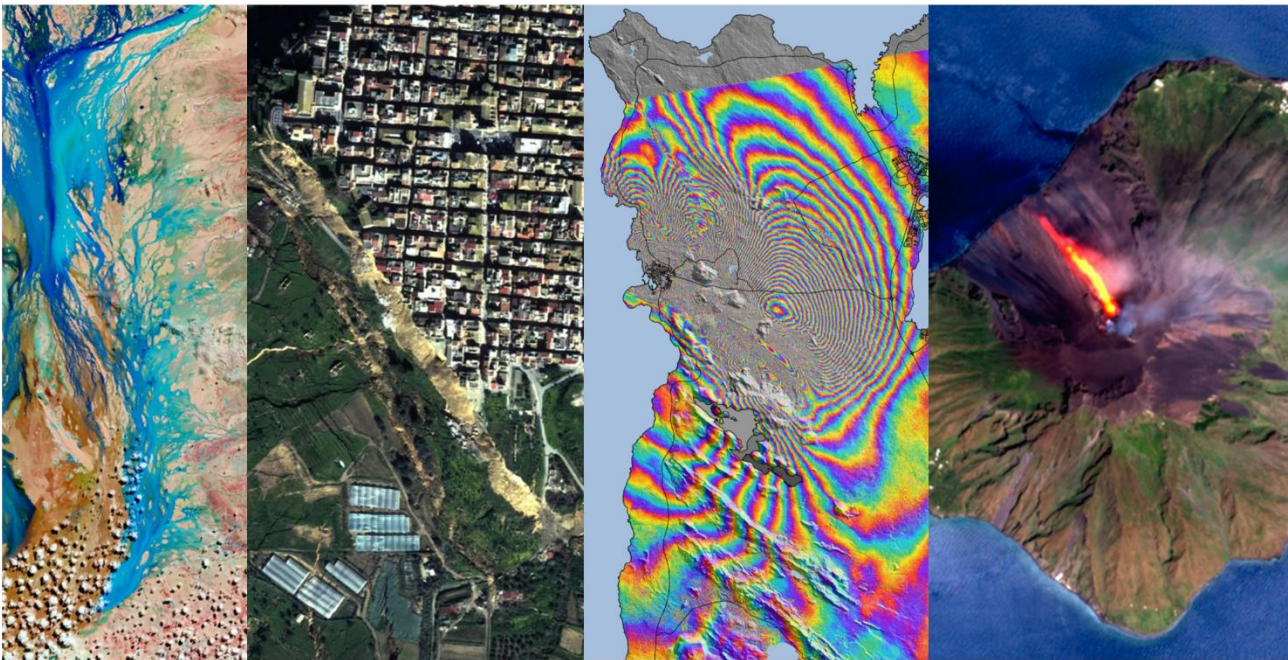




ASI – CEOS WGD International Workshop on “Earth Observation for Disaster Risk Management”



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**Organised by Agenzia Spaziale Italiana / Italian Space Agency (ASI) &
the Working Group on Disasters (WGD) of the Committee on Earth Observation
Satellites (CEOS)**

ASI Headquarters in Via del Politecnico snc, Rome, Italy

16 September 2026

Scientific and Organising Committee

Deodato Tapete

Antonio Montuori

Simona Zoffoli

Francesco Longo

Ufficio “Osservazione della Terra” / “Earth Observation” Office,
Settore “Coordinamento Utenti, Data Policy e Downstreaming” / “User
Coordination, Data Policy and Downstreaming” Sector

Lóránt Czárán

United Nations Office for Outer Space Affairs (UNOOSA)

Andrew Eddy

Athena Global

Working Group on Disasters (WGD)
of the Committee on Earth Observation Satellites (CEOS)

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SCIENTIFIC-TECHNICAL PROGRAMME

