
Caribbean	
CU	Cuba
DO	Dominican Republic
HT	Haiti
JM	Jamaica
AG	Antigua and Barbuda
BB	Barbados
DM	Dominica
GD	Grenada
KN	Saint Kitts and Nevis
LC	Saint Lucia
VC	Saint Vincent and the Grenadines

TT	Trinidad and Tobago
BS	Bahamas
North America	
MX	Mexico
Central America	
BZ	Belize
CR	Costa Rica
SV	El Salvador
GT	Guatemala
HN	Honduras
NI	Nicaragua
PA	Panama
South America	
BO	Bolivia
CO	Colombia
EC	Ecuador
GY	Guyana
PE	Peru
SR	Suriname
VE	Venezuela
AR	Argentina
BR	Brazil
CL	Chile
PY	Paraguay
UY	Uruguay

1. INTRODUCTION AND PURPOSE OF THE DOCUMENT

This Appendix is a complement to the 'Overview of the CopernicusLAC EO Services Development & Transfer Activity' report. It includes further elaboration beyond the assessment of information priorities and associated EO based developments provided in the report's main document. In particular, it provides detailed explanations on the Services (overview, inputs, products, usage in demonstrations with users) and the Use Cases (users involved, area of interest, demonstration exercise and operational scenario)

This document is shareable with the same audience as the report's main document.

2. SERVICES AND USE CASES DESCRIPTION

2.1 Summary

The Service Development activity provides the Panama Centre with eighteen open-source services plus two proprietary services accessible via permanent license. These services divide into three themes: hydrometeorological hazards (ten services for floods, three for fires, and one for drought), geological hazards (one service for landslides, and two for terrain motion) and exposure mapping (one service for urban context mapping, and one service for economic value mapping). In addition, three ancillary layers of exposure theme are made available to the users.

The full portfolio of services is accessible through the CopernicusLAC Platform (link to the Online User Manual) and its complementary Specialized Processing Environment (link to the Online User Manual). The Specialized Processing Environment hosts advanced hydromet services that are also used in a pre-operational demonstration with EO based workflows integrated in the digital infrastructure of the Caribbean Institute for Meteorology and Hydrology (CIMH).

The services are demonstrated in twelve use cases with the same themes as the services themselves. The use cases consist of pre-operational implementation of the services to certain areas in Latin America and the Caribbean to demonstrate their capabilities to the end-users and to tailor the processing chains to the needs of the region. The use case evolves in parallel with the service co-development with the end-users, who for this purpose play defined roles with associated efforts.

Table 1 : Services catalogue: name, code and acronym per hosting platform

Theme	Service acronym	CopernicusLAC platform	Specialized Processing Environment
		Service code and name	
Hydrometeorological Hazard	COIN-CD	**S14 SAR Features (amplitude and coherence maths)**	
	FEM	**S15 Flood Extent Mapping (SAR-based)**	**S1 Flood Extent Mapping**
	FFM	**S16 Flood Frequency Mapping (SAR-based)**	**S2 Flood Frequency Mapping**
	FlDM	**S17 Flood Depth Mapping**	**S3 Flood Depth Mapping**
	FHM	**S18 Flood Hazard Mapping**	**S4 Flood Hazard Mapping**
	DI		**S5 Drought Indices**
	UFM		S19 Urban Flood Mapping
Wildfires	BAM	**S6 Burned Area Mapping**	
	FDM	**S7 Fire Danger Mapping**	

	FRM	**S8 Post-fire Recovery Mapping**	
Geohazards	LSHM	**S9 Landslide Susceptibility and Hazard Mapping**	
	kinesIS	**S10 Interferometric Stacking**	
	TM-GD	**S13 Terrain Motion 3D Geometric Decomposition**	
	SNAPPING	S20 SNAPPING IFG and SNAPPING PSI	
Exposure	PD	**S11 Population Distribution**	
	EVM	**S12 Economic Value Mapping**	
	WSF Tracker		
	WSF 3D		
	WSF Imperviousness		

Table 2: color code of Table 1

Proprietary Service
Layers (not services)
Service under development
Service integrated in the platform and available
Service implementation under way
Service development not started

The Service Development activity has reached Milestone 2 of the project. At this point, of the eighteen open-source services, seven are in version 4 (i.e., they have completed the development process and are also deployed on the platform), and three are in version 2 (i.e., they are halfway through the Agile development process). The version 4 services are the three fire services (S6, S7, S8), three flood services (S1, S2, S3) , and one landslide service (S9). In addition, two extra services for on-demand flood mapping have completed their unique cycle of development (S15 and S16). Table 1

maps the full catalogue of the services including their name, acronym and code, and divided per hosting platform. The table follows a color code to reflect the status of developments or nature of the service/geospatial layer (Table 2).

The status of this development is directly linked with the use cases which give the framework of the co-development. The Use Case of the fire services is close to closure as it has already completed the pre-operational demonstration phase. The use cases of floods (UC1, UC2) and landslides (UC7) linked to the services S1, S2, S3 and S9 will enter the pre-operational demonstration phase soon. The use cases of terrain motion and economic value mapping are halfway through their lifetime.

2.2 The Services

The following pages provide a summary of all services to be developed, with a narrative exposing:

- Service overview in non-technological language: description of what the service does
- Products delivered: name and description
- Data used: with emphasis in EO information
- Usage in demonstrations with users:
    - Use cases that make use of the service (for details see section 2.3.3. of the main document and section 2.3 of this Appendix)
    - The special execution of the service tailored to users' requests.
    - Extra data employed, if any.
    - Articulation with other services within the use case, if proceeds.
    - Mode of execution.

2.2.1 Open services

2.2.1.1 Flood Extent Mapping (FEM, S1-S15)

- Overview: A service to map the full extent of a flood during a specific event.
- Products delivered: Flood delineation map, showing the maximum extent of water coverage during a flood.
- Data used: Sentinel-1 GRD only, or also Sentinel-2 L2A
- Usage in demonstrations with users: employed in multiple use cases as a stand-alone service or articulated inside other processing chains to provide single or multiple flood extents as input data. For more information see Use Cases 1 to 4 in section 2.2
    - In the application over the Caribbean (section 2.3.1) the service is exploited stand-alone for single past flood event analysis and mapping for preparation purposes. The flood extent maps are used as inputs for the service Flood Depth Mapping (S3).
    - In the application over Colombia (section 2.3.2) the service is executed in a systematic way over a defined area every time there are new passes of satellites to provide monthly flood extents. It is also used within the processing chain of the Flood Frequency Mapping service to extract all the flood extents within a time period (which can be limited or applied to the whole catalogue of Sentinel-1/Sentinel-2).

2.2.1.2 Service 2 (S2): Flood Frequency Mapping (FFM, S2-S16)

- Overview: service to analyze historical flood events and identify frequently affected areas.
- Products delivered: empirical flood frequency maps, indicating how often specific locations have been flooded, in terms of return period.
- Data used: Sentinel-1 GRD only, or also combined with Sentinel-2 L2A
- Usage in demonstrations with users: employed in several use cases as a stand-alone service or articulated inside other processing chain to provide an empirical flood frequency map as input data. For more information see Use Cases 2 to 4 in section 2.2.
    - In the application over la Mojana (Colombia (section 2.3.2) the service is exploited as a stand-alone service and is executed yearly in a systematic mode to analyze the whole catalogue of Sentinel-1 and Sentinel-2 data over the Area of Interest. It uses as input data all the monthly flood extents provided by the Flood Extent Mapping executed in a monitoring, systematic mode.
    - In the applications over Bolivia (section 2.3.3,TBC) and over Central and South America (section 2.3.4) the service is used to provide adjusted flood hazard maps by combining service outputs with hazard maps from hydrological/hydraulic models.

2.2.1.3 Service 3 (S3): Flood Depth Mapping (FlDM, S3-S17)

- Overview: Service to estimate the depth of floodwaters during specific events.
- Products delivered: map of maximum water depth per pixel.
- Data used: flood extent map (user-provided or produced by the Flood Extent Mapping service), elevation and drainage data.
- Usage in demonstrations with users: the service is used in several use cases as a stand-alone service or articulated within other processing chain to provide flood depth maps as input data.
    - In the applications over the Caribbean (section 2.3.1) and Colombia (section 2.3.2) the service is executed on demand by the user to extract the depth of each flooded pixel within a user-selected AOI. In the applications over Bolivia (section 2.3.3,TBC) and the application over Central and South America (section 2.3.4), the service is part of the flood hazard workflow (see 2.2.1.4)

2.2.1.4 Service 4 (S4): Flood Hazard Mapping (FHM, S4-S18)

- Overview: Service to combine satellite-derived flood frequency data with hydrological models to assess flood hazard.
- Products delivered: hazard maps providing information on water depth and return periods.
- Data used: hydrological/hydraulic models' outputs and EO data (Sentinel-1 only)
- Usage in demonstrations with users: employed in two use cases with variated area of application and input data.
    - in the application over Bolivia (section 2.3.3,TBC) the service is applied to small areas of interest where flood hazard results from a high-resolution local hydrological/hydraulic model exist.
    - In the application over Central and South America (section 2.3.4) the service is applied to extensive areas (big regions within countries) in a systematic mode for mass production to enhance the results of a global hydraulic model (GloFAS).

