Recovery Observatory (RO) Demonstrator – recent updates and proposal to establish a pre-Operational RO

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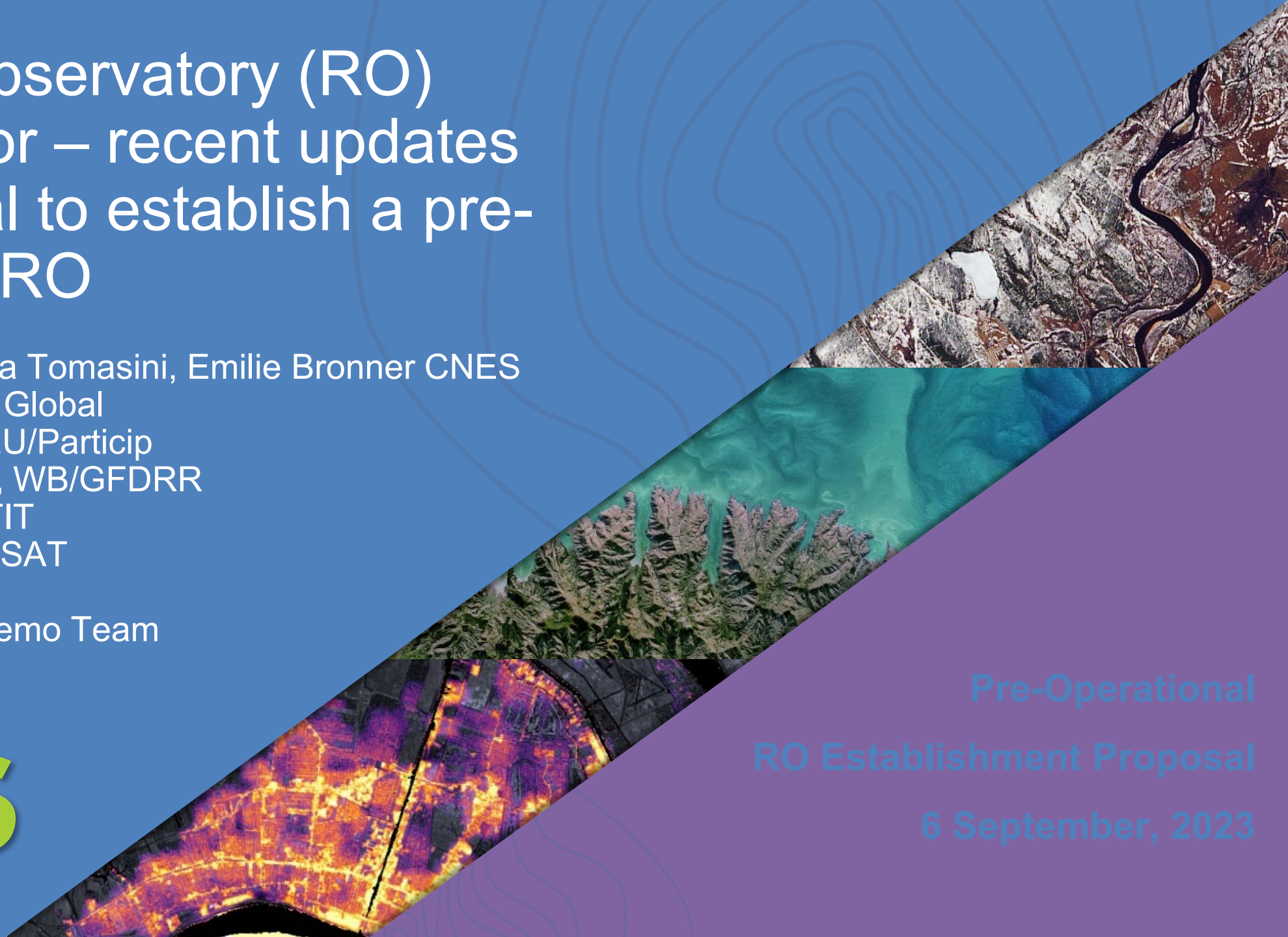
on behalf of the RO Demo Team



Pre-Operational

RO Establishment Proposal

6 September, 2023

CEOS
Committee on
Earth Observation Satellites

Overview

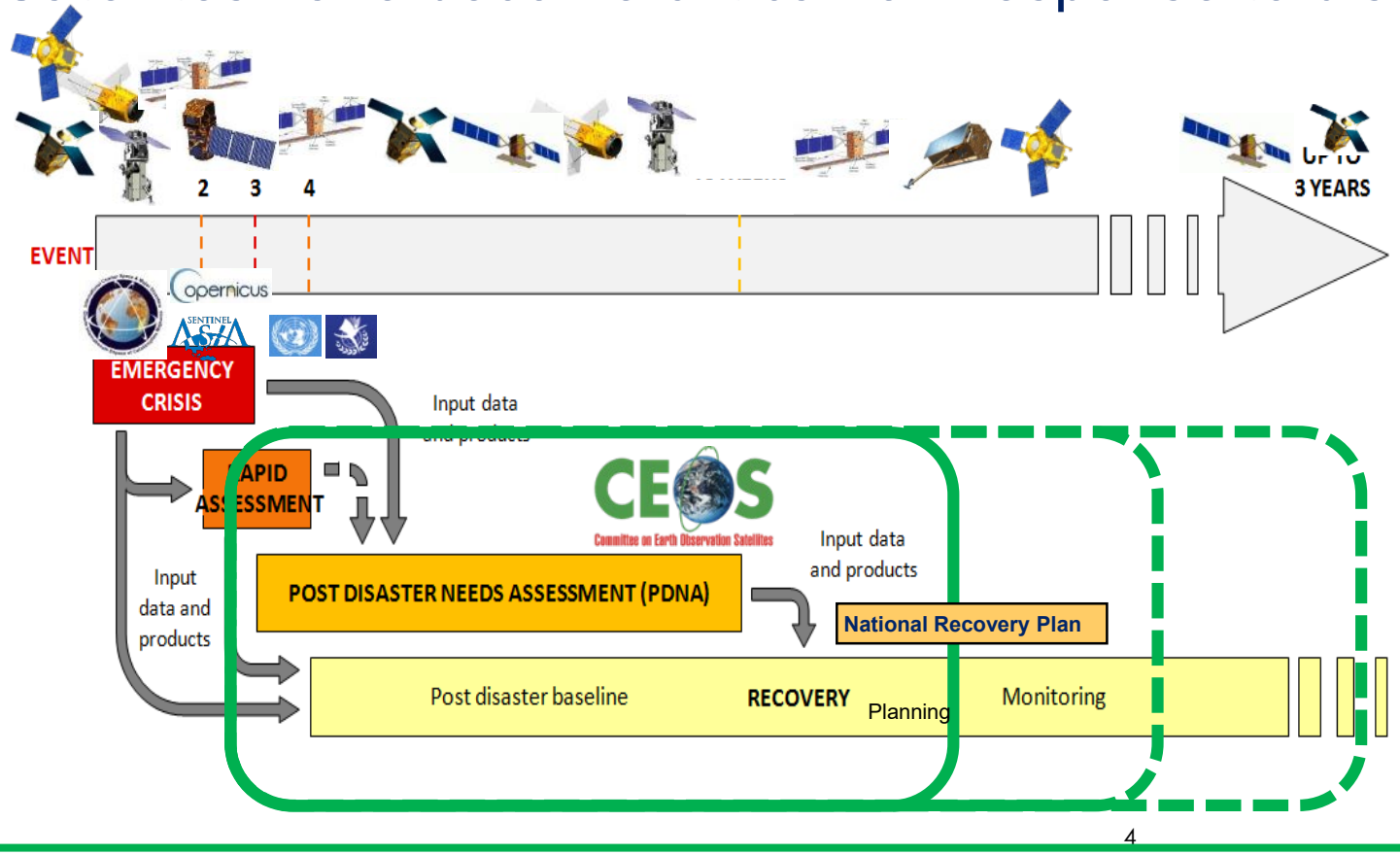
- ***Objectives of Presentation***
- ***RO Demo Objectives from 2020***
- ***Activations***
- ***Accomplishments***
- ***Cost benefit use cases***
- ***Proposal for 2024-2026***

Objectives of Presentation

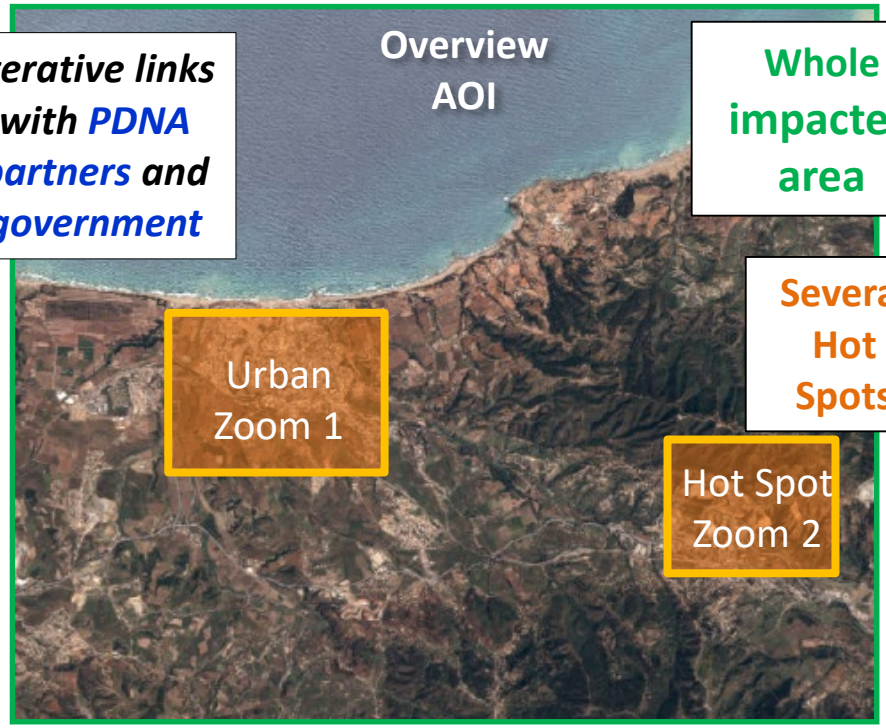
- ***Review work of last three years against objectives***
- ***Outline a vision for sustainability***
- ***Propose a concrete plan of action for 2024-2026***

Recovery Observatory (RO) Demo Philosophy

Satellites have become critical for Response to disasters… but what about Recovery?