16 September 2026

Title	Speaker	CEST (UTC+2)	IST (UTC+5:30)	PST (UTC-7)
Participants registration		08:30 – 09:00	12:00 – 12:30	23:30 – 00:00
Welcome and Workshop objectives	Simona Zoffoli & Francesco Longo Italian Space Agency (ASI)	09:00 – 09:05	12:30 – 12:35	00:00 – 00:05
	Lóránt Czárán United Nations Office for Outer Space Affairs (UNOOSA)	09:05 – 09:10	12:35 – 12:40	00:05 – 00:10
Session #1 “CEOS WGD and DRM at space agencies” Chair: Antonio Montuori and Deodato Tapete ASI				
CEOS WGDISASTERS: The Italian Space Agency contribution to disaster response	Antonio Montuori ASI	09:10 – 09:20	12:40 – 12:50	00:10 – 00:20
EO for Resilience: NASA's SIT Chair Term & Disasters Program	Eleanor Pierel CEOS-SIT, NASA	09:20 – 09:30	12:50 – 13:00	00:20 – 00:30
Innovation, Coordination and Capacity Building in the International Charter ‘Space and Major Disasters’	Zachary Foltz ACRI-ST for ESA	09:30 – 09:40	13:00 – 13:10	00:30 – 00:40
Hyperspectral Earth Observation for Disaster Response: First Operational Experiences with EnMAP in the International Charter: Space and Major Disasters	Samuel Stettner German Aerospace Center (DLR)	09:40 – 09:50	13:10 – 13:20	00:40 – 00:50
Copernicus LAC EO Service Development - developing open EO services for DRM	Andrew Eddy Athena Global	09:50 – 10:00	13:20 – 13:30	00:50 – 01:00
The Role of EO Small Satellites in Strengthening Disaster Risk Management: Catalonia’s Strategy and Use Cases	Davoud Omarzadeh Institute of Space Studies of Catalonia (IEEC)	10:00 – 10:10	13:30 – 13:40	01:00 – 01:10
NADI-RISK: Natural Disaster Risk Assessment in Cyprus using Earth	Marios Tzouvaras	10:10 – 10:20	13:40 – 13:50	01:10 – 01:20

Observation and geospatial datasets	ERATOSTHENES Centre of Excellence & Cyprus University of Technology, Cyprus			
Regional Digital Public Infrastructure project on Human-Nature Security and Resilience in Africa	Remi Chandran Remote Sensing Technology Center of Japan (RESTEC)	10:20 – 10:30	13:50 – 14:00	01:20 – 01:30
Further Q&A & discussion		10:30 – 10:40	14:00 – 14:10	01:30 – 01:40

Coffee break	CEST (UTC+2)	IST (UTC+5:30)	PST (UTC-7)
	10:40 – 11:00	14:10 – 14:30	01:40 – 02:00

Session #2 “Wildfires & Forestry” Chairs: Antonio Montuori & Lóránt Czárán ASI and UNOOSA/CEOS WGD				
Title	Speaker	CEST (UTC+2)	IST (UTC+5:30)	PST (UTC-7)
Spatio-Temporal and Seasonal Characterization of Global Fire Regimes	Athira V. Mukundan Indian Institute of Remote Sensing (IIRS), ISRO	11:00 – 11:10	14:30 – 14:40	02:00 – 02:10
CEOS Wildfire Preparedness Pilot - Fuel Dryness	Marta Yebra The Australian National University	11:10 – 11:20	14:40 – 14:50	02:10 – 02:20
Presentation of the new CEOS LSI-VC Wildfire Group - Objectives and Activity Scope	Steffen Dransfeld European Space Agency (ESA)	11:20 – 11:30	14:50 – 15:00	02:20 – 02:30
How EO data are used by the National Fire Corps (CNVVF) of Italy to support urgent technical rescue during disaster response, fire prevention and surveillance	Gianmarco Valletta Italian National Fire Corps (CNVVF)	11:30 – 11:40	15:00 – 15:10	02:30 – 02:40
AI-Enabled Forest Structure Mapping from Multi-Channel SAR to Support Disaster Risk Management	Francesca Razzano University of Naples ‘Parthenope’	11:40 – 11:50	15:10 – 15:20	02:40 – 02:50