2.2.1.5 Drought Indices (DI, S5)

- Overview: A service to monitor drought conditions using satellite and climatic data.

- Products delivered: combined drought index and higher-resolution global drought index.
- Data used:
    - Earth Observation data from Sentinel-1, Sentinel-2 and Sentinel-3
    - Regional climatic data
    - Downscaled Global Drought Index
- Usage in demonstrations with users: employed in a single application over Paraguay (see section 2.3.5). It includes WorldCereal datasets of crop maps and seasonality as additional inputs. This application provides, in addition to the results of the service itself, crop masks and anomaly indicators in precipitation, soil moisture and vegetation photosynthetic performance.

2.2.1.6 Burned Area Mapping (BAM, S6)

- Overview: A near real-time monitoring service for wildfire detection and burned area mapping.
- Products delivered: hotspots, fire extent, fire probability and fire severity
- Data used: Sentinel-3 thermal data, Sentinel-2 (bottom of atmosphere) optical data.
- Usage in demonstrations with users: employed in the application over Central America and Colombia (see section 2.3.6)
    - Mode of execution:
        - Development phase: On demand for a specific case study (Chilean wildfires 2023)
        - Demonstration phase: Systematic over Colombia and Central America

2.2.1.7 Fire Danger Mapping (FDM, S7)

- Overview: A tool to estimate fire danger using meteorological, biophysical, and topographical variables derived from diverse data sources.
- Products delivered: fire danger map.
- Data used: static variables (land use/land cover, vegetation height, fire probability, topography); daily fire weather index
- Usage in demonstrations with users: employed in the application over Central America and Colombia (see section 2.3.6)
    - Mode of execution:
        - Development phase: On demand for a specific case study (Chilean wildfires 2023)
        - Demonstration phase: Systematic over Colombia and Central America

2.2.1.8 Post-fire recovery mapping (FRM, S8)

- Overview: Service to estimate vegetation recovery in areas affected by wildfires.
- Products delivered:
    - 15-days-NDVI composites
    - 15-days-vegetation recovery (percentage)
- Data used: Sentinel-2 optical data; fire extent area
- Usage in demonstrations with users: employed in the application over Central America and Colombia (see section 2.3.6)

- Mode of execution:
    - Development phase: on demand over a fire extent area from the case study of Chilean wildfires (2023)
    - Demonstration phase: systematic over automatically detected burned areas in Colombia and Central America.

2.2.1.9 Landslide Susceptibility and Hazard Mapping (LSHM, S9)

- Overview: Service to estimate landslide susceptibility and hazard with Machine Learning and several data sources, including InSAR-derived ground motion rates from other services.
- Products delivered: landslide susceptibility map; landslide potential hazard map.
- Data used:
    - Digital elevation model (DEM)
    - Geological layers: geology and lithology
    - NDVI map
    - Landslide inventory
    - Land use / land cover
    - Ground motion information.
- Usage in demonstrations with users: employed in the application over Peru (see section 2.3.7)
    - Development phase: Offline study
        - Data used:
            - Local geodata information shared by the users
            - Ground motion rates: Outputs of service SNAPPING PSI Full Resolution, run in GEP platform
        - Mode of execution: stand-alone extensive analysis
    - Demonstration phase:
        - Data used:
            - Global geodata information
            - User-inserted landslide inventory
            - Ground motion rates: Outputs of service Terrain Motion mapping – Interferometric Stacking
        - Mode of execution: on demand

2.2.1.10 Terrain motion mapping using the Interferometric Stacking service (IS, S10)

- Overview: A service for mapping the terrain motion of an area.
- Products delivered: average surface motion rates and corresponding uncertainties at pixel level.
- Data used: Sentinel-1 (SLC) imagery.

- Usage in demonstrations with users: employed in all use cases involving geological hazards. (see sections 2.3.7 to 2.3.10)
    - In the application over Peru (section 2.3.7): provides on demand maps of average ground motion rates as input data for the landslide potential hazard estimation processing chain.
    - In the applications over Panama, Ecuador, Mexico and other locations (sections 2.3.8 to 2.3.10): on demand execution and exploitation as a stand-alone service.

2.2.1.11 Population Distribution (PD, S11)

- Overview: A service to provide high-resolution population density estimates.
- Products delivered:
    - Population density map: Estimation of the distribution of the population per pixel.
    - Vector population estimates: Number of residents per building.
- Data used:
    - Reference total population counts optionally provided by the users, or by national census data/UN population estimates.
    - Ancillary open data (Open Street Map, World Settlement Footprint, Google Open Buildings).
- Usage in demonstrations with users: employed in a single application in three cities in LAC (TBD)
    - Mode of execution: users can request updated population density estimates for specific areas by (potentially) refining the data with own population figures.

2.2.1.12 Economic Value Mapping (EVM, S12)

- Overview: Service designed to estimate the economic value of various sectors within a territory by integrating the monetary value of assets and ecosystem services on a per-pixel basis
- Products delivered: detailed land use / land cover map with price per pixel in USD / square meter.
- Data used:
    - For assets:
        - ESA's World Cover
        - Overture Maps (infrastructure)
        - World Settlement Footprint building height
        - Global layer of human settlement (residential and non-residential areas)
        - World Cereal
    - For ecosystem services:
        - Copernicus Digital Elevation Model (DEM)
        - ESA CCI Land Cover
        - ESDAC- Global Rainfall Erosivity R Factor
        - ESDAC- Global Soil Erodibility K factor
        - Soil Carbon Storage

- Usage in demonstrations with users in a single application over certain sites in LAC and extensively in Dominican Republic (see section 2.3.12)

2.2.1.13 Terrain Motion 3D Geometric Decomposition (S13)

- Overview: service to facilitate the interpretation of interferometric measurements of ground motion rates by providing the actual vertical and horizontal motion components.
- Products delivered: Vertical (up, down) and horizontal (East-West) terrain motion components in a regular grid.
- Data used: Sentinel-1 SLC imagery, outputs of Terrain Motion - Interferometric Stacking service (average surface motion rates at pixel level) and SNAPPING IFG and SNAPPING PSI service (average ground motion rates and time series at point-like targets)
- Mode of execution: on demand
- Usage in demonstrations with users: employed in all use cases that involve geohazards (see sections 2.3.7 to 2.3.10))

2.2.1.14 SAR Features (COIN Change Detection) (S14)

- Overview: The service provides a detection of changes in urban areas.
- Products delivered: Built-up area mask and a change detection map indicating building damage or flooding.
- Data used: Sentinel-1 pairs acquired before or after an event.

2.2.2 Proprietary services

2.2.2.1 Urban Flood Mapping (UFM, S19)

- Overview: service for urban flood detection using Artificial Intelligence and an advanced radar analysis.
- Products delivered: enhanced flood maps for urban areas
- Data used: Sentinel-1 SLC imagery.
- Usage in demonstrations with users: employed as a stand-alone service in the applications over the Caribbean and over Colombia.
    - Results to complement the bare-soil flood detection with the Flood Extent Mapping service.
    - Workflow of urban area detection can be executed on demand over the areas of demonstration (see sections 2.3.1 and 2.3.2)

2.2.2.2 SNAPPING IFG and SNAPPING PSI (S20)

- Overview: A service for ground motion monitoring.
- Products delivered (at point-like targets):
    - Average surface motion rates
    - Displacement time series
- Data used: Sentinel-1 SLC imagery
- Usage in demonstrations with users: employed as a stand-alone service in several applications involving geohazards (see sections 2.3.8 to 2.3.10)
    - Mode of execution: on demand

2.3 The Use Cases

The following pages provide a summary of all services to be developed, with a narrative exposing:

- Use Case Definition in non-technological language.
    - Additional specifications on Service Outputs, Frequency of Production, scheduled demonstrations and timeline (based on the phases of each service) are included.
- Demonstration exercise, detailing the pre-operations of the services, with an explanation of:
    - The key users and stakeholders who are particularly relevant to the application of the demonstration exercise, along with the proposed area of interest.
    - The design of the services demonstrations at this stage, including key assumptions that will guide the implementation of the demonstration.
- Operational scenario, in view of the Services Transfer to the Copernicus LAC Panama Centre or other scenarios.
    - The processing chains will be accessible through two geoportals hosted at the Copernicus LAC Panama Centre, available to users across Latin America and the Caribbean.
    - The use costs are associated to the use of processing resources, platform operations and maintenance fees.
    - The Specialized Processing Environment hosts the original hydrometeorological hazard services offered for the Baseline activity and is complementary to the CopernicusLAC platform, which will host the rest of services plus a simplified version of the hydromet services.
    - The geoportals are built on open-source architectures, utilizing open standards, and will include the processing chains developed in all the service developments,
    - Additionally, the geoportals will feature tools for accessing and managing satellite imagery, as well as generating standard products.
    - It is also possible to deploy instances of these platforms at partner or user locations, provided that the installation benefits the country and project resources are available. This approach can help avoid the cost of external processing resources and allows the project to leverage in country resources close to the user.