Collection of satellite images and maps at several scales during ~ 6 months after a major disaster



Iterative links with PDNA partners and government

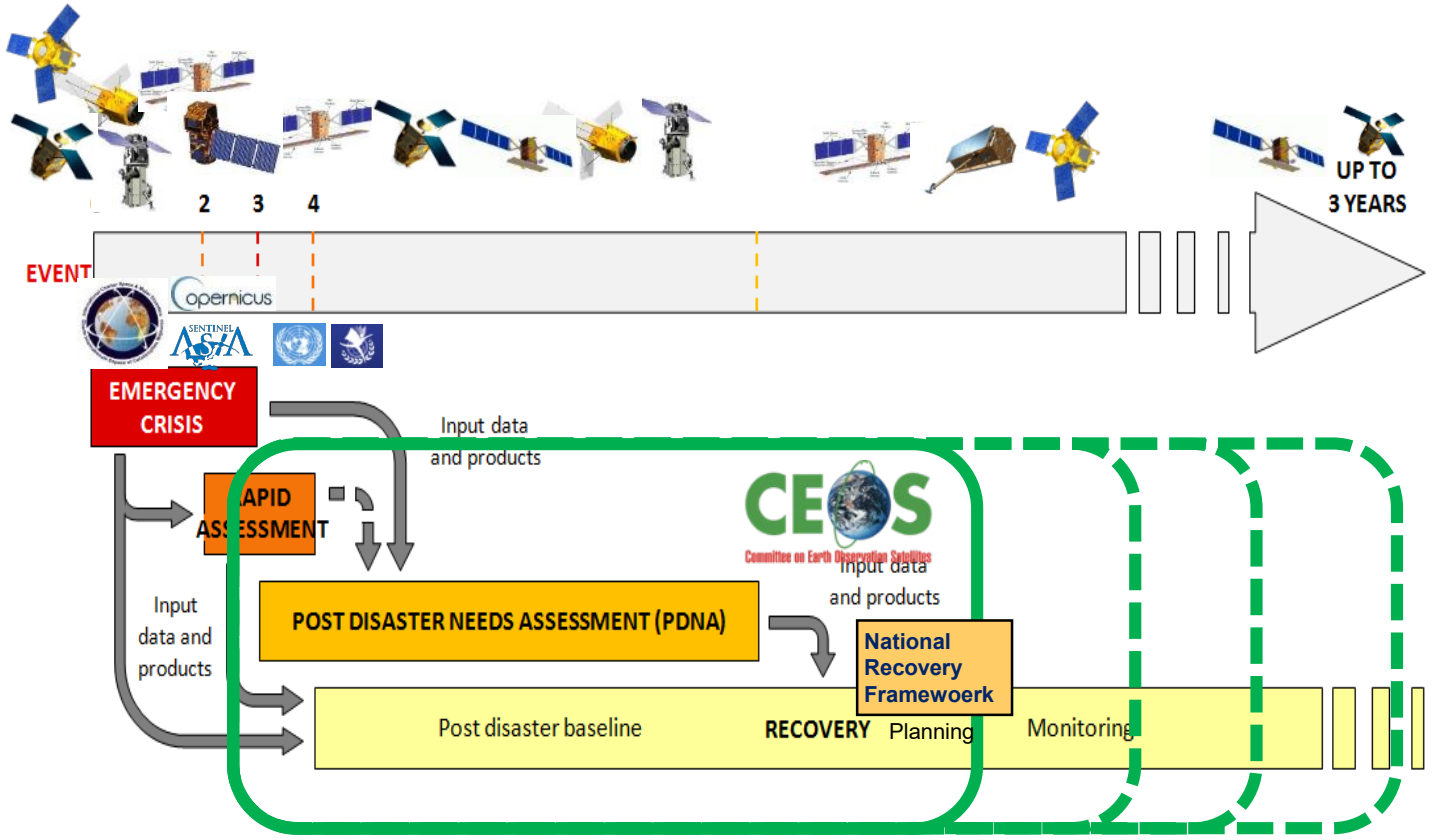
Whole impacted area

Several Hot Spots

Ancillary data are indispensable: ***terrain validation data, aerial and drone data, statistics, cartography, ….***

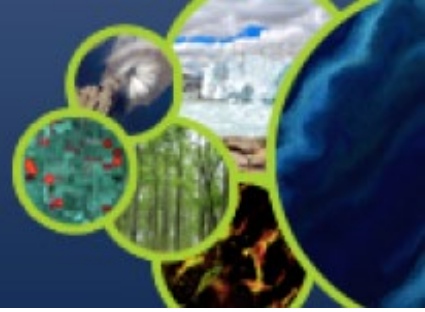
"Recovery Observatory" : Process allowing operational use of EO for PDNA, Recovery Planning, then M&E

Objective in medium term : RO integrated in Recovery process



"Recovery Observatory" : Process allowing operational use of EO for Rapid Assessments, PDNA, Recovery planning & Recovery M&E

Satellite EO and remote sensing used in Recovery



Disaster Event → **Post Disaster Needs Assessment** → **Disaster Recovery Framework**

Emergency & Humanitarian Response: satellite in[illegible] affected area, infrastructure and[illegible]

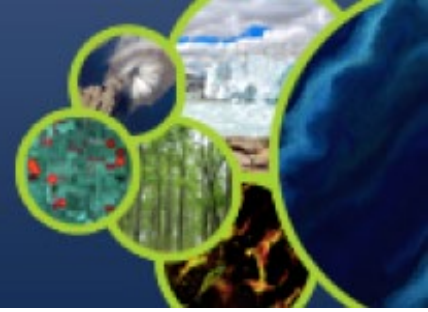
Assessment process supported by more focused, sector specific images of pre and post [illegible] agriculture, environment, infrastructure, housing, [illegible]

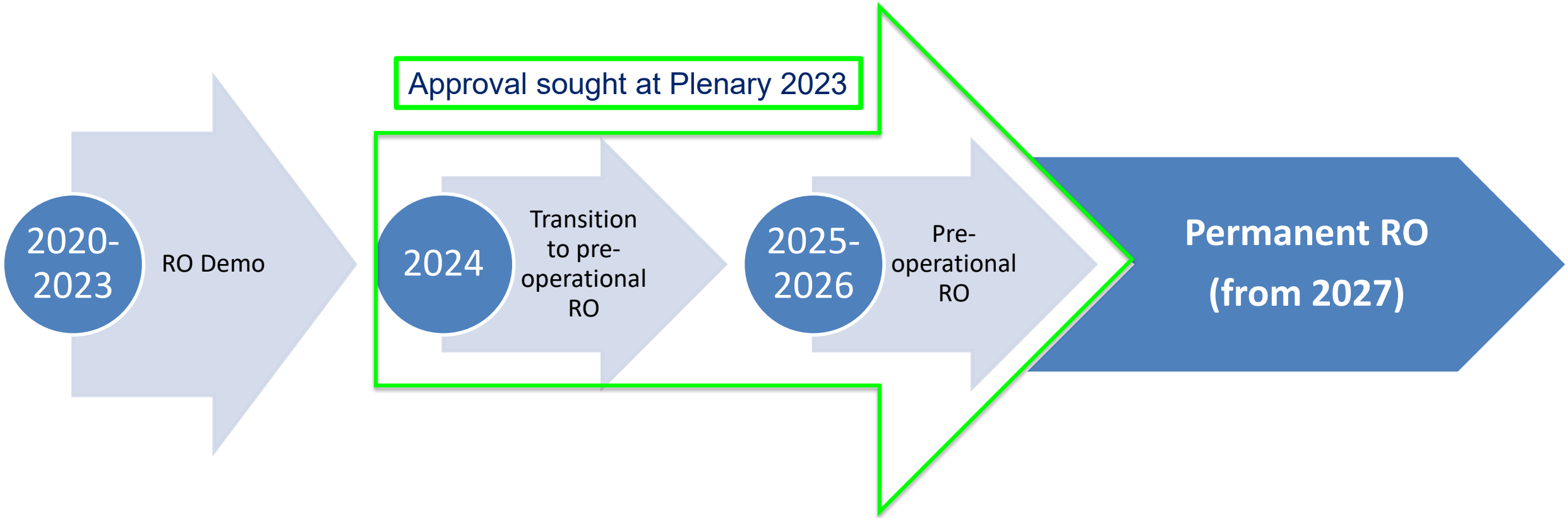
Continued use of selected imagery to monitor and document recovery processes 6 Months +

RO Demonstrator

RNA/GRADE → PDNA → DRF [illegible]REC PLANNING → RECOVERY M&E

RO Implementation Timeline





RO Demonstrator

Objectives slide presented at CEOS SIT#35 and Plenary2020

Based on lessons from RO Pilot (2017 – 2020) completed, RO Demonstrator will:

- **Deliver a use and utility report** reviewing and evaluating the timely contribution of EO data/products at several scales
  - **Characterizing impacts on livelihoods and environment**
  - **Assessing general and sectoral needs**
    - Post-Disaster Needs Assessments (PDNAs) with UNDP, EU, World Bank and others for reconstruction and rehabilitation
    - Global RApid-post-disaster Damage Estimation (GRADE) approaches with governments and other stakeholders for reconstruction
  - **Determining extent and scale of damage and losses**
    - Complement Charter observations to complete damage assessment and support recovery planning (3-6 months)
- **Complete** 1 RO test then **3 to 5 ROs over 3yrs**
  - **Activation by PDNA Tripartite Agreement partners (UNDP, GFDRR/WB, EU)**
  - **Communicate results to CEOS agencies and stakeholders**