Session #3 “Landslides”

Chairs: Deodato Tapete and Andrew Eddy

ASI and Athena Global/CEOS WGD

Title	Speaker	CEST (UTC+2)	IST (UTC+5:30)	PST (UTC-7)
An Earth Observation based approach in characterization of selected landslides and debris flows in parts of the Indian Western Himalaya: From Causes to Early Warning	Shovan Lal Chatteraj Indian Space Research Organisation (ISRO)	11:50 – 12:00	15:20 – 15:30	02:50 – 03:00
Remote sensing solutions for heavy rainfall induced landslides detection and identification of slow landslides impacting on infrastructure	Daniele Giordan Institute of Geosciences (CNR-GEO), National Research Council (CNR) of Italy	12:00 – 12:10	15:30 – 15:40	03:00 – 03:10
The UGLC Global Landslide Catalogue: Building a Harmonized Data Foundation for AI-Driven Landslide Susceptibility and Hazard Modeling at Multiple Scales	Saverio Mancino University of Bari Aldo Moro	12:10 – 12:20	15:40 – 15:50	03:10 – 03:20
Assessing the contribution of MT-DInSAR SAOCOM-1 L-band observations to the Italian landslide monitoring scenario	Manuela Bonano Institute for Electromagnetic Sensing of the Environment (IREA), National Research Council of Italy (CNR)	12:20 – 12:30	15:50 – 16:00	03:20 – 03:30
Sentinel-1 imagery for quantitative landslide vulnerability assessment of buildings at regional scale	Francesco Poggi University of Florence	12:30 – 12:40	16:00 – 16:10	03:30 – 03:40

Board number	Poster session Hall in front of ASI's canteen	CEST (UTC+2)	IST (UTC+5:30)	PST (UTC-7)
		12:40 – 13:30	16:10 – 17:00	03:40 – 04:30
1	ComeOnboard Project: How to empower PRISMA Second Generation Mission with AI-driven Onboard Edge Computing for Real-Time disasters detection			

	Dario Spiller et al. Sapienza University of Rome, Italy
2	Cross-Sensor Portability of On-Board Wildfire Detection: Towards Cooperative Satellite Constellations Alvise Ferrari, Lorenzo Manunza et al. GMATICS srl, Italy
3	Machine Learning for Super Resolution Burned Area Mapping Isabelle Adorisio et al. Serco Italia S.p.A., Italy
4	SFIDE and the EOSIAL Viewer: Multi-Source Near-Real-Time Fire Detection from MTG-FCI and other Satellite Platforms for Disaster Risk Management Valerio Pampanoni & Giovanni Laneve Sapienza University of Rome, Italy
5	P-Band TomoSAR and Machine Learning for Forest Disaster Risk Assessment Francesco Buonavolontà et al. University of Sannio, Italy
6	Automated detection of active mass movements in SAR wrapped interferograms using CNN Fabio Bovenga et al. CNR-IREA, Italy
7	From Landslide Detection to Multi-Source LLM-Based Reporting: A Complete Earth Observation Framework for Rapid Assessment of Post Disaster Scenarios Mohammed Alrugimi et al. University of Trento and University of Florence, Italy
8	From rapid screening to landslide evolution monitoring. Multispectral satellite Earth Observation workflows for landslide emergency response and post-event analysis Davide Notti et al. CNR-GEO, Italy
9	Long-term investigation of the Mendatica landslide through the integration of MT-InSAR measurements, building damage surveys, and ancillary data Davide Cardone et al. CNR-GEO, Italy; Faculty of Geo-Information Science and Earth Observation (ITC), the Netherlands
10	Integrating Multi-Sensor Satellite Observations to Reconstruct the Complete Evolution of the Niscemi Landslide Nicola Casagli et al. University of Florence, Italy