A short rationale on user selection as well as partners and stakeholders' identification for the Services application and demonstration is also included.

2.3.1 UC#1: Flood extent mapping for preparedness

Definition

Delineation mapping of past flood extents for preparation for future analogous events.

Services applied: S1 (Flood Extent Mapping), S3 (Flood Depth Mapping), S19 (Urban Flood Mapping)

Services demonstration: pre-operations

- Users and stakeholders: the highest level of user and stakeholder interest in this service was expressed in the Caribbean, where strong and frequent hurricanes cause significant damage on an annual basis. Stakeholders identified are CDEMA, CIMH, with the roles of political partner and technical partner, respectively. They selected locations that are prone to regularly occurring urban or port flooding. Final users of the service are the national disaster authorities, the meteorological institutions, and the municipalities of the selected cities of application. The engaged entities are Hydro-Meteorological Service (HMS) of Guyana, Guyana's Civil defense department, National Meteorological Service (NMS) of Belize, Hydrology Department – Ministry of Natural Resources (MNR) (Belize), National Emergency Management Organization (NEMO) (Belize), Meteorological Service of Jamaica

(MSJ), Water Resources Authority (WRA) of Jamaica, and Office of Disaster Preparedness and Emergency Management (OPDEM).

- Areas of Interest: the first demonstration of the services will be in the municipalities of Georgetown (Guyana), Kingston (Jamaica), and in urban areas in Belize with a possibility of roll-out to other locations.
- Demonstration exercise: generation of past flood maps for better preparation against floods, from Sentinel-1 and Sentinel-2 images. Such map generation occurs on a non-rush basis, prior to floods, on demand by the user, who selects the dates of interest. With this, a catalog of 'sample floods' is generated, which are characterized by certain parameters (e.g.: type of provoking event, periodicity, damage extent, etc.) agreed upon by stakeholders, users, and developers. When an event with characteristics like those found in the catalog is predicted, the reference map can be extracted from the system for use in decision making. The system also downloads acquisitions after the event strikes and obtains new flood delineation and water depth maps that will feed the catalog. This exercise is possible thanks to two dedicated applications especially developed for this activity: "Flood Map Labeling" and "Flood Map Fetching".
- The products generated for the user are:
    - Past flood extents catalogue
    - Maximum flood extent and water depth of new flood events
- Essentials and Assumptions: the system must be coupled with meteorological predictions, so there is a need of intervention of a technical user (CIMH in the case of the proposed demonstration). Such a technical user may provide technical assistance to the other users in the Caribbean region. It is also assumed that the floods that are intended to be detected are not flash floods, but rather slow onset floods tied to extreme weather events. In addition, to be truly effective, it is assumed that stakeholders and users will generate a sufficiently robust catalog based on their knowledge about past flooding.

Services operational scenario: the intended forms of exploitation of the services involved (best guess):

- The operational scenario includes the deployment of the services' processing chains in the two geoportals (Specialized Processing Environment and CopernicusLAC platform)
- The Specialized PE will be deployed in the CopernicusLAC Panama Centre and installed on CIMH premises. The CopernicusLAC platform will be installed in the CopernicusLAC Panama Centre.
- The processing chains deployed in the Specialized PE, and their intended forms of exploitation are:
    - Flood Extent Mapping Service: fully transferred in open-source code
        - Articulated in the workflows of other services (FEM, FFM, FlDM)
        - Potentially articulated in the applications developed for the demonstration exercise to operationally exploit the FEM as a generator of the catalogue of past events for analogous event comparison, disaster preparation and decision making.
        - As a stand-alone service for single flood events analysis
    - Flood Depth Mapping Service: fully transferred in open-source code
        - As a stand-alone service to extract the depth of floodwaters from:
            - a flood delineation provided by user
            - a flood delineation extracted with Flood Extent Mapping Service.
        - Articulated in the workflow of Flood Hazard Mapping Service.

- Urban Flood Mapping Service: transferred open access only on demonstration areas.
    - To be used as a stand-alone service to complement results of Flood extent Mapping service. Merging of both products is the responsibility of the user.

Table 3 Main features of the UC#1

Outputs	Timeline	Frequency of production
Catalogue of Map of maximum flood extent of past flood events. Maximum flood extent and water depth maps (res. 20 m x 20 m) of new flood events.	**Development phase**: Oct.'18-Jul'21	Short service demonstrations in Dec'24, Feb'25, Apr'25, Jun'25
	Demonstration phase: Sep'25-Dec'25	On demand
	Operational phase: Jan'26 on (when infrastructure for processing is available)	On demand

- The operational scenario requires certain conditions to ensure sustained use of the services developed:
    - Areas within the Caribbean: CIMH exercises its role as technical user. CIMH is installing an instance of the Specialized PE in its own premises. The execution of the services/dedicated applications shall be articulated to CIMH's weather prediction systems. CIMH will liaise with the local users (meteorological and hydrological services, emergency management organizations and civil defenses) for a coordinated and prioritized exploitation of the services.
    - Areas outside the Caribbean (affected by hurricanes or ENSO): As in the case of the Caribbean with CIMH, the prospect of use for this service in other LAC countries requires to identify an organization with expertise management of weather forecast information such as national institutes/agencies of meteorology/hydrology. A robust weather forecasting system is also needed, so that such entity can analyze hurricane forecasts or precipitations forecasts linked to ENSO and execute the services when necessary.

2.3.2 UC#2: Flood frequency and impact mapping

Definition

Representation of frequency of flooding in different areas from 2016 to the present with indication of flood depth of the maximum potential flood extent. Regular flood extent monitoring with on-demand extraction of flood depth and impact.

Services applied: S1 (Flood Extent Mapping), S2 (Flood Frequency Mapping), S3 (Flood Depth Mapping) and S19 (Urban Flood Mapping). The demonstration exercise will include an on-demand estimation of flood impact.

Services demonstration: pre-operations

- Users and stakeholders: users and stakeholders most interested in the services are in Colombia. Fondo de Adaptación Nacional is identified as main partner involved providing also layers of exposure information. Fondo Adaptación, UNGRD and IDEAM are becoming users of the service. Pontificia Universidad Javeriana, Universidad Nacional, and NUVU are identified as stakeholders. On a broader level, there is interest in these services from international stakeholders such as World Bank.
- Area of Interest: lower basins especially prone to long-lasting repetitive flooding. Based on interests of stakeholders, the demonstration focuses on La Mojana region in northeastern Colombia, a wetland in the floodplains at the confluence of the Magdalena, Cauca and San Jorge rivers, of great biological and socioeconomic importance. This a region of particularly important and varied flood dynamics, prone to dam failures and unexpected flooding in large areas.

- Demonstration exercise: Application of retrospective flood mapping generated by the analysis of all flood events captured by Sentinel-1 and Sentinel-2 from 2015 to today. The outputs are systematically, yearly updated flood frequency maps. The flood frequency map in turn can be used as an input for a flood depth analysis, executed over the maximum flood extent in the flood frequency. The demonstration includes a continuous systematic monitoring of new flood extent with updates provided monthly, with possibility to extract the associated flood depth. The use case offers the possibility as well of mapping the flooded area on specific events of interest, with flood detection enhancement in urban areas.
- The products generated for the user are:
    - Product 1 - Flood detection catalogue (most significant events) and empirical frequency estimation: frequency of flood extension based on the analysis of the full catalogue of Sentinel-1 and Sentinel-2 data (2015 to date).
    - Product 2 - Monitoring service (demonstrator-only): continuous and systematic mapping of flood extension, based on change detection algorithms using Sentinel 1 and Sentinel 2 products.
    - Product 3 - On-demand service: on an area of interest selected by the user, water depth and flood impact estimates, with enhancement on urban areas (only available for the demonstration area). Flood extension maps get overlayed to Digital Elevation Models and exposure layers.
- Essentials and Assumptions: It is assumed that the floods that are intended to be detected are not flash floods, but rather longer-term floods tied to heavy rainfall and dam failures. For impact assessment, the existence and operational use of exposure layers are required and assumed to be provided by the users. For validation, knowledge and maps of past floods are also needed and assumed to be provided by the users.

Services operational scenario: the intended forms of exploitation of the Service (best guess).