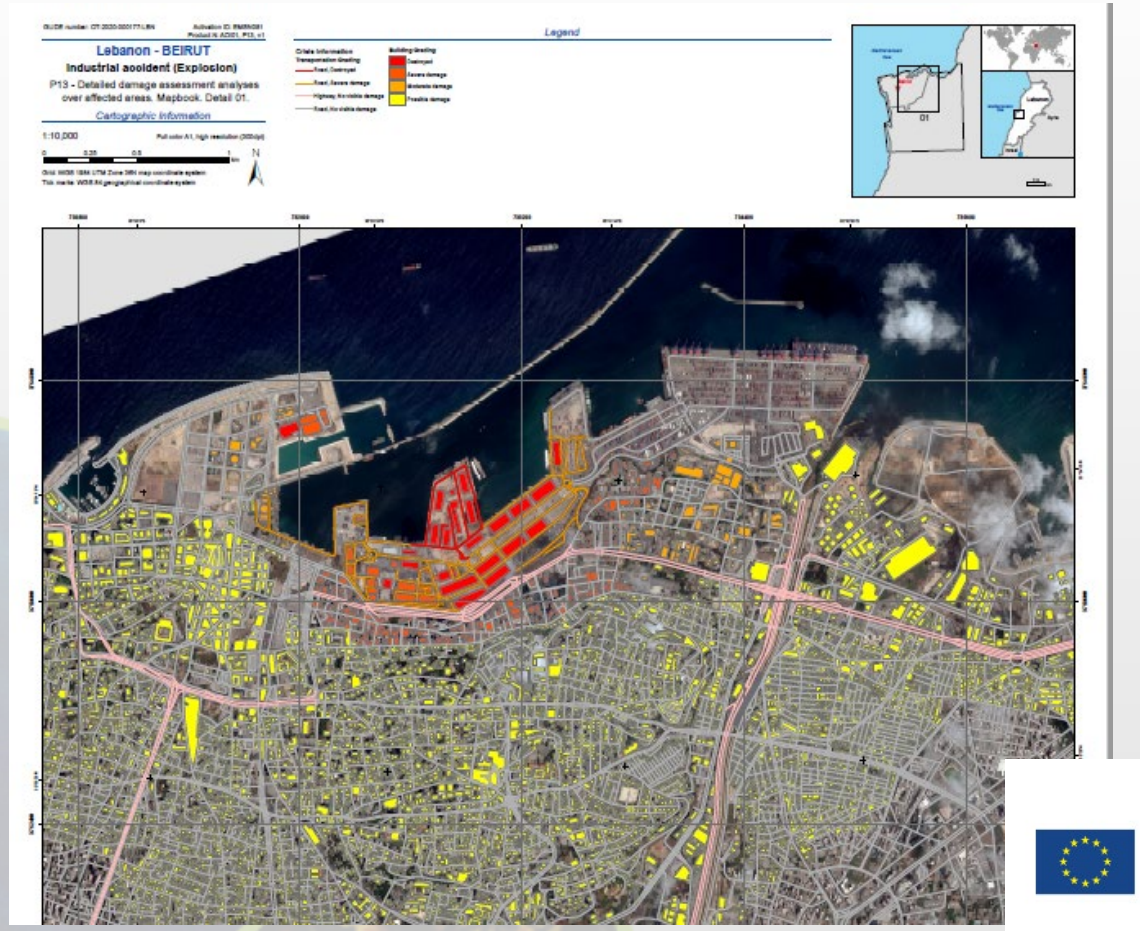
Maps and analysis at various scales

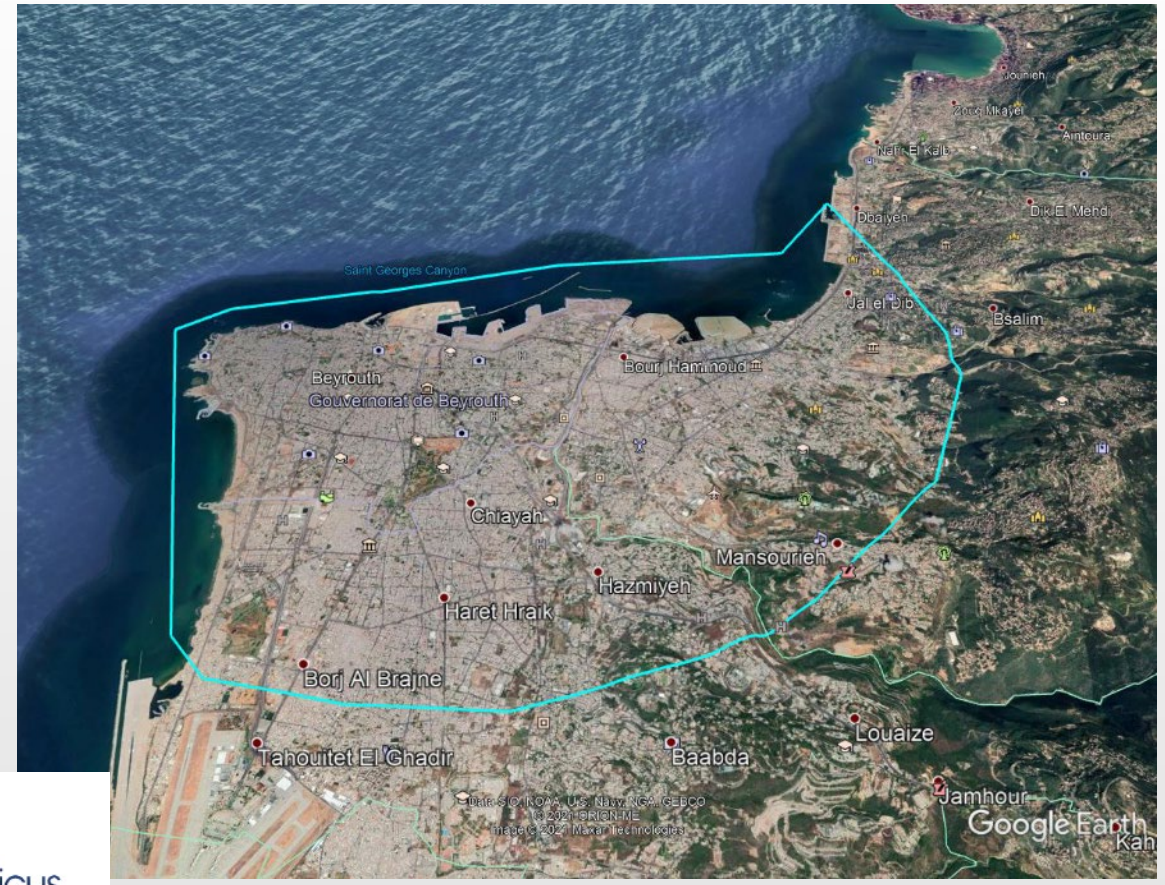
- **Mid-scale** (10m) overviews of changes in land use and cover updated every 10 days for 6 months
- **High-resolution** hot-zones and lifelines, infrastructure, transport, residences, camps …updated every 1 to 2 months
- **Integrate essential ancillary data**: terrain validation data, aerial and drone data, statistics, cartography, ….

RO Demonstrator 1 : Beirut blaze

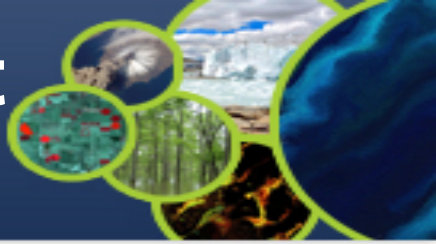
RO "test case" : Beirut blazes - activated by European Union FPI (+ UNDP, WB/GFDRR) in January 2021

- Copernicus EMS R&R activation (from fall 2020) updated every three months for one year