11	Dynamic Assessment of Landslide Activity along Road Corridors Using Multi-Mission SAR Interferometry Cristiano Lanni & Deodato Tapete Anas SpA – Gruppo FS and ASI, Italy
12	Beyond Classical Change Detection: A COSMO-SkyMed and Machine Learning Framework for Multiscale Post-Disaster Landslide Mapping and Environmental Recovery Gabriele Punzo et al. University of Sannio, Italy
13	High altitude slope instabilities: detection, monitoring and challenges Chiara Crippa et al. Eurac Research, Institute of Earth Observation, Italy
14	Spatio-Temporal Hazard Monitoring for Disaster Risk Management of Transport Infrastructures through Multi-Source Remote Sensing and Intelligent Data Analytics Mattia Reale et al. University of Sannio, Italy
15	Rheticus® Safeland: New Frontiers in Hydro - Geomorphological Risk Management Anna Sblano et al. Planetek Italia, Italy
16	DeepHail: Hail Monitoring and Nowcasting Using AI applied to geostationary satellite observations in combination with auxiliary data Emanuela Vessichelli et al. University of Sannio, Italy
17	Large-scale delineation of flood prone areas and risk estimation: Results from the RESCUE_SAT project Elena Volpi et al. Roma Tre University, Italy
18	On-board flood segmentation under edge constraints: automated architecture search and quantization Alessandro Togni et al. AizoOn Technology Consulting, Italy
19	From Orbit to Action: AquaCubeAI for Onboard Coastal Water-Quality Alerts and Disaster Risk Management Francesca Razzano et al. University of Naples ‘Parthenope’, Italy
20	TALOS: An End-to-End AI Framework for Operational SAR Oil Spill Monitoring Vito Moliterni et al. Starion Group Italia S.p.A., Italy

21	Earth Observation for Disaster Risk Management: Monitoring Coastal Erosion on Ko Phi Phi Don, Thailand, Using Multi-Temporal Satellite Imagery Sara Aharon Alexandru Ioan Cuza University of Iași, Romania
22	A novel approach for estimating water level changes through SAR amplitude data Lorenza Ranaldi et al. Sapienza University of Rome
23	Harvesting Heat: Agricultural Cycles as Hidden Drivers of Heat Risk Davoud Omarzadeh et al. Institute of Space Studies of Catalonia (IEEC), Spain
24	From Multimodal Building Damage Assessment to Preliminary Recovery Monitoring after the 2025 Myanmar Earthquake Using CSG SAR, Pléiades Imagery and Building Footprints Luigi Russo et al. University of Pavia, Italy
25	Monitoring Urban Change and Post-Earthquake Recovery Using Deep Learning and Sentinel-2 Time Series: The Osmaniye Case Study Pietro Di Stasio et al. University of Sannio, Italy
26	Inflation Dynamics and Magma Recharge within the Svartsengi Volcanic System (SW Iceland) Inferred from GNSS and InSAR Data Chiara Lanzi et al. Icelandic Meteorological Office (IMO), Iceland
27	Tracking volcanic unrest episodes at Campi Flegrei and Fentale calderas using long (≥ 25 years) time series of thermal infrared data from ASTER and Landsat satellites Federico Galetto et al. INGV, Italy
28	A novel risk assessment workflow for differential land subsidence based on satellite InSAR and urban settlement data: present-day risk scenario in the metropolitan cities of Italy Francesca Cigna et al. CNR-ISAC, Italy
29	Multi-Hazard Risk Mapping for Power Grid Resilience Sara Ciaccia, Vincenzo Massimi et al. Planetek Italia, Italy
30	Leveraging Observation Networks for Space Weather Disaster Risk Management: The INGV Operational Experience Claudio Cesaroni et al.