- The operational scenario includes the deployment of the services' processing chains in the two geoportals (Specialized PE and CopernicusLAC platform).
- Both geoportals will be deployed in the CopernicusLAC Panama Centre.
- The processing chains deployed in the Specialized PE, and their intended forms of exploitation are:
    - Flood Extent Mapping Service (FEM). open source
        - Articulated in the workflows of the services FFM, FlDM and FHM.
        - As a stand-alone service for past events analysis
    - Flood Frequency Mapping Service (FFM): open source
        - As a stand-alone service to be executed on demand by the user or on request through the platform operator.
            - On demand modality: for the analysis of Sentinel-1 and Sentinel-2 imagery within a user-defined time period.
            - On-request modality: For the analysis of the whole catalogue of Sentinel-1 and Sentinel-2.
        - Articulated in the workflow of Flood Hazard Mapping.
    - Flood Depth Mapping Service (FlDM): open source
        - As a stand-alone service to extract the depth of floodwaters from:
            - a flood delineation provided by user

        - a flood delineation extracted with Flood Extent Mapping Service.
        - the maximum flood extent extracted from the flood frequency map (FFM).
    - Articulated in the workflow of Flood Hazard Mapping.
- Urban Flood Mapping Service (UFM): transferred open access only on demonstration areas.
    - To be used as a stand-alone service to complement results of the Flood Extent Mapping Service.

Table 4 Main features of the UC #2

Outputs	Timeline	Frequency of production
Product 1: Catalogue of most significant past flood events and hazard map; Product 2: Flood severity and impact assessment of latest flood events (just for demonstrator); Product 3: On demand flood depth and impact maps	**Development phase**: Oct.'24-June'25	Short service demonstrations in Dec'24, Feb'25, Apr'25, Jun'25
	Demonstration phase: Sep'25-Dep'25	Product 1: Updated every year; Product 2: updated every 15-30 days; Product 3: On demand
	Operational phase: Jan'26 on (when infrastructure for processing is available)	Product 1: launched on demand or systematically produced depending on a requested job; Product 2: updated every 15-20 days (only over the demonstrator areas); Product 3: On demand (only over the demonstrator areas)

- The operational scenario requires certain conditions to ensure sustained use of the services developed:
    - Within Colombia: The engaged institutions provide a good stakeholder environment and willingness to extend the cooperation further to this project. Fondo Adaptación has expressed interest in installing an instance of the platform in its own infrastructure. The services will be available as well in the CDC within the Specialized PE. UNGRD and IDEAM closely collaborate with Fondo de Adaptación so they are becoming users of the services as well.
    - Rest of LAC: the area of interest must be affected by long-term floods.
        - As in the case of Colombia with Fondo Adaptación, the prospect of use for this service in other LAC countries requires to identify an organization with expertise in geospatial data analysis and knowledge of floods management (e.g.: national institutes/agencies of meteorology/hydrology with staff specialized in floods).
        - For service exploitation for flood preparedness, a good knowledge of past flooding events (location and dates) is recommended. Likewise, user must be capable of selecting areas and dates of interest in the platform. For the impact assessment, the user must be capable of uploading to the platform its own layers of exposure information.

2.3.3 UC#3: Flood historical records in urban areas

Definition:

Hazard mapping and flood forecasting by combination of local hydrological models' outputs and flood observations in urban and non-urban areas.

Services applied: S1 (Flood Extent Mapping), S2 (Flood Frequency Mapping), S3 (Flood Depth Mapping), S4 (Flood Hazard Mapping), S19 (Urban Flood Mapping),

Services demonstration: pre-operations

- Users and stakeholders: users and stakeholders interested in this service are in Bolivia. The ABE is identified as main stakeholder and partner, with support from SENAMHI and INRE as technical stakeholders, and municipalities as users.
- Area of Interest: the main riverine areas in two river basins in Bolivia (Beni River and Mamore River), prone to repetitive slow flooding; municipalities of Rurrenabaque and Villa Tunari.
- Demonstration exercise: High-resolution flood hazard mapping in two municipalities, derived from local Hi-res hydrological and hydraulic models enhanced by empirical flood frequency maps derived from Sentinel-1 and Sentinel-2 and urban flood detection.
- Products generated for the user: a new set of hazard maps for different return period expressed in terms of flood water depth, that can be used to feed the existing impact-based forecasting system already operational in the application areas.
- Essentials and Assumptions: it is assumed that the floods that are intended to be detected are not flash floods, but rather slow onset floods. For the impact assessment, exposure layers are required. A buildings layer is provided by the urban flood detection algorithm. It is assumed that the rest of exposure information will be made available by users. Pre-existing detailed hydraulic modelling setup is also required, as well as a detailed updated DTM.

Services operational scenario: the intended forms of exploitation of the Services when transferred to the Copernicus Panama Centre (estimate).

- The operational scenario includes the deployment of the services' processing chains in two geoportals (Specialized PE and CopernicusLAC platform).
- Both geoportals will be deployed in the CopernicusLAC Panama Centre.
- The processing chains deployed in the Specialized PE and their intended forms of exploitation are:
    - Service 1 (Flood Extent Mapping): open-source
        - Articulated in the workflows of FFM, FlDM, FHM
        - As a stand alone service for past events analysis
    - Service 2 (Flood Frequency Mapping): open-source
        - As a stand-alone service to be executed on demand by the user
            - For the analysis of the whole catalogue of Sentinel-1 and Sentinel-2
        - Articulated in the workflow of Flood Hazard Mapping Service.
    - Flood Depth Mapping (FlDM): open-source
        - As a stand alone service to extract the depth of floodwaters from:
            - a flood delineation provided by user
            - a flood delineation extracted with Flood Extent Mapping sertvice.
            - the maximum flood extent extracted from the flood frequency map (FFM).
        - Articulated in the workflow of S4 (Flood Hazard Mapping)

- Flood Hazard Mapping (FHM): open-source
  - As a stand alone service to be used mostly in the version of Use Case 4 mass production of enhanced flood hazard maps by merging outputs of the FFM service with GloFAS model outputs.
  - in very specific areas that fulfill the essentials and assumptions, as a stand-alone service to be executed on demand to merge the outputs of the FFM service with hi-res hydraulic models outputs.
- Urban Flood Mapping Service (UFM): transferred open access only on demonstration areas.
  - To be used as a stand-alone service to complement results of Flood Extent Mapping Service

Table 5 Main features of the UC #3

Outputs	Timeline	Frequency of production
Flood hazard map for different return period expressed in terms of flood water depth.	**Development phase**: From Mar'26 onwards	Short service demonstrations during Dev. Phase
	Demonstration phase: 3 months after ending of dev. phase	On demand
	Operational phase: One month after ending of demo. phase	On demand/systematic (TBD)

- The operational scenario requires certain conditions to ensure sustained use of the services developed:
  - Within Bolivia: ABE has expressed interest in installing an instance of the Platform in its own infrastructure and the services will be installed in the CDC, especially in the case of application of the service in the same area of interest as the demonstration area. If the service is to be run in other areas, it is required to include the new hydraulic models and DEM and customize the processing chain.
  - Outside Bolivia: The application of this processing chain requires the existence of detailed hydraulic model and customization of the processing chain to integrate modelled and observational hazard maps.

2.3.4 UC#4: Flood hazard with hydrological modelling and Earth Observation

Definition:

Hazard mapping and flood forecasting by combination of the outputs of the European Commission's Global Flood Awareness System (GloFAS) with high-resolution flood observations from Copernicus satellites.

Services applied: S1 (Flood Extent Mapping), S2 (Flood Frequency Mapping), S3 (Flood Depth Mapping), S4 (Flood Hazard Mapping)

Service demonstration: pre-operations

- Users and stakeholders: users and stakeholders identified are in Costa Rica, Panama, El Salvador, Ecuador, and Perú. The demonstration will involve different national institutions of these countries with responsibility in disaster risk management or hydrometeorological issues. UNDRR, UNDP and IADB are considered as stakeholders with interest in the Use Case.
- Areas of Interest: The demonstration is to be carried out in an area of 1.500.000 km^2 that can be continuous or fragmented in no more than 3-4 different sectors and in any region in LAC, since the S4 Hazard Mapping is not conditioned by cloud coverage nor the hydrological model.
    - Based on the previously stated and the ecosystem of Stakeholders/Users identified, the first application of the Service will take place in Central America and the Pacific basins of Peru and Ecuador. However, there are still 200000 km^2 to be defined.
- Demonstration exercise: The service will provide flood frequency mapping for flood prevention on a large domain, based on an optimal merging of empirical flood frequency maps derived from Sentinel-1 and hazard maps from the GloFAS model produced by the European Commission's Joint Research Centre.
- The products generated for the user are:
    - Product 1 - Flood detection catalogue and empirical frequency estimation: Flood delineation based on processing the full catalog of Sentinel-1 (SAR intensity) and derivation of empirical frequency.
    - Product 2 - Hazard Flood Maps: Hazard maps derived from the merge of GloFAS hazard maps and the full catalogue of flood delineation maps from Sentinel-1. With this, a new set of improved maps are created: water depth at each location for different frequencies/return periods.
- Essentials and Assumptions (to be defined): access to the GloFAS model outputs is required. The system must be coupled with meteorological/hydrological predictions (in terms of return periods), so there is a need for technical user intervention.