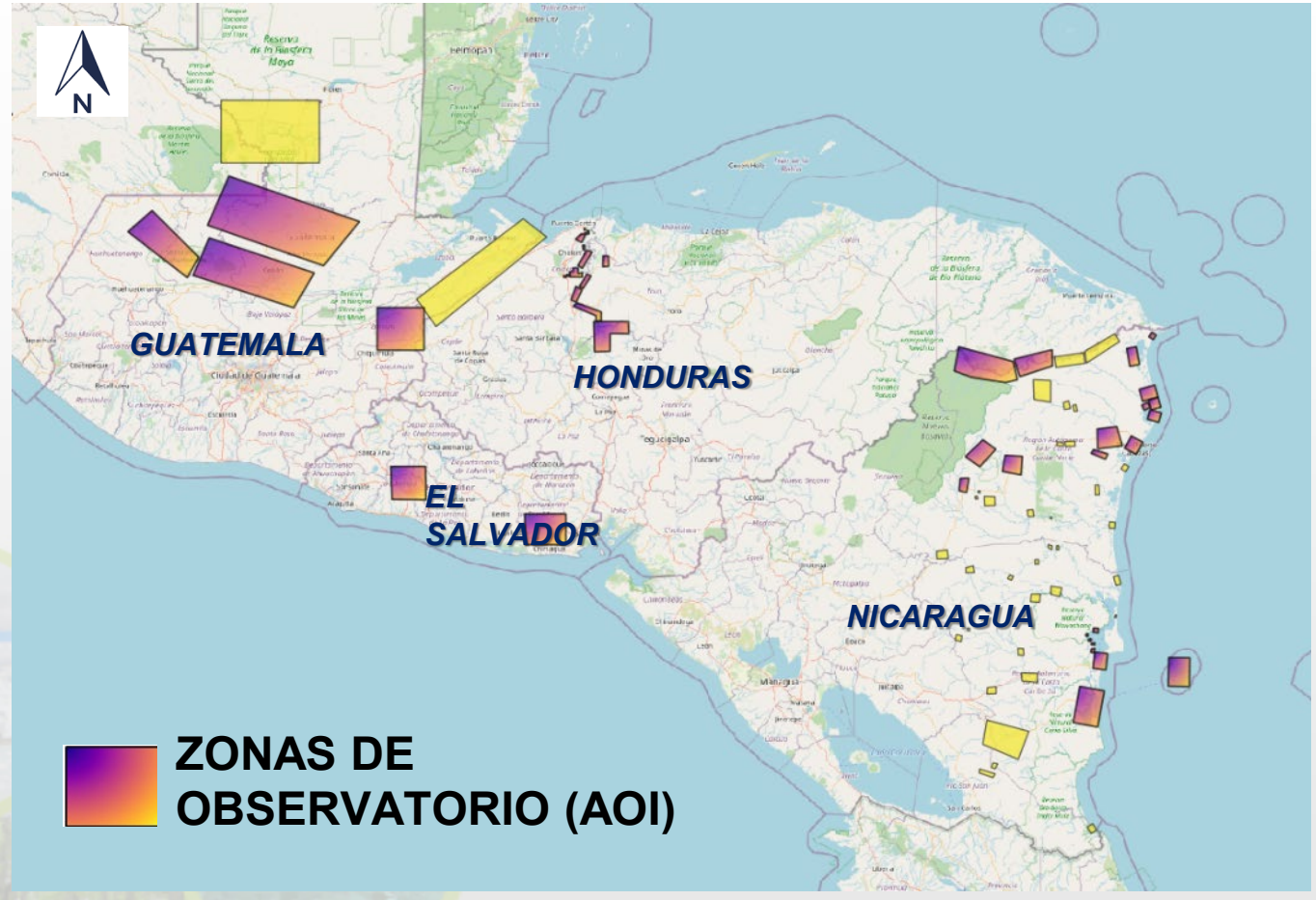




RO Demo2 on Eta/Iota hurricane impact in Central America



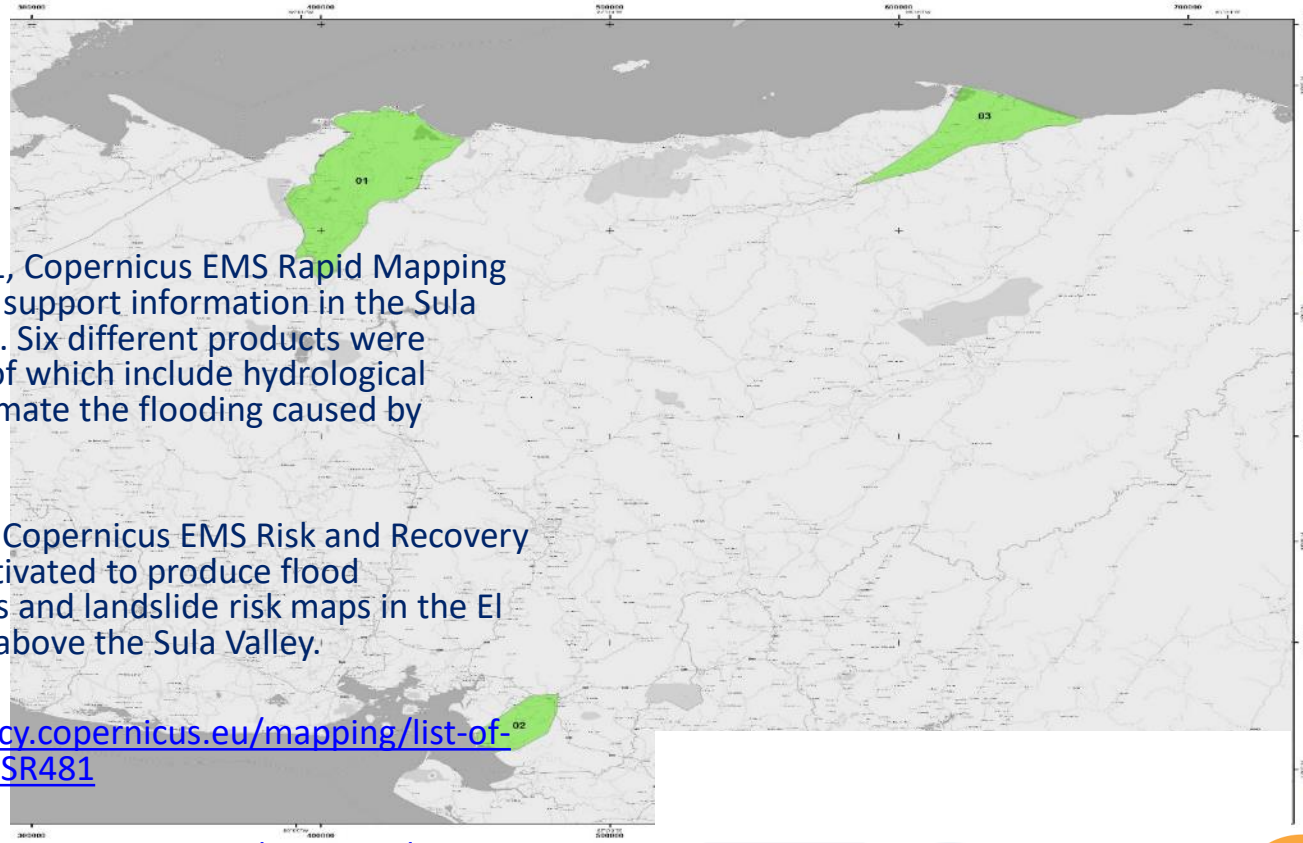
RO Demo2 : Priority Damage Zones (post Eta/Iota)*



Honduras (1,200 km²)
El Salvador (1,900 km²)
Nicaragua (7,500 km²)
Guatemala (20,000 km²)

*AOI included in RO Iota as agreed by CEPREDENAC and 4 national country partners at 9th April “needs identification” meeting

RO Demo2 - Honduras



On November 11, Copernicus EMS Rapid Mapping was activated to support information in the Sula Valley, Honduras. Six different products were obtained, most of which include hydrological modeling to estimate the flooding caused by hurricane ETA.

On December 3, Copernicus EMS Risk and Recovery Mapping was activated to produce flood delineation maps and landslide risk maps in the El Cajon Reservoir above the Sula Valley.

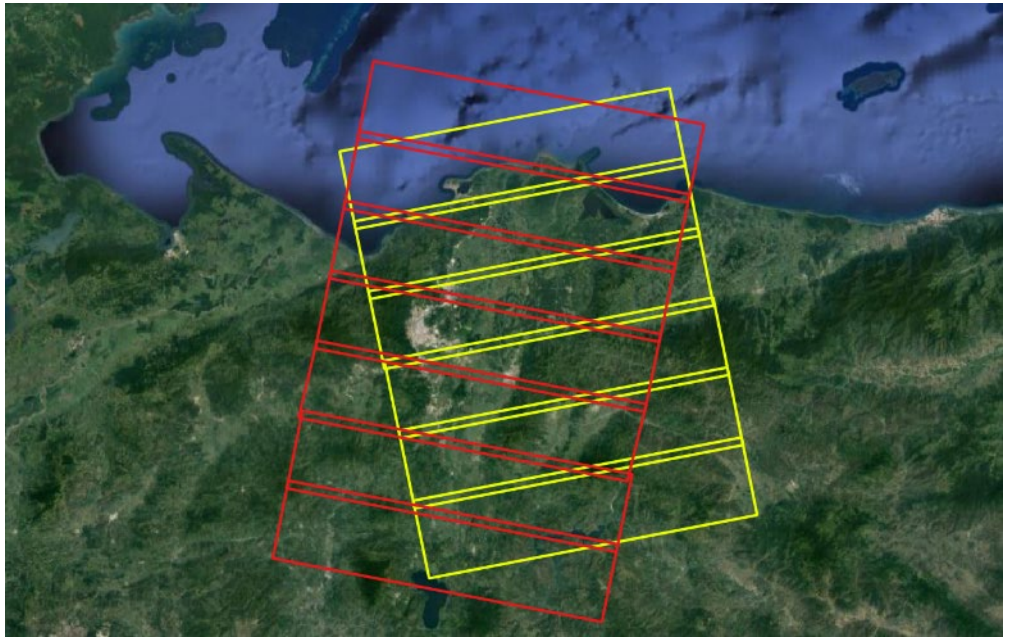
https://emergency.copernicus.eu/mapping/list-of-components/EMSR481

https://emergency.copernicus.eu/mapping/list-of-components/EMSN084

opernicus
Europe's eyes on Earth

RO Demo2 : Italian Space Agency activities on Eta/Iota

Honduras: Sentinel-1 dataset



Integrated CosmoSkyMed analysis

Mean velocity map

RO Demo3 : Haiti 2021
Earthquake & Grace tropical storm

3rd RO activation: September 6th, at request of EU on behalf of tripartite team, in support of PDNA and emerging Recovery Framework

Support Haiti Recovery from EQ and Grace through EO-derived products:

- to augment and validate **PDNA** analysis (by end of September 2021) => PHASE 1
- to support the **Recovery Framework** => PHASE 2

Contributors/Partners

CNES – Centre National d'Études Spatiales
CEOS
Sertit – ICUBE
ASI – Agenzia Spaziale Italiana
DLR
NASA
cima Research Foundation
BGC
UNOSAT
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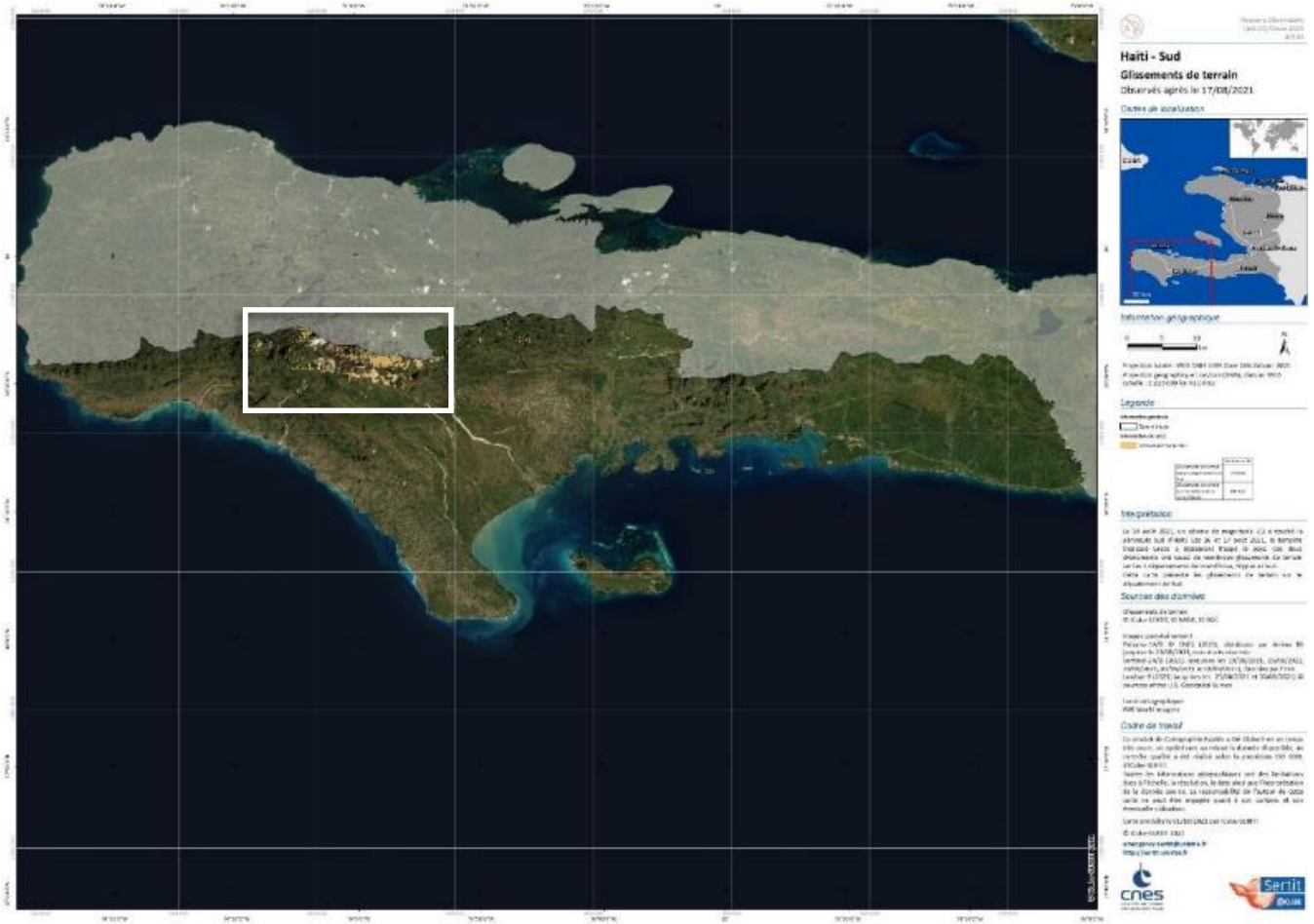
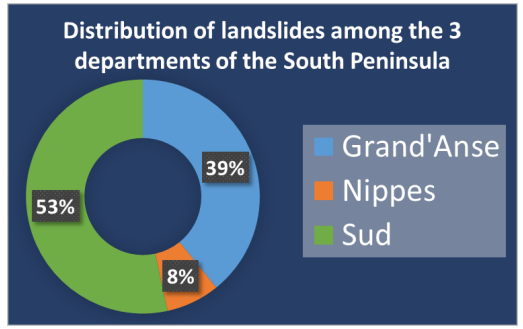
Luxembourg Institute of Science and Technology – LIST
Ministère de l'Environnement
CIAT – Comité Interministériel d'Aménagement du Territoire – Primature
Agriculture, Ress. Naturelles, Développement Rural
CARIBACT
MPCE
IOM • OIM
Commission européenne
EU Delegation in Haiti
Foreign Policy Instruments
participp
THE WORLD BANK
UNDP

RO Demo3 – Haiti EQ 2021
Phase 1: support to the PDNA

P01: Assessment and qualification of areas where EQ/Grace landslides have occurred, in South Peninsula