	INGV, Italy
31	CALHYPSO: High resolution DSMs from single RGB images Riccardo Contu & Andrea Nascetti CALHYPSO
32	Digitalizing Community Disaster Risk Management Plans to Strengthen Early Warning and Community Resilience in Armenia Lilit Minasyan Climate Change and Disaster Risk Management Specialist, Armenia; University of Lisbon, Portugal
33	ORSS: Integrating Copernicus EGMS and Open Data for Preliminary Screening and Prioritization of School Sites Nicholas Rasetta Ministero dell'Istruzione (MUR), Osservatorio sul Rischio Strutturale Scolastico (ORSS), Italy
34	From Earth Observation to Actionable Geohazard Digital Twins: the GEO-DREAM and GET-it Initiatives Elisa Trasatti et al. INGV, Italy
35	Digital Twin Earth Hydrology Next: advanced EO integration for high-resolution operational water cycle monitoring and civil protection Jaime Gaona et al. CNR-GEO, Italy
36	A validation procedure to assess the precision and accuracy of satellite-derived land surface temperature Anastasiia Khimchenko et al. Sapienza University of Rome, Italy
37	Matera Space Center Lab Deborah Katia Pallotti et al. ASI, Italy

Lunch	CEST (UTC+2)	IST (UTC+5:30)	PST (UTC-7)
	13:30 – 14:30	17:00 – 18:00	04:30 – 05:30

Session #4 “Floods & Drought”

Chairs: Antonio Montuori and Marcelo Uriburu Quirno

ASI and CONAE/CEOS WGD

Title	Speaker	CEST (UTC+2)	IST (UTC+5:30)	PST (UTC-7)
Unsupervised Continuous Flood Mapping from Multi-temporal, Multi-view, and Multi-sensor SAR Sequences	Shafi Ullah Miakhil University of Pavia	14:30 – 14:40	18:00 – 18:10	05:30 – 05:40
Surface Water Monitoring for Hydrological Risk Forecasting: a Multisensor Earth Observation and Deep Learning Framework	Alessia Iannaccone University of Sannio	14:40 – 14:50	18:10 – 18:20	05:40 – 05:50
Reducing latency in flood monitoring: A Sentinel-2 Level 0 pipeline for on-board generation of water/land masks	Debhora Bonfiglio aizoOn Technology & Consulting, and University of Turin	14:50 – 15:00	18:20 – 18:30	05:50 – 06:00
The National Drought Monitoring Board (MNMS) of Argentina: an interinstitutional model for multi-index drought assessment and its integration with early warning systems	Luciana D'Acunto Instituto de Clima y Agua, CIRN, INTA, Argentina	15:00 – 15:10	18:30 – 18:40	06:00 – 06:10
A hierarchical robust combined index for agricultural drought detection and monitoring using EO big data	Filippo Bocchino Sapienza University of Rome	15:10 – 15:20	18:40 – 18:50	06:10 – 06:20
Modeling Alpine Glaciers Melting using GEDI and ICESat-2 Altimetry data	Sofia Pelosi Sapienza University of Rome	15:20 – 15:30	18:50 – 19:00	06:20 – 06:30

Coffee break	CEST (UTC+2)	IST (UTC+5:30)	PST (UTC-7)
	15:30 – 15:45	19:00 – 19:15	06:30 – 06:45

Session #5 “Earthquakes and building damage assessment”

Chairs: Deodato Tapete and Zachary Foltz

ASI and ESA/CEOS WGD

Title	Speaker	CEST (UTC+2)	IST (UTC+5:30)	PST (UTC-7)
The use of high-resolution satellite-derived elevation data in earthquake hazard identification and mitigation	Richard Walker University of Oxford	15:45 – 15:55	19:15 – 19:25	06:45 – 06:55
From Building Damage Assessment to Post-Disaster Recovery Monitoring: An Integrated Very High-Resolution SAR and Geospatial Workflow for the 2023 Türkiye–Syria Earthquake	Luigi Russo University of Pavia	15:55 – 16:05	19:25 – 19:35	06:55 – 07:05
Earthquake damage mapping by means of SAR and Super-resolution Optical images	Christian Bignami National Institute of Geophysics and Volcanology (INGV)	16:05 – 16:15	19:35 – 19:45	07:05 – 07:15
Extending VHR Optical/SAR Building Damage Assessment Benchmarks with Multi-Resolution TerraSAR-X Data: Impact of Sensor Variety on Model Robustness	Christian Hümmer German Remote Sensing Data Center (DFD), German Aerospace Center (DLR)	16:15 – 16:25	19:45 – 19:55	07:15 – 07:25