Service operational scenario: the intended forms of exploitation of the service (estimate).

- The operational scenario includes the deployment of the services' processing chains in two geoportals (Specialized PE and CopernicusLAC platform).
- Both geoportals will be deployed in the CopernicusLAC Panama Centre.

- The processing chains deployed in the Specialized PE and their intended forms of exploitation are:
    - Service 1 (Flood Extent Mapping): open-source
        - Articulated in the workflows of the services FFM, FlDM and FHM
        - As a stand alone service for past events analysis
    - Flood Frequency Mapping Service (FFM): open source

        - As a stand-alone service to be executed on demand by the user or on request through the platform operator.
            - On demand modality: for the analysis of Sentinel-1 and Sentinel-2 imagery within a user-defined time period.
            - On-request modality: For the analysis of the whole catalogue of Sentinel-1 and Sentinel-2.
        - Articulated in the workflow of Flood Hazard Mapping.
    - Service 3 (Flood Depth Mapping): open-source
        - As a stand alone service to extract the depth of floodwaters from:
            - a flood delineation provided by user
            - a flood delineation extracted with Flood Extent Mapping.
            - the maximum flood extent extracted from the flood frequency map (FFM).
        - Articulated in the workflow of Flood Hazard Mapping Service.
    - Service 4 (Flood Hazard Mapping): open-source
        - As a stand alone service to be executed systematically over the whole LAC

Table 6 Main features of the UC #4

Outputs	Timeline	Frequency of production
Product 1: Flood frequency map. Product 2: GloFAS flood hazard mapping and forecasting maps enhanced with observations from Sentinel-1 mission.	**Development phase**: Apr.'25-Jan'26	Short service demonstrations in May'25, Jul'25, Oct'25, Jan'26
	Demonstration phase: Feb'26-Apr'26	Product 1: updated every year; Product 2: On demand
	Operational phase: May'26 on	Product 1: updated every year; Product 2: On demand

- The operational scenario requires certain conditions to ensure sustained use of the services developed:
    - The most likely infrastructure to be used will be that of the CDC with access to the GloFAS model products.
    - A strong entity that fulfills the role of checking the meteorological/hydrological forecasts is required, and, in the eventuality of a forecasted flooding, extracts from the service the corresponding delineation maps for flood prevention (foreseen: national institutes/agencies of meteorology/hydrology and/or national units for disaster risk management).

2.3.5 UC#5: Drought and crops surveillance

Service definition

Systematic production of drought indices based on Earth Observation data and climatic time series analysis, focusing particularly on monitoring vegetation and crops.

Service applied: S5 (Drought Indices)

Services demonstration: pre-operations

- Users and stakeholders: users and stakeholders interested in this service are in Central America, Paraguay, and Bolivia. In Paraguay, Agencia Espacial de Paraguay has been identified as key partner while DMH can be an important stakeholder. In Bolivia, Agencia Boliviana Espacial is a key partner.
- Areas of Interest: The service demonstration will start in Paraguay with the Agencia Espacial del Paraguay as key stakeholder, committed to provide regular information and to cooperate with different technical partners in the country.
- Demonstration exercise: To monitor regional drought in LAC through a calculation and combination of anomalies connected to precipitation, soil moisture and vegetation and local and regional crops seasonality and practices. Fine tuning of the combined drought index with the downscaled Global Drought Index.
- The products generated for the user are:
    - Individual, automatically calculated drought indices (i.e. environmental anomalies indicators, linked to Precipitation, Soil Moisture and Vegetation) derived from measurements of Sentinel-1, Sentinel-2, Sentinel-3, and others, using as input for parametrization long-term statistics, climatology and WorldCereal-derived crops masks.
    - Combined Drought Index (CDI): Automatic calculation with the individual drought indices above mentioned. The process gets tuned with a dataset of past events. CDI is in turn compared and aligned with downscaled GDI.
    - Global Drought Index (GDI) from Copernicus GDO.
- Essentials and Assumptions: For a better deployment and tuning of the service, local climatic data and a dataset of past drought events is recommended, potentially provided by the final user or stakeholder and convertible to the standard format.

Service operational scenario: the intended forms of exploitation of the Service (estimate).

- The operational scenario includes the deployment in the Specialized Processing Environment as described in the introduction of this chapter, which in turn will be installed in the CopernicusLAC Panama Centre.
- The processing chains transferred to the Specialized PE, and its intended form of exploitation (best are:
    - Service 5 (Drought Indices): open-source
        - Usage as a stand-alone service executed systematically (best guess) over wide regions in LAC. Its workspace should allow the insertion of local climatic data layers.

Table 7 Main features of the UC#5

Outputs	Timeline	Frequency of production
Product 1: drought indices based on EO; Product 2: Combined drought index (CDI) from Product 1; Product 3: tuning of CDI based on Global Drought Index (GDI)	**Development phase**: From Mar'26 onwards	Short service demonstrations during Dev. Phase
	Demonstration phase: 3 months after ending of dev. phase	Updated with certain frequency (TBD)
	Operational phase: One month after ending of demo. phase	Updated with certain frequency (TBD)

- Within Paraguay: AEP is likely continuing with the role acquired during demonstration. AEP would use the CDC but has expressed interest in installing an instance of the Platform in its own infrastructure, articulated with its own sources of local climatic information.
- Outside Paraguay: As in the case of Paraguay with the space agency AEP, the prospect of use for this service in other LAC countries requires to identify an organization with expertise in geospatial data analysis . The most likely infrastructure to be used will be that of the CDC. To enhance service deployment and fine-tune regional indices, users would have the possibility to upload their own local climatic data layers to the platform. In addition, FAO could become a key stakeholder with a potential strong interest, which could facilitate the continuation of the service. Nevertheless, this would depend upon the results of future consultations.

2.3.6 UC#6: Wildfires: mapping of events, fire, and danger

Definition:

Comprehensive monitoring of forest fires, covering all stages of the disaster risk management cycle.

Services applied: S6 (Burned Area Mapping), S7 (Fire Danger Mapping) and S8 (Post-fire Recovery Mapping).

Services demonstration: pre-operations

- Users and stakeholders: Users and stakeholders interested in this service are present in several countries in Latin America, such as Colombia, Guatemala, Honduras, and Belize. Nevertheless, there is a strong ecosystem of stakeholders/users identified in Colombia (IDEAM, Ministry of Environment, UNGRD, IDIGER, etc.), with willingness to cooperation and maintenance of relationships. On another hand, in Central America, other strong ecosystems have been found in Honduras (lead by ICF) and Guatemala (including Ministries, foundations and national entities, being SE-CONRED the point of contact), willing for cooperation and their own efforts and advances in wildfire risk management. At the international level, UNEP is a strongly interested stakeholder.
    - For the final list of entities engaged for the pre-operational demonstration phase, please see the Appendix 2.
- Area of Interest: Colombia and Central America, as the whole area of application must cover a total of one million square kilometers.
- Demonstration exercise: The proposed joint usage of the three services provides valuable insights at all stages of the disaster risk management cycle of wildfires. The fire danger mapping allows for anticipating risk areas and prioritizing preventive interventions, optimizing land planning and management. As for the Burned area mapping, the application automatically detects active wildfires by hotspots analysis and triggers the obtention of fire extension, fire probability and fire severity maps. When the Burned area mapping does not detect active hotspots, the Wildifres recovery is activated, for evaluation of vegetation recovery in areas affected by wildfires, providing temporal NDVI composites and time series per pixel of percentage of recovery.
- Products generated for the user in an automatic/systematic execution mode:
    - From Burned Area Mapping Service:
        - Shapefiles of Hotspots derived from measurements of Sentinel-3 and NASA satellites & sensors (Landsat, MODIS, VIIRS (Suomi-NPP, NOAA series)).
        - Burned Area Extension, Probability and Severity Maps derived from Sentinel-2 spectral indices.
    - From Fire Danger Mapping Service:
        - Fire Danger Map in terms of Fire Danger Index. Derived from static geospatial layers and the daily Fire Weather Index.
    - From post-Fire Recovery Mapping Service:

- Temporal NDVI composite
- Post-fire spectral recovery in percentage

- Essentials and Assumptions: It is assumed that in most fire events there will be enough detected hotspots to trigger the Burn Area Products, despite the presence of clouds.

Service operational scenario: the intended forms of exploitation of the service (estimate).