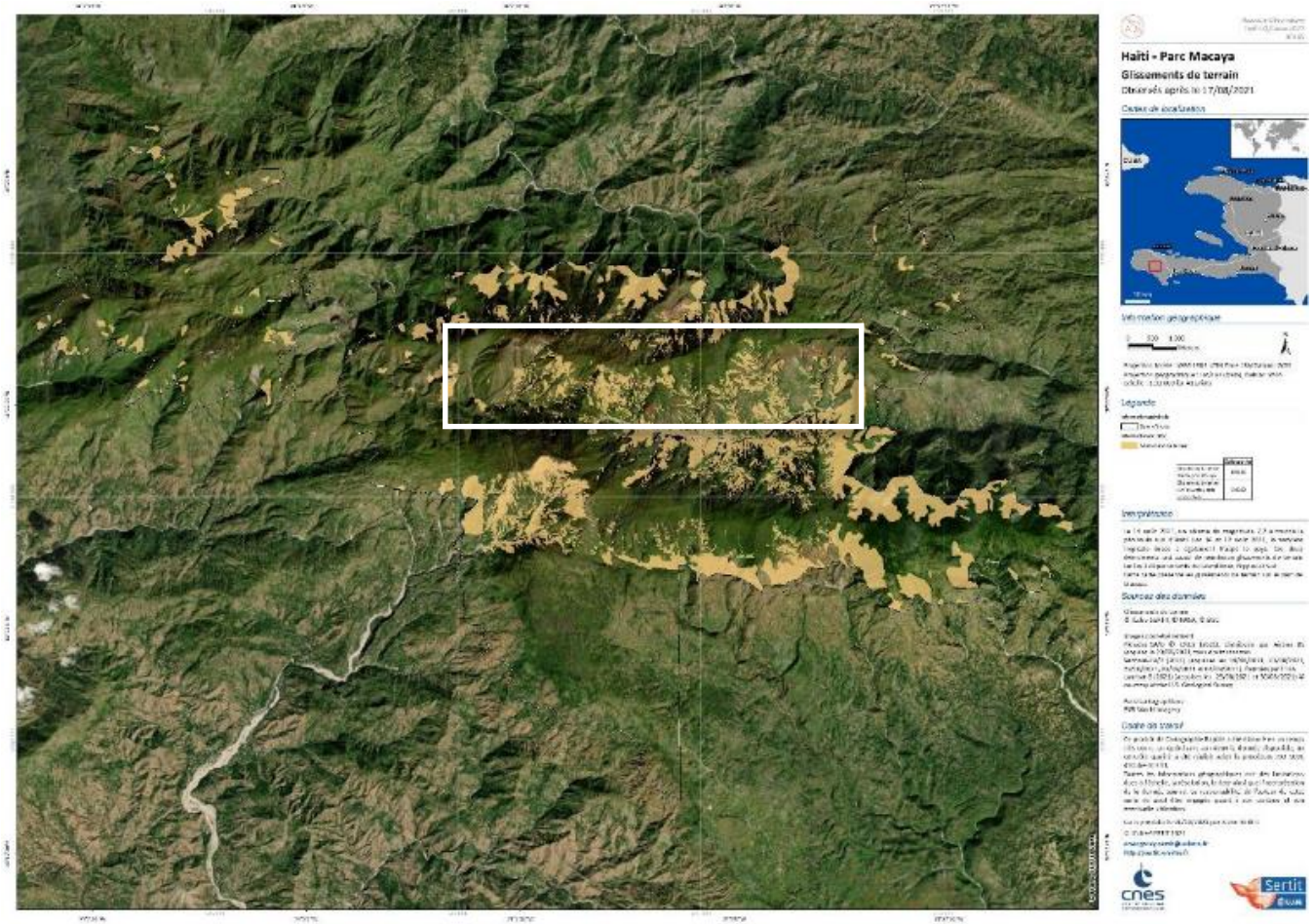
Landslides

South Peninsula: 6949.02 ha

Sud area: 3709.94 ha

RO Demo3 – Haiti EQ 2021
Phase 1: support to the PDNA

P01: Assessment and qualification of areas where EQ/Grace landslides have occurred, in South Peninsula



Landslides

South Peninsula: 6949.02 ha
Macaya Park area: 1901.66 ha **(27%)**

RO Demo3 – Haiti EQ 2021
Phase 1: PDNA including RO results and figures

P01: EO: a valuable tool for assessing the agricultural, environmental and economic impact

Les images satellites que nous avons pu recueillir auprès du CEOS[115], font état d'un total de 6, 949,02 ha de glissements de terrain dans l'ensemble des trois départements. Ces informations, croisées avec des données antérieures d'occupation des sols, ont permis de constater une perte de 4,114 ha de végétation arborée : Grand'Anse/ 1,687 ha, Nippes/ 297 ha et Sud : 2,130 ha.

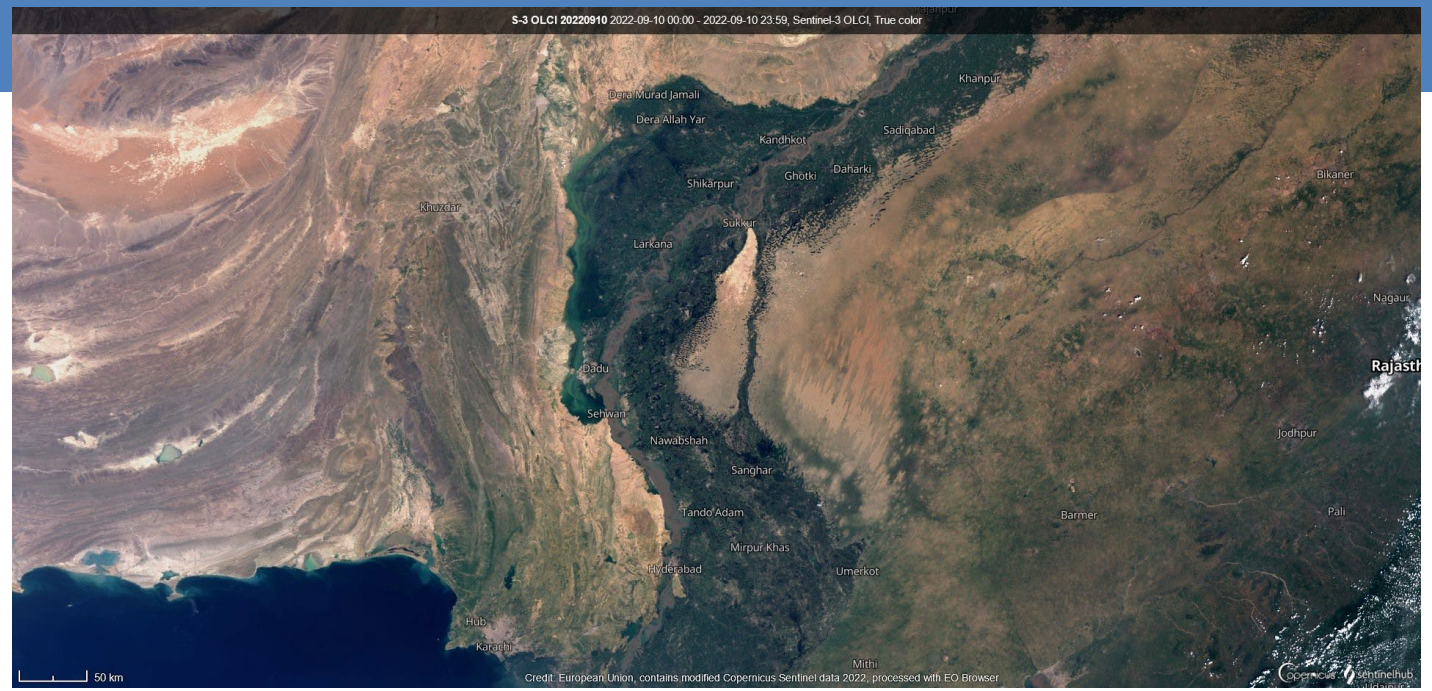
Selon une analyse établie par le SERTIT, plus de 431 Ha de cultures agricoles denses, 567 ha de systèmes agro-forestiers denses, 1251 ha de cultures agricoles moyennement denses et 154 ha de pâturages auraient été affectés par les glissements de terrains dans les trois départements.[46]

Les Dommages : les dommages les plus importants se retrouvent dans le sous-secteur des cultures, avec des dommages sérieux sur les terres agricoles, perdues à la suite des nombreux glissements de terrains et éboulements (13,9 millions $US) et sur les infrastructures hydro-agricoles, principalement dans le département du Sud (2,4 millions $US). Le sous-secteur de l'élevage a subi un montant total de dommage de 4,9 millions $US, notamment avec la disparition d'animaux et les destructions d'infrastructures (poulaillers, porcheries) et pâturages. Dans le sous-secteur de la pêche, les dommages consistent principalement en la destruction ou l'ensevelissement des outils de pêche (0,55 million $US)[31].

RO Demo 4 - Pakistan

The **4th Recovery Observatory Demonstrator** was triggered 20 September at request of EU, on behalf of the tripartite team (**EU / World Bank and UNDP**), in support of:

- the **Post Disaster Need Assessment**
- the **Recovery Framework**

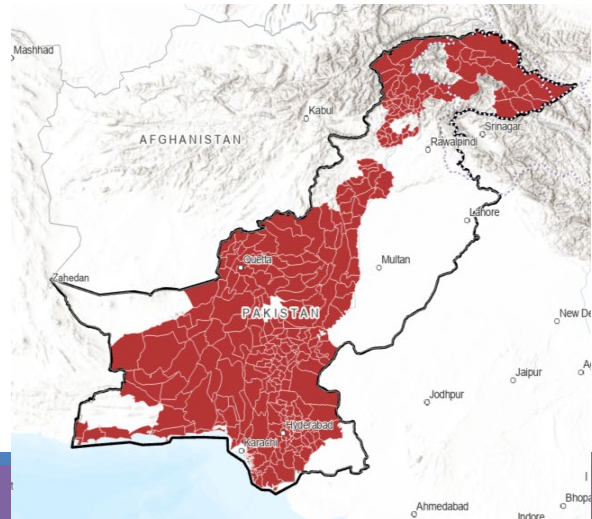


RO Demo 4 – Pakistan
PDNA Needs

- PDNA officially requested September 16, 2022, followed by a request for a DRF in October
- The PDNA report was produced in October and the DRF in December 2022

- RO activation focussed on providing complementary information to what was already committed (e.g. IPSOS and CIMA/LIST contributions)
- The analysis focussed on 84 districts that were identified as « calamity districts »
- Needs expressed concerning:

- potential landslides that impacted orchards
- potential impacts in Natural Parks and Reserves