Session #6 “Processing and application platforms”

Chairs: Simona Zoffoli and Deodato Tapete

ASI

Title	Speaker	CEST (UTC+2)	IST (UTC+5:30)	PST (UTC-7)
From Earth Observation to Institutional Decisions: Rheticus® Services for Disaster Resilience in Developing Countries	Vincenzo Massimi Planetek Italia	16:25 – 16:35	19:55 – 20:05	07:25 – 07:35
Empowering Disaster Risk Management through Earth Observation: The Role of	Alessia Cattozzo	16:35 – 16:45	20:05 – 20:15	07:35 – 07:45

GDA Analytics and Processing Platform	Meteorological and Environmental Earth Observation (MEE0)			
Debris-Flow prediction using Digital Twins: the IRIDE Cyber Italy Framework	Stefano Scancella Serco Italia S.p.A. & Francesco Zaffanella Autorità di Bacino Distrettuale delle Alpi Orientali/Eastern Alps District Basin Authority	16:45 – 16:55	20:15 – 20:25	07:45 – 07:55
From Earth Observation Data to Operational Decisions: Platform-as-a-Service Solutions for Geohazard and Infrastructure Risk Management	Alessandro Brunetti NHAZCA	16:55 – 17:05	20:25 – 20:35	07:55 – 08:05
Climate Hazard Data to Decision Support: A Settlement-Level Interactive Climate Hazard Atlas for Armenia	Lilit Minasyan Climate Change and Disaster Risk Management Specialist, Armenia; University of Lisbon, Portugal	17:05 – 17:15	20:35 – 20:45	08:05 – 08:15

Conclusive discussion & closing remarks	CEST (UTC+2)	IST (UTC+5:30)	PST (UTC-7)
	17:15 – 17:25	20:35 – 20:45	08:05 – 08:15

ABSTRACT BOOK

Oral presentations

Session #1 “CEOS WGD and DRM at space agencies”

Session chaired by Antonio Montuori, Senior Technologist at the Italian Space Agency (ASI) and ASI Point of Contact and Vice-chair of the Committee on Earth Observation Satellites (CEOS) Working Group on Disasters (WGD), and Deodato Tapete, Senior Researcher at ASI and ASI Deputy & Program Scientist for CEOS WGD.

The session aims to provide an overview of the CEOS WGD activities, pilot projects and demonstrators, as well as showcase initiatives and programs undertaken by space agencies using Earth Observation (EO) assets and data in support to Disaster Risk Management (DRM).

CEOS WGDISASTERS: The Italian Space Agency contribution to disaster response

Antonio Montuori ⁽¹⁾, Deodato Tapete ⁽¹⁾, Lóránt Czárán ⁽²⁾, Andrew Eddy ⁽³⁾

⁽¹⁾ Italian Space Agency (ASI)

⁽²⁾ United Nations Office for Outer Space Affairs (UNOOSA)

⁽³⁾ Athena Global

The increasing frequency of natural hazards and extreme events suggests that climate change is a driver and adaptation to disasters is part of the wider effort towards a more climate-change resilient approach. Earth Observation (EO) data are now well-established scientific means to address Disaster Risk Management (DRM), from response to preparedness.