- The three services are deployed in the CopernicusLAC platform for an automatic/systematic execution mode.
- The operational scenario includes the operational exploitation of the CopernicusLAC platform deployed in the CDC or on premises of the users. For such operation it is needed that the platform operator makes the effort to orchestrate the services elements for the execution of on-request jobs.
- The processing chains are:
    - Burned Area Mapping: open-source
    - Fire Danger Mapping: open-source
    - Fire Recovery Mapping: open-source
    - The current form of exploitation (pre-operational demonstration phase) is the joint usage of the three services executed coupled and in a systematic execution. Nevertheless, an on-demand production scenario of the services de-coupled is under implementation in a separated workspace of the systematic scenario. This will allow for instance an on-demand execution of the Fire Danger Mapping Service launched by the user over a user-defined AOI, with potential allowance of user-provided weights for the AOI.

Table 8 Main features of the UC #6

Outputs	Timeline	Frequency of production
Product 1: Hotspots detection; Product 2: burned area severity maps. Product 3: Fire Danger Map and geospatial layers. Product 4: Post-Fire recovery in percentage and monthly NDVI	**Development phase**: Mar'24-Nov'24	Short service demonstrations in Apr'24, Jul'24, Sep'24, Nov'24
	Demonstration phase: Feb'25-Jul'25	Product 1: updated in NRT; Product 2: triggered any time there is a minimum value of detected hotspots and updated with every Sentinel-2 pass. Product 3: on demand. Product 4: triggered once there are no more hotspots, updated every certain time derived by the user.
	Operational phase: Sep'25 (when infrastructure for processing is available)	same as in demonstration phase / on demand production (TBD)

- The operational scenario requires certain conditions to ensure sustained use of the services developed:
    - Within Colombia, Honduras and Guatemala: In Colombia, Ministry of Environment, UNGRD and IDEAM provide a good stakeholder environment with willingness to extend the cooperation further to this project by providing support with own staff. In Honduras and Guatemala, the users/stakeholders ecosystem are also very interested in an operational usage of this service integrated in their workflows. In the three countries they would use the CDC under the applicable conditions with staff trained during the demonstration exercise. Nevertheless, they also have have expressed interest in installing an instance of the Platform in their own infrastructure.

- Outside area defined above: The prospect of use for this service in other LAC countries requires to identify an organization with expertise in geospatial data analysis applied to wildfires.

2.3.7 UC#7: Landslide Susceptibility Mapping

Definition

Estimation of the likelihood and the hazard of an area to suffer landslides.

Services applied: S9 (Landslide Susceptibility and Hazard Mapping); S20 (SNAPPING IFG and PSI) (for demonstration purposes only), S10 (Interferometric Stacking)

Services demonstration:

- Users and stakeholders: users and stakeholders interested in this service are present in Peru. The latter presents a strong stakeholder/user environment, with CONIDA identified as stakeholder, INDECI, INGEMMET and IGP as the final Users. Other countries are susceptible to be recipients of a roll-out of the service. The World Bank is a potentially interested international stakeholder. INDECI, INGEMMET and IGP are the institutions that promoted to support the developments.
- Area of Interest: Peruvian Users/Stakeholders have stressed the importance of the landslides in their territory. On the other hand, it is interesting for the service full deployment the presence of shallow vegetation coverage on the slopes to be analyzed.
    - INGEMMET pointed out a particular area in Chavin de Huantar, in the Ancash Department. It is characterized by a marked relief and an arid landscape with shallow vegetation. This region is affected by various geological risks (landslides, debris flows, rock falls, etc) prone to reactivation. Therefore, and given the deep knowledge of users over this area and the existence of a landslide inventory, Chavin de Huantar is proposed as the first area of application of the service. I
    - IGP proposed a second area of application in the Colca River valley. It will be used to demonstrate the capabilities of the processing chain deployed in the CopernicusLAC platform.
- Demonstration exercise: landslide susceptibility maps and hazard maps from two differentiated systems:
    - Customized service (offline analysis): A complex system integrating local, user-provided information (geology, lithology, elevation, landslides inventory) and using ML techniques (Random Forest) and traditional geotechnical methods to derive the likelihood of landslides per geomorphological units. The output is a customized, refined landslide susceptibility map. The landslide susceptibility map is in turn converted to hazard map by overlaying ground motion rates at point-like targets.
    - Generic service: A straightforward system deriving maps of susceptibility to landslides using multi-criteria analysis, that can be exported elsewhere in LAC as far as some basic input data is available (i.e. a landslide inventory). The landslide susceptibility map pixel-based is converted to slope-unit based so it can be compared as well with average ground-motion rates derived from Terrain Motion-Interferometric Stacking service to produce a potential hazard map.
- Essentials and Assumptions: To run the services a local landslide inventory is mandatory, susceptible to be converted to a usable standard. For a successful application of the InSAR processing chains, the area of application must be characterized by shallow vegetation.

Service operational scenario: the intended forms of exploitation of the service (estimate).

- The operational scenario includes the deployment in the CopernicusLAC platform as described in the introduction of this chapter, including generic processing chains for the management of satellite data and ancillary datasets such as the geology, lithology and user-provided landslide inventories. A workspace allowing

on-demand execution from the user is mandatory. The CopernicusLAC platform will be installed in the CopernicusLAC Panama Centre.

- The processing chains deployed in the CopernicusLAC platform, and their intended forms of exploitation are:
    - Landslide Susceptibility and Hazard Mapping Service: open-source
        - to be exploited as in the present use case (on demand execution), as a stand-alone service.
    - Terrain Motion - Interferometric Stacking Service: open-source
        - To be exploited as in the present use case or as a stand-alone service as in Use Cases 8 to 10.

Table 9 Main features of the UC #7

Outputs	Timeline	Frequency of production
Landslide susceptibility and hazard maps (Product 1: customized map and ancillary layers, Product 2: landslide susceptibility maps (per pixel and per slope unit) and potential hazard map (per slope unit)	**Development phase**: Sep'24-Jul'25	Short service demonstrations in Nov'24, Feb'25, Jul'25, Sep'25. Include the delivery of Product 1.
	Demonstration phase: Sep'25-Dec'25	Product 2: On demand
	Operational phase: Jan'26 on (when infrastructure for processing is available)	Product 2: On demand

- The operational scenario requires certain conditions to ensure sustained use of the services developed.
    - In Perú: INGEMMET and IGP exercise the role of technical users at national level and probably operator of the service, while INDECI would be final users of the information produced by the other two. An instance of the platform can be installed in the infrastructure of CONIDA and CONIDA would coordinate with INGEMMET, IGP and other entities the provision of relevant sources of geoinformation (landslide inventories and other layers).
    - Outside Peru: As in the case of Peru with INGEMEMET, the prospect of use for this service in other LAC countries requires to identify an organization with expertise in geospatial data analysis and with access relevant local geoinformation such as landslide inventories. Examples include national institutes/agencies of geology, dedicated Ministries or Civil Protections.

2.3.8 UC#8: Precise terrain motion mapping

Definition

Ground motion rates through SAR Interferometry with Sentinel-1 in urban areas to measure subsidence.

Services applied: S10 (Interferometric Stacking), S13 (Terrain Motion 3D Geometric Decomposition) and S20 (SNAPPING IFG and SNAPPING PSI)

Services demonstration: pre-operations.

- Users and stakeholders: the users identified are the Geoscience Institute from Panama linked to other institutions in the country such as the University of Panamá, and the Geophysical Institute (IGEPN) in Ecuador.
- Area of interest: Panama and Ecuador

- Essentials and assumptions: For a successful application of InSAR processing chains, the area of demonstration must be characterized by shallow vegetation.
- Demonstration exercise: On-demand up-to-date mapping depicting the terrain motion of several areas in LAC through InSAR processing of Copernicus radar imagery (Sentinel-1). Interpretation of the results and identification of the associated geohazards is included.
- Products to be generated for the user:
    - Product 1:
        - Vertical and E-W ground motion components
        - average ground motion rates in millimeters per pixel
    - Product 2 (at point-like targets)
        - Ground motion rates
        - Displacement time series

Service operational scenario:

- The operational scenario includes the deployment of the services in the CopernicusLAC platform, including generic processing chains for the management of Sentinel -1 data. On-demand execution and parameters fine tuning must be ensured. The CopernicusLAC platform will be installed in the CopernicusLAC Panama Centre.
- The processing chains to be deployed in (or made accessible through) the CopernicusLAC platform are:
    - Terrain Motion – Interferometric Stacking Service: open-source
        - to be used as a stand-alone service or in combination with Landslide Susceptibility and Hazard Mapping Service to derive landslide hazard maps.
    - Terrain Motion 3D Geometric Decomposition Service: open-source
        - To be used tailored IS and SNAPPING products.
    - SNAPPING IFG and SNAPPING PSI Service: open-access transference over demonstration areas of geohazards use cases.

Table 10 Main features of UC#8

Outputs	Timeline	Frequency of production
Product 1: Maps of ground motion rates; Product 2: ground motion rates and displacement time rates at point-like targets	**Development phase**: Feb'25-Oct'25	Short service demonstrations in Mar'25, May'25, Jul'25, Oct'25
	Demonstration phase: Nov'25-Feb'26	Product 1: on demand, Product 2: on demand
	Operational phase: Mar'26 on	Product 1: on demand

The operational scenario requires certain conditions to ensure sustained use of the services developed.