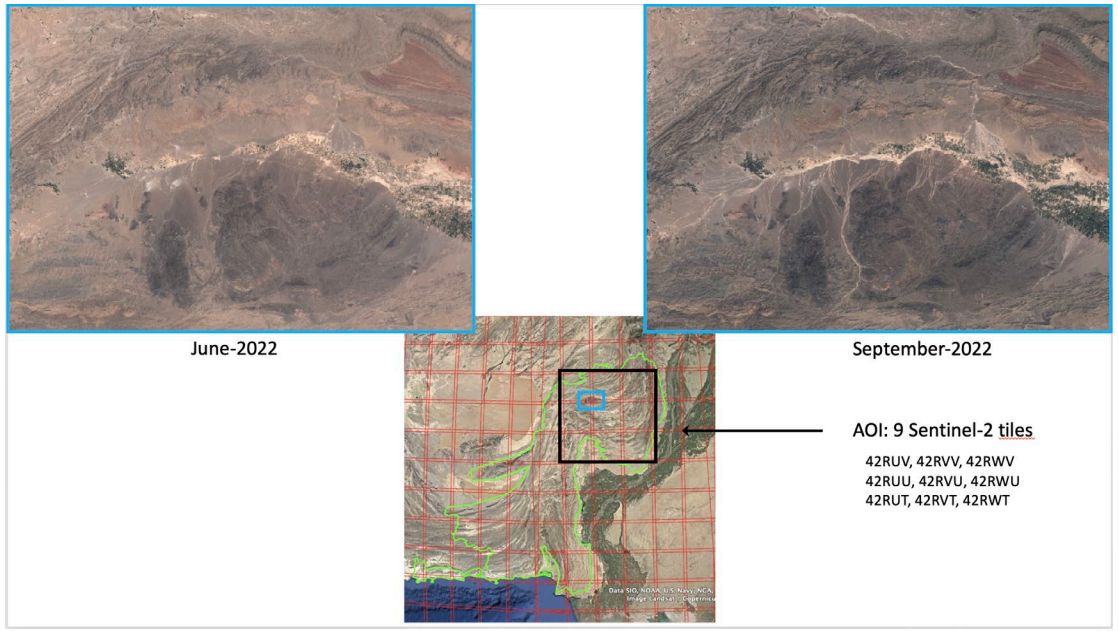


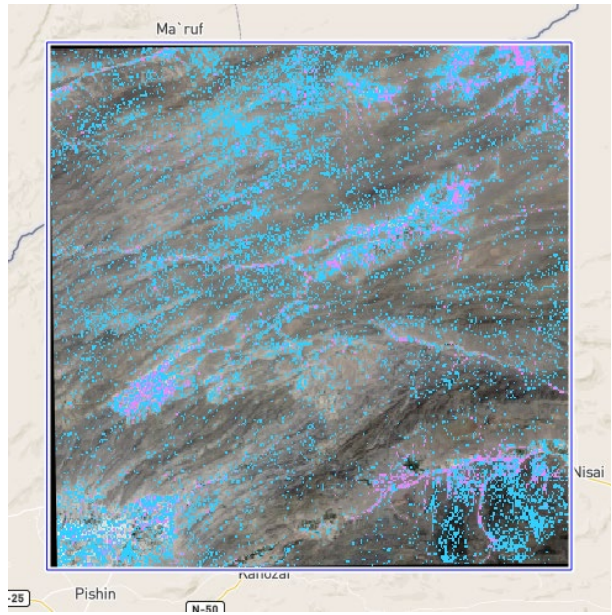
The 84 calamity districts with a priority level

RO Demo 4 – Pakistan
CEOS Contributions

Landslides detection

- EOST launched automated process with the ALADIM machine learning service, exploited on GEP, over a part (9 Sentinel-2 tiles) of Balochistan Province





RO Demo 4 – Pakistan
CEOS Contributions

Multi-sources flood extraction layers:

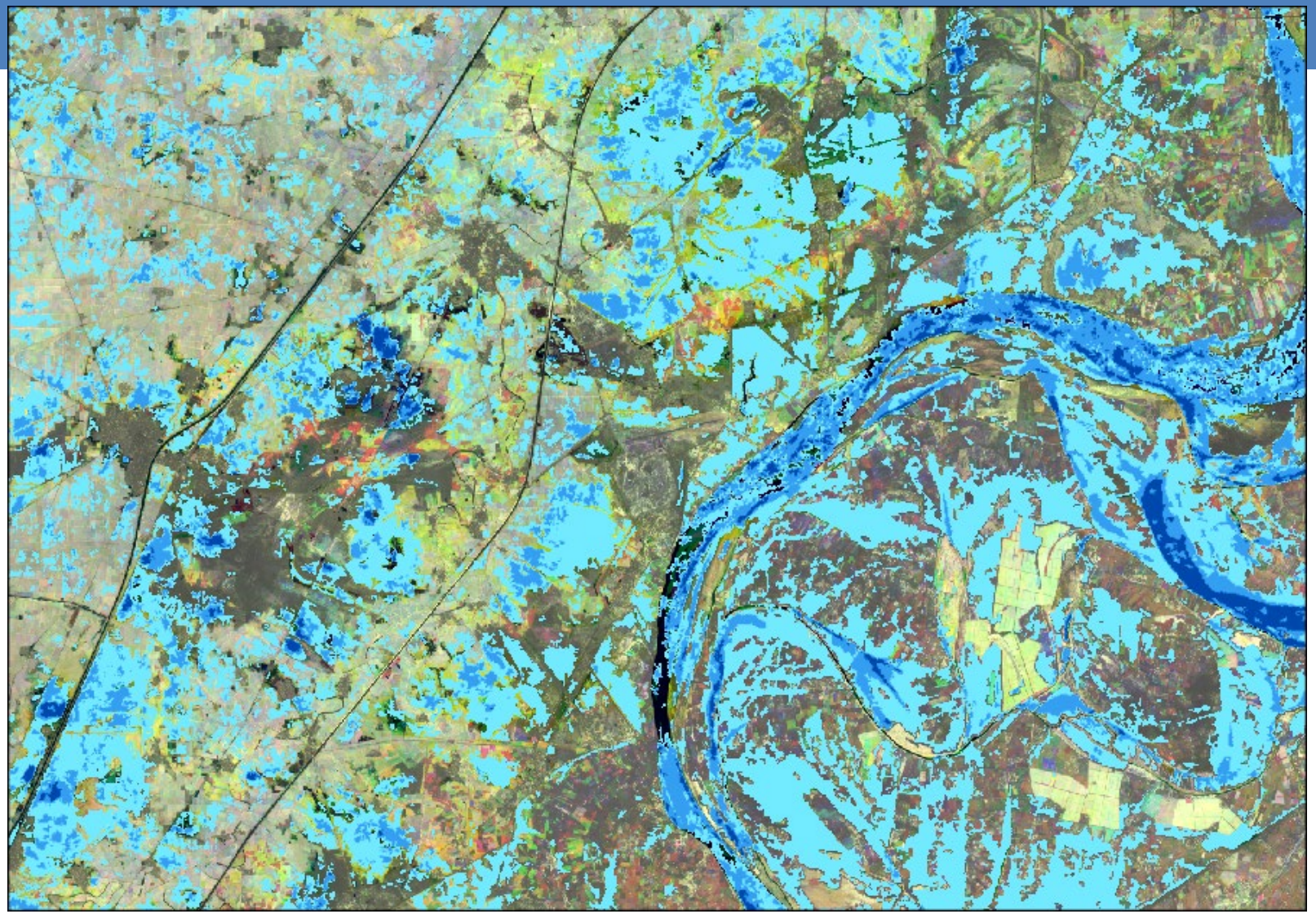
- Gathering
- Analysis and validation

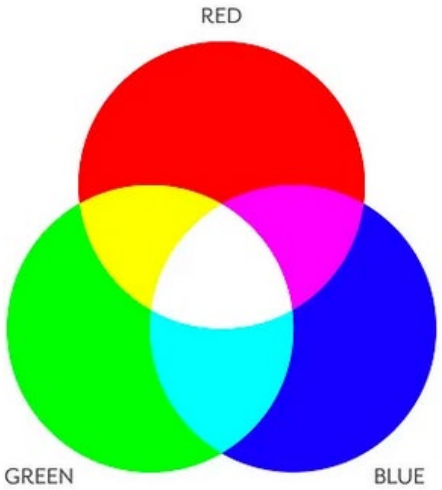
Flood synthesis product:

- Generation
- Intersection with landuse/landcover layer
- Statistics derivation

Impact on natural protected areas

RO Demo 4 – Pakistan
Recovery Framework Contribution





2020
2021
2022

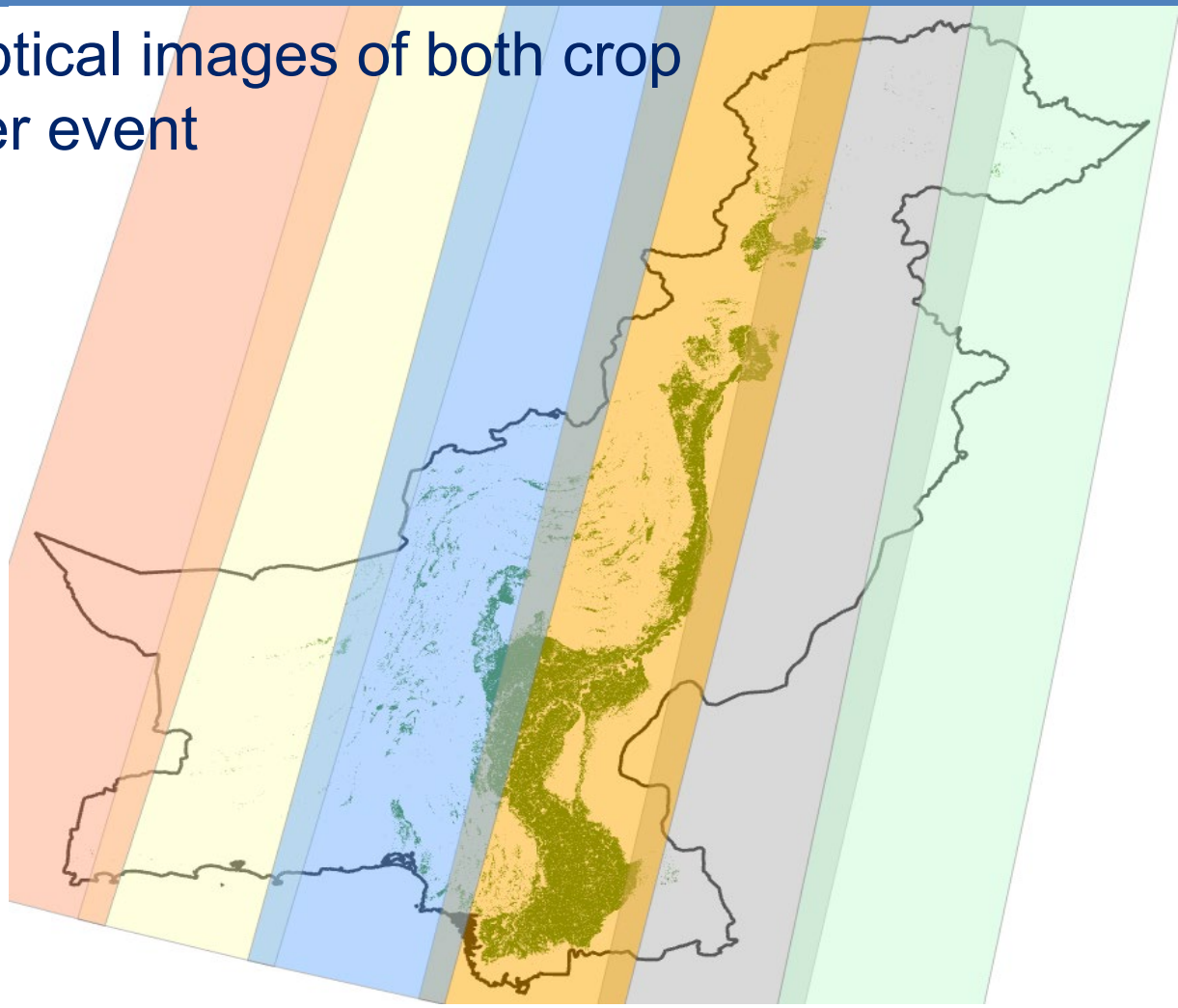
Flood duration
(number of flood observations during the 2022 summer)

Up to 5
Up to 10
Up to 14

RO Demo 4 – Pakistan
Recovery Framework Contribution

- Analysis of NDVI values from Sentinel-2 optical images of both crop seasons, before and after the 2022 summer event

RABI	KHARIF
Rabi crops are sown between September and October	The Kharif Crops are sown between April and May
Rabi crops are harvest at the end of the winter season (February/March)	The Kharif crops are harvested after the monsoon or rainy season (September)



RO Demo 5?
Turkey and Syria – possible activation?