In this regard, the Working Group on Disasters (WGDisasters) has been established since 2013 by the Committee on Earth Observation Satellites (CEOS, <https://ceos.org>) to ensure the sustained coordination of disaster-related activities undertaken by the CEOS Agencies as well as to act as an interface between CEOS and the community of stakeholders and users involved in risk management and disaster reduction. For this

purpose, CEOS WGDisasters has initiated, promoted and supported a series of concrete initiatives for DRM and DRR activities, i.e. single-hazard Pilot and Demonstrator projects (currently focusing on fires, floods, landslide, volcanoes and seismic hazards) as well as multi-hazards projects as the Recovery Observatory (RO) and the Geohazard Supersites and Natural Laboratories (GSNL). All these projects, based on “best effort” contributions from CEOS Agencies and WG members, translate into several actions supporting DRM authorities, e.g. United Nations Office for Disaster Risk Reduction (UNDRR), United Nations Office for Outer Space Affairs, (UNOOSA), Group on Earth Observation (GEO), International Charter Space & Major Disasters and Copernicus Emergency Management Service (EMS), in order to foster the increased use of EO data in support of all phases of DRM and DRR.

In this regard, some showcases will be presented at the time of the conference to highlight the contribution to WGDisasters’ activities for DRM and DRR purposes.

EO for Resilience: NASA's SIT Chair Term & Disasters Program

Eleanor Pierel ^(1,2), Ayia Lindquist ⁽¹⁾, Shanna McClain ⁽²⁾, Lauren Childs-Gleason ⁽²⁾

⁽¹⁾CEOS SIT Chair

⁽²⁾ NASA Disasters

Building resilience to hazards through risk- and recovery-focused observations and applications is increasingly important. Supported by the CEOS SIT Chair Priority 2, Connected Data for Community Resilience, earth observation interoperability, impact, and value are advanced through WGDisasters, WGISS, and other CEOS entities to deliver timely, analysis-ready datasets that help communities anticipate, withstand, and recover from disasters. NASA’s NISAR mission, a joint NASA-ISRO synthetic aperture radar satellite, embodies this approach by providing measurements of Earth’s land and ice surfaces. These observations will dramatically enhance our ability to monitor ground deformation, flooding, landslides, and ecosystem change, providing actionable insights for decision-makers before, during, and after hazard events. Concurrently, the NASA Disasters Program leverages and creates analysis-ready data to translate satellite observations into open tools and applications to understand risk, speed recovery, and build long-term resilience. By connecting global EO assets with local needs, through partnerships, rapid-response mapping, and community-driven applications, the program supports more resilient infrastructure, earlier warning, and

informed recovery strategies. Together, CEOS Priority 2 and the NASA Disasters Program illustrate how coordinated EO investments are driving a new era of connected, impact-focused data for safer and stronger communities.

Innovation, Coordination and Capacity Building in the International Charter ‘Space and Major Disasters’

Philippe Bally ⁽¹⁾, Zachary Foltz ⁽²⁾, Vittorio Trivigno ⁽³⁾

⁽¹⁾ European Space Agency (ESA)

⁽²⁾ ACRI-ST

⁽³⁾ STARION

The International Charter Space and Major Disasters has long provided timely satellite data and value-added products to support emergency response worldwide. However, beyond its core activation mechanism, the Charter also serves as a platform for operational innovation, international coordination, and capacity building across the Earth Observation / Disaster Risk Management community. This presentation will highlight three complementary dimensions of recent Charter activities. First, it will present outcomes and lessons learned from the 2025 Charter AI Challenge on earthquake building damage assessment, including the operational relevance of the winning approaches, limitations identified during the challenge, and perspectives for a future 2027 edition. Second, the presentation will review the Charter’s response to the recent earthquake in Venezuela, where 32 technical scientists from 20 space agencies, humanitarian organizations and civil institutions worked together to produce almost 230 value-added and rapid mapping products. This case will be used to illustrate how coordinated EO-based workflows support situational awareness after major earthquakes, with additional examples from the 2023 Türkiye earthquake showing how the ESA Charter Mapper can support product and image access, visualization, and analysis. Finally, the presentation will address the importance of outreach, training, and the Value Adder community. Recent Charter training activities will be briefly summarized, followed by a practical overview of the Value Adder role, the types of products expected during activations, and the process for organizations to apply. The presentation will conclude by emphasizing the need to expand and strengthen the Value Adder network to improve the Charter’s operational capacity and ensure that EO-based disaster information reaches users quickly, reliably and effectively.