- Within Panama: users/stakeholders, especially the Geoscience Institute of Panama, continue with their usage of the service. Civil protections and municipalities would be normally final users (In Panama: SINAPROC). The most likely infrastructure to be used will be that of the CDC.

- Outside Panama: the prospect of use for this service in other LAC countries requires to identify an organization with expertise in geospatial data analysis. A strong entity is needed to perform the role of the IGEPN (e.g.: national institutes/agencies of geology or geosciences, or dedicated Ministries, or national units of disaster risk management). Civil protections and municipalities would be normally final users. The most likely infrastructure to be used is the one on the CDC.

2.3.9 UC#9: Wide area terrain motion mapping

Definition

Measuring terrain deformation in non-urban contexts for multiple applications of SAR Interferometry for geological hazards monitoring and assessment.

Services applied: S10 (Interferometric Stacking), and S13 (Terrain Motion 3D Geometric Decomposition), S20 (SNAPPING IFG and SNAPPING PSI)

Services demonstration: pre-operations.

- Users and Stakeholders: IGEPN (Ecuador) and possibly other geohazards Institutes.
- Area of interest: Wide areas outside urban context (under definition)
- Demonstration exercise: This use case will provide ground motion rates through SAR Interferometry with Sentinel-1 in areas outside urban context. It will focus on multiple applications such as active faults, seismicity, landslides detection and exposure.
- Products to be generated for the user:
    - Product 1:
        - Vertical and E-W ground motion components
        - average ground motion rates in millimeters per pixel
    - Product 2 (at point-like targets, full sensor resolution)
        - Ground motion rates
        - Displacement time series
- Essentials and assumptions: For a successful application of InSAR processing chains, the area of demonstration must include areas of shallow vegetation as the service performs optimally on those areas. A priori knowledge about local seismicity, active faults and landslides is useful for validation.

Service operational scenario:

- The operational scenario includes the deployment of the services in the CopernicusLAC platform , including generic processing chains for the management of Sentinel -1 data. On-demand execution and parameters fine tuning must be ensured. The CopernicusLAC platform will be installed in the CopernicusLAC Panama Centre.
- The processing chains to be deployed in the CopernicusLAC platform, and their intended forms of exploitation are:
    - Interferometric Stacking Service: open-source
        - to be used as a stand-alone service or in combination with Landslide Susceptibility and Hazard Mapping Service to derive landslide hazard maps.
    - Terrain Motion 3D Geometric Decomposition Service: open-source
        - To be used tailored to IS and SNAPPING products

- S20: open-access transference over demonstration areas of geohazards use cases.

Table 11 Main features of the UC #9

Outputs	Timeline	Frequency of production
Product 1: Maps of ground motion rates; Product 2: ground motion rates and displacement time rates at point-like targets	**Development phase**: From Mar'26 onwards	Short service demonstrations during dev. Phase
	Demonstration phase: 3 months after ending of dev. phase	Product 1: on demand, Product 2: on demand
	Operational phase: One month after ending of demo. phase	Product 1: on demand

- The operational scenario requires certain conditions to ensure sustained use of the services developed:
  - Within the country selected as demonstrator: Users/Stakeholders continue with their usage of the service. The most likely infrastructure to be used is the one on the CDC.
  - Outside the country selected as demonstrator: A strong entity is needed to perform the role of technical user (best guess: national institutes/agencies of geology, dedicated Ministries, or national units for disaster risk management). Civil protection agencies are the most likely final users. The most likely infrastructure to be used is the CDC.

2.3.10 UC#10: Mass production of terrain motion measurements

Definition

Medium resolution terrain deformation maps produced automatically over large areas.

Services applied: S10 (Interferometric Stacking), and S13 (Terrain Motion 3D Geometric Decomposition), S20 (SNAPPING IFG and SNAPPING PSI)

Services demonstration: pre-operations.

- Users and stakeholders: The identified key user is CENAPRED, in Mexico, which will foster collaborations with other institutions. Universidad Autónoma del Estado de México is identified as stakeholder.
- Area of interest: Given the stakeholder's interests, the demonstration takes place initially in the Mexico State with the support and participation of CENAPRED. As the area of interest of the Estado de Mexico is only 22.000 km², it'll be necessary to find another user to complete the expected 150.000 km².
- Demonstration exercise: On-demand automatic service for terrain motion mapping and monitoring based on Earth Observation with Copernicus Sentinel-1 mission.
- Products to be generated for the user:
  - Product 1:
    - Vertical and E-W ground motion components
    - average ground motion rates in millimeters per pixel
  - Product 2 (at point-like targets, medium resolution)
    - Ground motion rates

- Displacement time series

Service operational scenario:

- The operational scenario includes the deployment of the services in the CopernicusLAC platform, including generic processing chains for the management of Sentinel -1 data. On-demand execution and parameters fine tuning must be ensured. The CopernicusLAC platform will be installed in the CopernicusLAC Panama Centre.
- The processing chains to be deployed in the CopernicusLAC platform, and their intended forms of exploitation are:
    - Service 10 (Interferometric Stacking): open-source
        - to be used as a stand-alone service or in combination with Landslide Susceptibility and Hazard Mapping Service to derive landslide hazard maps.
    - Terrain Motion 3D Geometric Decomposition Service: open-source
        - To be used tailored to IS and SNAPPING outputs.
    - SNAPPING IFG and PSI Service: open-access transference over demonstration areas of geohazards use cases.

Table 12 Main features of the UC#10

Outputs	Timeline	Frequency of production
Product 1: Maps of ground motion rates ; Product 2: ground motion rates and displacement time rates at point-like targets	**Development phase**: From Mar'26 onwards	Short service demonstrations during Dev. Phase
	Demonstration phase: 3 months after ending of dev. phase	On demand
	Operational phase: One month after ending of demo. phase	On demand

- The operational scenario requires certain conditions to ensure sustained use of the services developed:
    - Within Mexico and demonstrator's country: CENAPRED continue with their usage of the service. An instance of the Platform is installed in CENAPRED's own infrastructure and articulates with own sources of geoinformation and/or alerting systems.
    - Outside Mexico: A strong entity is needed to perform the role of technical user (best guess: national institutes/agencies of geology, dedicated Ministries, or national units of disaster risk management.) Civil protections are the most likely final users. The most likely infrastructure to be used is the one on the CDC.

2.3.11 UC#11: Urban characterization

Definition

Provision of high-resolution population density estimates. By leveraging the WSF Tracker for settlement extent, WSF Imperviousness, WSF3D for building height data, and (user-provided) reference total population counts per admin unit, the service redistributes population at 10m spatial resolution.

Service applied: S11 (Population Distribution)

Service demonstration: pre-operations:

- Users and stakeholders: relevant users for this demonstration have been identified in Ecuador and Costa Rica.
- Area of interest: three cities to be defined.
- Essentials and assumptions: User's local knowledge for optimal classes selection would be useful.
- Demonstration exercise: (under definition)
    - On-demand provision of urban characteristics (settlement footprint, percentage of imperviousness, building height) and provision of population distribution across settlements.

Service operational scenario:

- The operational scenario includes the deployment in the CopernicusLAC platform allowing platform inter-connection with DLR's WSF servers.
- The processing chains to be deployed in the CopernicusLAC platform, and their intended forms of exploitation (best guess), as a result of this demonstration are:
    - Population Distribution Service: open-source
        - Exploitation in a similar fashion to the one demonstrated in this use case
    - In addition, the next layers are made available in the CopernicusLAC platform:
        - WSF Imperviousness
        - WSF Tracker
        - WSF3D

Table 13 Main features of the UC#11

Outputs	Timeline	Frequency of production
Map of urban land use classes (e.g. residential buildings, commercial, industrial…)	**Development phase**: Sep'25-May'26	Short service demonstrations at Nov'25, Jan'26, Mar'26, May'26
	Demonstration phase: Jun'26-Sep'26	On demand
	Operational phase: Oct'26 onwards	On demand

- The operational scenario requires certain conditions to ensure sustained use of the services developed:
    - Within Stakeholders/users jurisdiction: users/stakeholders continue with their usage of the service installed in CDC.
    - Outside stakeholders/users' jurisdiction: A strong entity is needed to perform the role of technical user (e.g.: national institutes/agencies of geography, dedicated Ministries or national units for disaster risk management). The most likely infrastructure to be used is the one on the CDC.

2.3.12 UC#12: Economic Value Mapping

Definition

Economic value of different sectors in the territory in USD/square meter allocated on a complete land use / land cover map.