- On February 6th 2023, a major earthquake struck southwestern Turkey and Syria. The Kahramanmaraş event is the most significant earthquake to strike the region in recent years. To date over 12,000 aftershocks , up to Mw 6.7; Final death toll >57,000 ; >850,000 people are displaced; >160,000 buildings destroyed; Length of the main seismic ruptures: >400 km and >150 km

- RO Demo response to the event:
  - Liaison with EU and WB (Tripartite agreement partners);
  - Liaison with GSNL during establishment of event supersite;
  - Generation of report with links to existing products – understanding status of Copernicus response;
  - Informal team discussion to prepare for possible activation.

- To date, no formal RO activation has taken place. The RO did not prepare products for the Rapid Assessment (timeline too short); complexity of political situation in the area has increased difficulty of making a formal contributions; no formal Disaster Recovery Framework has been established, but should one be established, RO is prepared for activation.

RO Demo 5b?
Myanmar – possible activation?

- On May 14, 2023, Cyclone Mocha caused destructive storm surges, heavy rainfall, and flooding, impacting areas such as Rakhine, Chin, Magway, Ayeyarwady, Mandalay, and Sagaing. The estimated impact in Myanmar is over $2.24 billion, equivalent to 3.4% of Myanmar's GDP in 2021. This includes damages to residential and non-residential buildings and contents, agriculture, and infrastructure.

- RO Demo activation was requested in late July to quantify clean up effort and cost for support to donor conference late August.

- After reviewing the timeline and request, it was determined that no products could be developed within the necessary timeline.

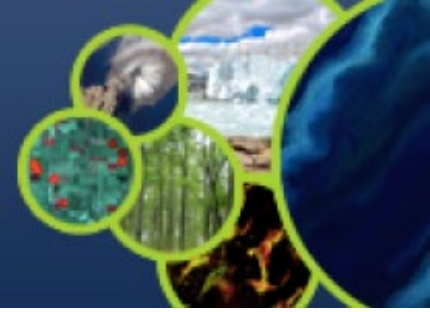
Summary of Activations

- ***1. Beirut:*** *high-level changes quarterly for monitoring purpose*
- ***2. Eta-Iota:*** *Input to Recovery Framework provided but too late for early damage assessment and weak linkages to long-term recovery effort; highlights unique CEOS contributions (e.g. interferometric analysis)*
- ***3. Haiti EQ 2021:*** *clear demonstration of value of EO for PDNA – only quantified report of damage for agriculture and environment*
- ***4. Pakistan:*** *challenges of coordination across actors for large events – valid input but insufficient impact*
- *(5.) Turkey/Syria: no activation but support provided by compiling all satellite activations done by different actors*
- *(5b.) Myanmar Cyclone Mocha impact May 2023: requested late July for 25 August – timeline too short – no activation*

Summary of Activations

Activation	Pros	Cons	Comments
1. Beirut	Synthetic update of situation	Very small area not representative of typical activation	Coordination with Copernicus but no other added CEOS value
2. Eta-Iota	Excellent. Multinational coordination. Innovative products (e.g. interferometry Sula Valley)	Request came months after events; no direct impact on early recovery	Demonstrated need for increased tripartite coordination
3. Haiti EQ	Activation in days; results in PDNA only input for agriculture and environment	None	Excellent showcase
4. Pakistan	Excellent quality of CEOS products for two areas retained for Phase 1; strong interest in DRF products (agriculture)	Lack of coordination; evolving need analysis led to gaps in EO products; poor uptake in PDNA	Large events (Pakistan, Nepal EQ, …), pose unique coordination challenges
Turkey/Syria	Strong willingness of CEOS to contribute; linkages to GSNL	Complex political situation postponed decision to activate indefinitely	No activation but support provided in determining all remote sensing data available
Myanmar	Strong technical case for quality product	Impossible to deliver in proposed timeline	Need to fast-track activation requests

Accomplishments



- After nearly 3 years of activity, an efficient **RO Demonstrator community** working in **best effort** mode :
  - ✓ **Data providers**: ASI, CNES, ESA/Copernicus, DLR, International Charter Space & Major Disasters
  - ✓ **Value adder contributors**: Copernicus EMS, BGC, NASA, CIMA, LIST, CNIGS, ICube-SERTIT

- **Operational results :**
  - ✓ **on Lebanon :** monitoring of reconstruction regularly provided to **Reform, Recovery and Reconstruction Framework (3RF)**
  - ✓ **On Eta-Iota:** demonstration that very complex products can be delivered and used for improved understanding of long-term recovery (interferometric SAR for mm level subsidence analysis)
  - ✓ **on Haiti :** first products delivered in a relative rush mode that **directly inform the PDNA with quantitative data (environmental and agricultural damage)**
  - ✓ **on Pakistan:** first products delivered in rush mode; some critical areas not addressed; coordination issues with broader recovery effort; better coordination of resources could have provided more comprehensive results.
- **Various** products generated and diverse types of satellite made available

- Excellent **collaboration** between the **stakeholders** and the **RO team**; RO team responsive to the emergence of new needs. Products welcomed by the recovery community to help reconstruction and better prepare to future events

RO Cost-benefit work

- Key to RO sustainability lies in demonstrating benefit for work of RO to DRM community, especially PDNA Tripartite Agreement
- RO Demo team (UNOSAT, SERTIT, CIMA, WASDI) determined use cases and costed benefits
- Use case approach to be based on different balance points of coordination and value adding costs – 25k ; 50k ; 80k (does not at this time include cost of commercial data)
- Schedule:
  - May 2023 – kick off of activity with partners; identification of main use cases
  - June 2023 – presentation of draft use case categories to RO Demo Team telcon – discussion and refinement
  - August 2023 – finalization of use cases and preparation of promotional materials for the cases

RO Use Case Cost-Benefit – Riverine flood event

	25k	50k	80k
Description	Coordination across EO community and linkages to recovery teams (RO liaison); identification of free EO resources; basic products	Dedicated damage products linked to specific sectors in PDNA; dedicated recovery products tied to recovery timelines	Integrated EO-based spatialized recovery framework from event to DRF implementation
Details	Dedicated RO calls to coordinate existing EO resources; Sentinel-based products to determine maximum flood extent and changes to flood extent over periods around cresting (not daily, but probably every few days, depending on location and satellites)	Integration of dedicated SAR and VHR optical image acquisitions with lower resolution products; more detailed damage analysis (urban areas) and evolution over time (reconstruction progress) over specific hotspots	Interferometric SAR analysis of damaged infrastructure in hotspots; long-term environment and agriculture damage and recovery monitoring over large area

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RO Use Case Cost-Benefit – Windstorm (hurricane, cyclone)

	25k	50k	80k
Description	Coordination across EO community and linkages to recovery teams (RO liaison); identification of free EO resources; basic products	Dedicated damage products linked to specific sectors in PDNA; dedicated recovery products tied to recovery timelines	Integrated EO-based spatialized recovery framework from event to DRF implementation
Details	Dedicated RO calls to coordinate existing EO resources; Sentinel-based products to determine land cover changes at medium resolution	Integration of dedicated SAR and VHR optical image acquisitions with lower resolution products; more detailed damage analysis (wind damage, specific crops, roof tops) and evolution over time (reconstruction progress) over specific hotspots	Ability to extend in time and area covered the VHR analysis of change – detailed monitoring of progress of DRF

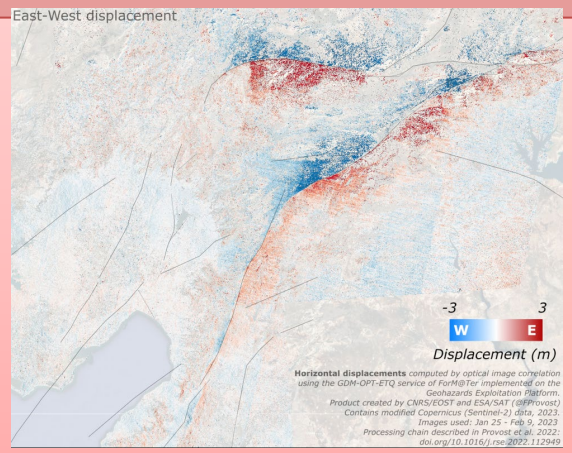
RO Use Case Cost-Benefit – Windstorm (hurricane, cyclone)

	25k	50k	80k
Description	Coordination across EO community and linkages to recovery teams (RO liaison); identification of free EO resources; basic products	Dedicated damage products linked to specific sectors in PDNA; dedicated recovery products tied to recovery timelines	Integrated EO-based spatialized recovery framework from event to DRF implementation
Details	RO Haiti EQ/Grace: landslide inventory, Landslide Susceptibility Index  Large flooded areas, costal erosion or fallen trees over large areas using Sentinel-1/2 images	More detailed damage analysis (wind damage, specific crops, roof tops) and evolution over time (reconstruction progress) over small specific hotspots using VHR optical images (small pre-selected priority areas (https://sertit.unistra.fr/rms/?action=655)) RO Demo 2 – Eta/Iota	Ability to extend in time and area covered the VHR analysis of change – detailed monitoring of progress of DRF

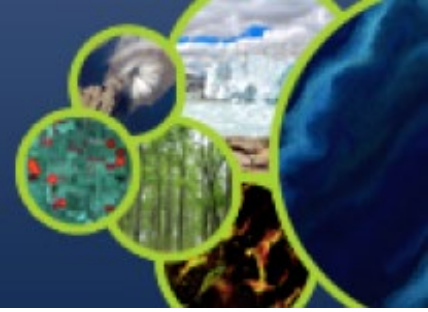
RO Use Case Cost-Benefit – Earthquake

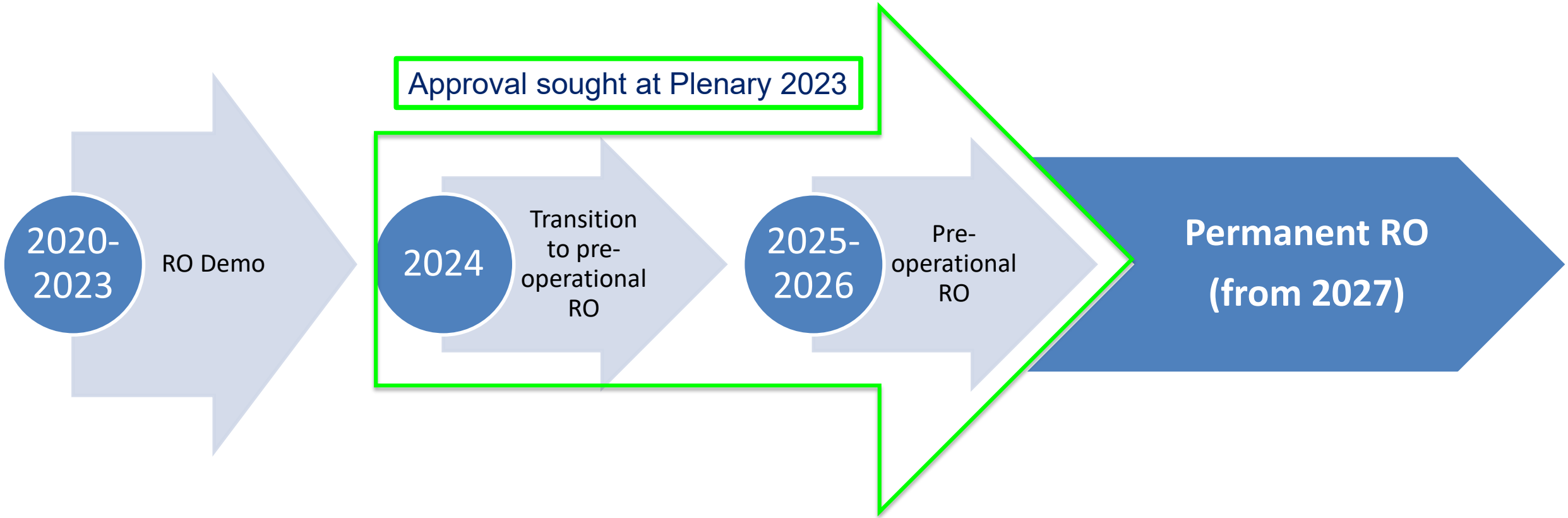
	25k	50k	80k
Description	Coordination across EO community and linkages to recovery teams (RO liaison); identification of free EO resources; basic products	Dedicated damage products linked to specific sectors in PDNA; dedicated recovery products tied to recovery timelines	Integrated EO-based spatialized recovery framework from event to DRF implementation
Details	Linkages to GSNL and Seismic Demonstrator; dedicated RO calls to coordinate existing resources; use of Sentinel imagery and linkages to non-EO products	Integration of dedicated SAR and VHR optical image acquisitions with lower resolution products; more detailed damage analysis and evolution over time over specific hotspots	Large area recovery monitoring and dedicated interferometric analysis of infrastructure concerns over large area – improved understanding of evolving risk and impact of aftershocks on recovery process

RO Use Case Cost-Benefit – Earthquake

	25k	50k	80k
Description	Coordination across EO community and linkages to recovery teams (RO liaison); identification of free EO resources; basic products	Dedicated damage products linked to specific sectors in PDNA; dedicated recovery products tied to recovery timelines	Integrated EO-based spatialized recovery framework from event to DRF implementation
Example and potential products	 Ground deformation/movement for S1/S2 over large areas	https://disasterscharter.org/web/guest/activations/-/article/earthquake-in-turkey-activation-797- Grading maps with VHR optical images over small pre-selected priority areas https://unosat.org/products/3490 RO Demo 3 Haiti EQ	Grading maps with VHR optical images over more small pre-selected priority areas. Possibility to implement aerial, drone and/or social media sources to improve the analysis

RO Implementation Timeline





Current partner contributions

Openly available response data and products

- International Charter
- Copernicus EMS RM
- Sentinel-Asia
- UNOSAT
- Open-source sat data (Landsat, Sentinels, DTM)
- Data bases (landcover, population,..)

CEOS best efforts RO data and products

- Dedicated acquisitions of commercial data
- Complex satellite products (e.g. SAR interferometry)
- RO liaison officer and overall coordination
- Value adding services
- Capacity building

Ad hoc contributions: academia, international organizations (e.g. CEMS, FAO, UN)

- Linkages to Copernicus Risk and Recovery
- Value adding services
- Expert analysis
- Integration of other advanced data sources (e.g. social media, drones, …)

Integrated Situational Awareness to support recovery:

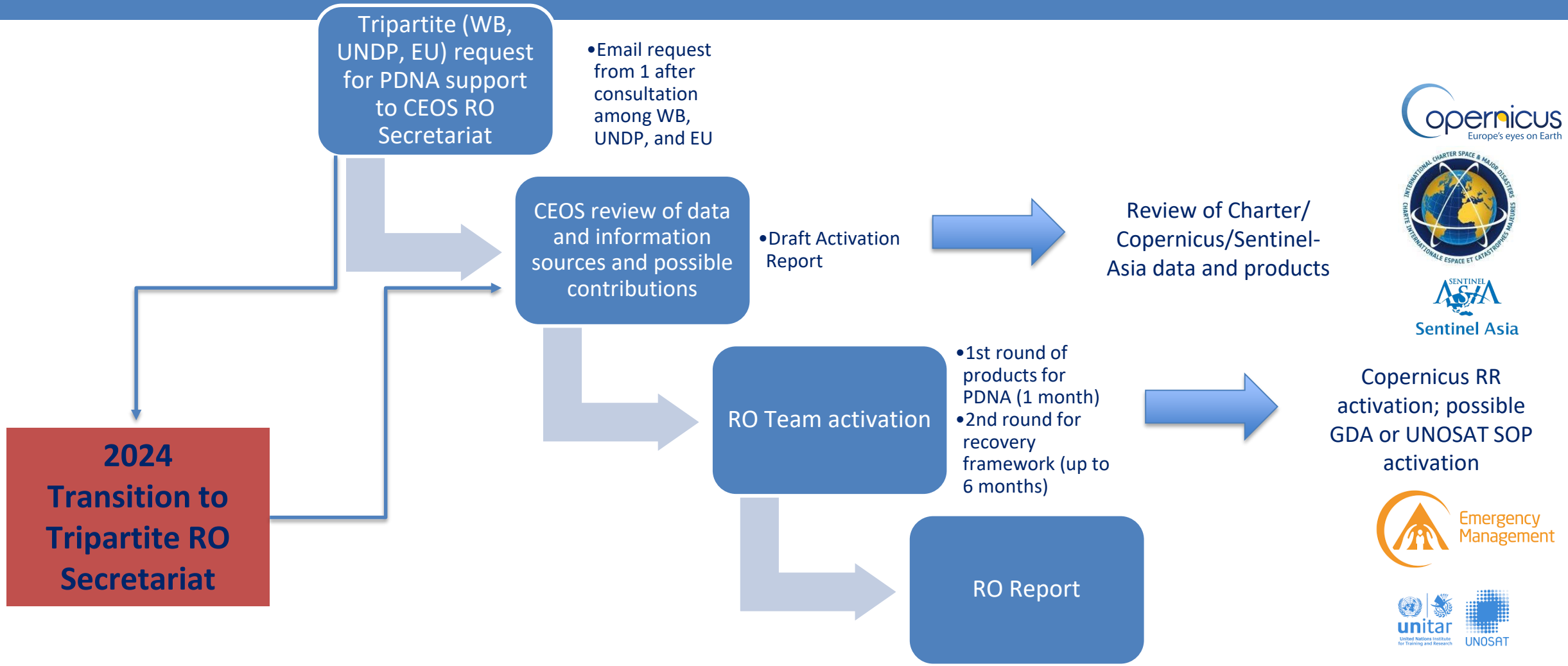
- Inform PDNA;
- Pre and post disaster baselines;
- Medium term monitoring;
- Capacity building assessment and plan.

Necessary “Core” RO

RO Secretariat and RO Liaison functions *(transition by 2025/2026 to recovery stakeholders)*

- ***Secretariat:***
  - *Identify **dedicated RO funds** that can be activated on demand – WB/GFDRR and GDA, EU PDNA support, UNDP SOP for UNOSAT, etc*
- ***Liaison:***
  - *Document and encourage **satellite and value adding contributions** from wide array of sources*
  - *Understand needs and **coordinate tasking** of CEOS satellites*
  - *Prepare **dedicated PDNA contribution** (rapid phase 1 for each activation)*
  - *Serve as **principal PoC for satellite community** with recovery stakeholders*
- ***Capacity building** – involve local and regional technical expertise and propose reinforced capacity after each activation, in conjunction with EU Copernicus, WB, and CEOS WGCapD*

Activation – RO Demo and pre-operational RO



Action Plan Proposal for 2024-2026 Establishment of pre-Operational RO

- ***Establish a capacity to provide 2 to 4 Recovery Observatories for the next three years beginning in 2024:***
  - ***Target one event per semester in 2024;***
  - ***Target one event per quarter in 2025 and 2026;***
  - ***Initially provide resources through demonstrator ad hoc best efforts mechanisms;***
  - ***Q1 2024 begin establishing mechanisms for private sector and intergovernmental organisation RO activation (operational Q1 2025)***
    - ***WB/GFDRR*** *mechanism to activate pre-qualified private sector support in conjunction with CB in country*
    - *Work with* ***UNDP and UNDP Crisis Bureau*** *to activate UNOSAT on regular basis for RO activations*
    - *Work with* ***EU*** *to task Copernicus EMS to rapidly respond to recovery intervention requests*
    - *Access existing* ***EU*** *framework contracts on PDNAs to ensure PDNAs benefit from satellite support in a coordinated fashion*

Transition to Pre-Operational RO

- ***Continue multilateral leadership of RO activity: CEOS (CNES)/WB-GFDRR/EU-FPI***
- ***Maintain for 2024 a dedicated CEOS team to support further implementation:***
  - ***Dedicated support to overall programme implementation for at least one more year (2024 – CNES leadership and consultancy)***
  - ***Progressive transfer of RO leadership to tripartite organisations (2025-2026)***
  - ***CEOS WGD data and in some cases VA contributions, at existing levels per activation***
  - ***Coordination with related CEOS pilots and demonstrators to ensure synergy (e.g. GSNL supersite for Kahmanmaras EQ, Pakistan landslides)***

CEOS Data Contributions

- ***Assume 2 to 4 activations per year for (2024-2026)***
- ***Imagery requirements:***
  - ***VHR optical: 2,000 sq km per activation***
  - ***X-band SAR: dedicated acquisitions to provide change detection products; hundreds of images (archived and new) per activation if interferometric analysis is useful***
  - ***L-band SAR: dedicated acquisitions to provide change detection products***
- ***Not significantly higher than existing RO Demo contribution, from same***

Next steps

- ***Complete cost-benefit analysis (September)***
- ***Work to increase RO awareness within partner organizations – missions to Washington (September) and Brussels (TBC Nov)***
- ***Joint WGCapD activity – DRM leadership events in November (GEO Ministerial in Cape Town in cooperation with African Networks of Excellence in EO; Asian event), promotional video under development***
- ***Seek approval of Pre-Operational RO Action Plan 2024-26: CEOS/Tripartite partners***
- ***Report to WGD20 (today!) and CEOS SIT-TW and Plenary (November 14-16)***