Service applied: S12 (Economic Value Mapping)

Service demonstration: pre-operations:

- Users and stakeholders: relevant users for this demonstration have been identified in Dominican Republic, led by the Dirección De Riesgo y Cambio Climático from the MEPYD. Other stakeholders identified are UNDRR, IADB, CCRIF, and UNEP.
- Area of interest: Given the interests of users/stakeholders, the initial demonstration of the detailed service will be applied on Dominican Republic covering the whole country territory. The generic service is being deployed in other regions in LAC as well.
- Essentials and assumptions: User's local knowledge for optimal classes selection and/or co-development would be useful. The final level of detail of the service will depend on it. The inputs for the service are infrastructure features (e.g., roads, railways, etc.) from overture maps, the building height from World Settlement Footprint, the crop types from world cereal, ESA's World Cover Dataset, the Copernicus digital elevation model (DEM), the ESA CCI land cover, the ESDAC global rainfall erosivity R factor, and global soil erodibility K factor. For the execution of the service, it is necessary the user contributions to identify the most suitable and up-to-date sources for determining the economic value of the assets and ecosystem services, based on the particularities and characteristics of the country.
- Pre-design of the service: Provision of a precise economic valuation of the territory, in USD per square meter and on a resolution of 10 m x 10 m. By leveraging geospatial analysis in a multivariate approach and targeted methods, the economic value of different sectors is allocated on a complete land use /land cover map generated with Earth Observation and ancillary data. This economic valuation is provided with two levels of detail:
    - Detailed level: Provides the most accurate and specific valuation, using data provided by local stakeholders and/or users. This includes detailed economic activity values and additional relevant geospatial, statistical, and demographic information.
    - General level: offers a broader valuation using globally available geoinformation layers.

Service operational scenario:

- The operational scenario includes the deployment in the CopernicusLAC platform, in a workspace allowing the storage of the complete Land Use Land Cover over the whole LAC region and ensuring user-driven insertion of economic figures at country level and AOI level.
- The processing chains to be deployed in the CopernicusLAC platform, and their intended forms of exploitation are:
    - Economic Value Mapping Service: open-source
        - To be exploited in the general level version.

Table 14 Main features of the UC#12

Outputs	Timeline	Frequency of production
Maps of financial value of the territory in USD/sq m	**Development Phase**: Jan'25-Oct'25	Short service demonstrations in Apri25, Jun'25, Sep'25, Oct'25.
	Demonstration Phase: Oct'25-Jun'26	On demand
	Operational phase: Jun'26 on (when infrastructure for processing is available)	On demand

- The operational scenario requires certain conditions to ensure sustained use of the services developed:
    - The service designed for the whole LAC (global or regional data provided by the platform) can be run for any user with access to CDC. For the service customized with national data, an entity with solid knowledge on economical or statistical data is needed to perform the role of technical user (e.g.: national institutes/agencies of geography, dedicated Ministries or National Units for Disaster Risk Management, statistics bureau). IADB is identified as key technical stakeholder which could contribute to the sustainability of the service and future uptake. The most likely infrastructure to be used is the CDC although it is to be analyzed if the RisHub of IADB can host the service as well.

3. CAPACITY BUILDING ACTIVITIES - OUTLINE

1. **Introduction and Objectives**
    - **Objective**: Introduce the training program, focusing on equipping participants with the skills to use the EO-based service independently.
    - **Content**:
        - **The goal**: sustainable EO service transfer through capacity building.
        - **Training focus**:
            i. Platform navigation
            ii. Understanding remote sensing foundations
            iii. Service execution: input preparation, output interpretation and product applicability.
            iv. Long-term service management
        - **Learning Outcomes**: by the end, participants will be able to navigate the platform, execute the service, interpret results, apply the EO products, and manage the service independently.
        - **Interactive elements**: practical exercises, Q&A sessions and group discussions.
2. **Navigating the platform**
    - **Objective:** Ensure participants are comfortable navigating and using the platform.
    - **Content:**
        - Introduction to the web platform's structure and user interface.
        - Walkthrough of the main features:
            - Accessing catalogues, services, executing tasks, and viewing results.
            - Locating the relevant tools for each stage of the service process (input preparation, execution, outputs analysis and visualization)
        - Practical session: navigate through a complete workflow on the platform, from login to result viewing.
            - Exercise: run a simple service to understand the platform's key functionalities.
3. **Understanding the science behind the service**
    - **Objective:** Build a foundational understanding of the scientific principles behind the service.
    - **Content:**
        - Introduction to satellite data, geospatial analysis, and key remote sensing concepts.
        - Explanation of common EO products (e.g., maps, indices, time-series data, graphs)
        - Exercise: relate satellite data from operational satellites to real-world applications for Disaster Risk Reduction (e.g. Sentinel-1 backscatter for flood detection; MODIS thermal data for hotspots detection)
4. **Inputs preparation**
    - **Objective:** guide participants through the process of preparing inputs for the service.

- **Content:**
    - Overview of input data types:
        - Explanation of satellite imagery and geospatial data (what users need to provide or select, and its characteristics of format, resolution, etc.
        - How to search for and import input data from various sources (e.g. the platform's catalogue or external datasets).
    - Processing of the input data (if needed)
        - How to ensure data compatibility and quality
    - Practical session: walk through input data preparation on the platform.
    - Q&A: addressing common challenges and difficulties in input selection and processing.

5. Execution of the service

- **Objective:** guide participants through the execution of the service
- **Content:**
    - The process behind the service: how the satellite data is processed to generate the outputs.
    - Overview of the service parameters and configuration
        - Explanation if needed of how to tailor the service for different regions or needs.
        - Explanation if needed of how to calculate the parameters for the service setup.
    - Service execution and products obtention.
    - Exercise: run the service with the prepared input data from the previous session.
    - Q&A: addressing common challenges and difficulties in service execution.

6. Obtaining and interpreting outputs/products

- **Objective:** Help participants to understand the outputs and products generated by the service.
- **Content:**
    - Explanation of the products generated by the service.
    - The interpretation of the outputs and their scientific and operational significance
    - Walkthrough the outputs visualization tools on the platform:
        - How to view, download, and analyze results.
    - Practical session: participants visualize the products obtained in the previous session and practice interpreting the data.

7. Applicability of the service and the Use Case

- **Objective:** explore with participants the potential of the service for future uses
- **Content:**
    - Explanation of the various applications for EO products
        - Summary of the use cases of the other services.
    - Demos review session: how the service was already applied, how it has evolved, differences and similarities with the current outputs and products (if applicable).

- Case studies: examples on how different organizations/institutions have used similar products in practical applications (e.g. impact assessments, landslides susceptibility for preparedness).
- Group discussion: explore potential new applications of the service beyond the Use Case, useful for participants' own work and its requirements.

8. **User Manual Overview and Usage**

- **Objective:** Ensure participants are familiar with the user documentation and know how to use it effectively.
- **Content:**
  - Walkthrough of the user manual:
    - How to navigate the manual and locate the necessary information for the service.
    - Explanation of the service functionality, processing chains and product interpretation covered in the manual.
  - Discussion: tips on using the manual for future independent service management.

9. **Long-Term Service Operation and adaptability**

- **Objective:** Prepare participants to manage and adapt the service independently after the project ends.
- **Content:**
  - Strategies for continued service operation
    - Best practices for managing the service.
    - How to scale the service from local to regional levels.
  - Discussion: how to ensure sustainability through continuous learning, with advice on where to find additional resources.
  - Q&A: addressing participant interest about long-term usage and customization.

10. **Final Assessment and Feedback**

- **Objective:** Evaluate participants' understanding and gather feedback about the service and to improve future training sessions.
- **Content:**
  - Hands on assessment: participants will execute the whole workflow from input preparation to product interpretation.
  - Review session: trainers will provide feedback and answer questions.
  - Feedback collection: gather participant insights on the training's effectiveness and any areas of improvement over the service and over the capacity building.

4. MAIN TOPICS AND USER STORIES

The following tables summarize the main topics of the user stories defined by the users in the user requirements process.

Table 15 Main topic of the user stories per country (The Caribbean)

Country	Hazard
Jamaica	Flood extent mapping
Guyana	Flood extent mapping
Dominican Republic	Floods, Exposure, Economic value, Copernicus data

Table 16 Main topic of the user stories per country (Central America)

Country	Hazard
Costa Rica	Volcanoes, Landslides, Earthquakes, Droughts, Flood hazard, Meteorology, Wildfires, Exposure
El Salvador	Wildfires; drought; floods; ground motion
Guatemala	Floods; landslides; Wildfires; volcanic; extreme weather; epidemics
Honduras	Extreme weather; wildfires; floods; air quality; landslides
Panama	Floods; wildfires; drought; sea level rise

Table 17 Main topic of the user stories per country (South America)

Country	Hazard
Bolivia	Wildfires; floods; landslides, fault movements, drought
Colombia	Floods; wildfires
Ecuador	Exposure, floods; landslides; river erosion, subsidence
Paraguay	Wildfires; drought; floods, land change
Peru	Landslides; floods; exposure

Copernicus LAC Panamá

Service Development Activity

Global Gateway

PROGRAMME OF THE EUROPEAN UNION

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