Hyperspectral Earth Observation for Disaster Response: First Operational Experiences with EnMAP in the International Charter: Space and Major Disasters

Samuel Stettner ⁽¹⁾, Maike Gerads ⁽¹⁾, Sandro Martinis ⁽²⁾, Julia Maria Wimmer ⁽²⁾

⁽¹⁾ German Space Agency at DLR, Earth Observation Division, Bonn, Germany

⁽²⁾ German Aerospace Center (DLR), Earth Observation Center (EOC), German Remote Sensing Data Center (DFD), Oberpfaffenhofen, Germany

The International Charter: Space and Major Disasters provides rapid access to Earth observation data from a growing range of satellite missions to support disaster response worldwide. As a long-standing contributor, DLR provides TerraSAR-X and TanDEM-X radar data and supports the Charter through operational and scientific activities. Building on this established contribution, DLR has recently expanded its operational data provision to include observations from the German hyperspectral EnMAP mission.

EnMAP provides imaging spectroscopy data across the visible, near-infrared and short-wave infrared spectral range at 30 m spatial resolution, opening complementary opportunities for disaster-related applications beyond established multispectral and radar observations. The contribution will present first experiences from the operational integration of EnMAP into Charter workflows and illustrate its potential using recent disaster-related acquisitions. Examples include wildfire and flood events from Charter activations as well as experimental acquisitions related to a recent oil tanker incident. Applications in the Charter include the characterization of burned areas and active fires, oil spills, floods, and volcanic events.

The presentation will discuss both the added value and operational constraints of hyperspectral observations in rapid disaster response, highlighting their complementary role within the multi-mission environment of the Charter.

Finally, an outlook will be provided on the planned further expansion of DLR's contribution through thermal Earth observation capabilities. In particular, the envisaged provision of OroraTech-derived thermal imagery and fire hotspot information. will complement existing radar and hyperspectral observations and further strengthen multi-sensor approaches for wildfire monitoring and disaster response.

Copernicus LAC EO Service Development - developing open EO services for DRM

Andrew Eddy ⁽¹⁾, Alberto Lorenzo ⁽²⁾

⁽¹⁾ Athena Global, Bonamour, 1 route du Canal, 58800, Sardy-les-Eprie, France

⁽²⁾ Indra Espacio S.L., Avenida de Bruselas, 35, 28108 Alcobendas (Madrid), Spain

The CopernicusLAC EO Services Development Project is one of the three strategic pillars of the broader CopernicusLAC (COPLAC) initiative led by the European Space Agency (ESA) on behalf of the European Commission under the Global Gateway and EU-LAC Digital Alliance. The initiative aims to strengthen Earth Observation (EO) capacity across Latin America and the Caribbean by combining regional data infrastructure, operational services and long-term knowledge transfer into a sustainable regional ecosystem.

Within this framework, the EO Services Development component is responsible for transforming Copernicus Sentinel data into operational information products tailored to regional priorities. The project develops a portfolio of twelve EO services addressing hydrometeorological and geological hazards, disaster risk reduction, exposure mapping and climate resilience. The services are designed to support national authorities, civil protection agencies and technical organisations through scalable, interoperable applications that can be deployed either centrally through the CopernicusLAC Hub or locally by participating institutions.

The service portfolio is organised around thematic application areas rather than individual technologies, integrating satellite observations with in situ information, modelling capabilities and cloud-based processing. Together, the services provide decision-support products for disaster preparedness, monitoring, emergency response, recovery planning and resilience-building, while promoting common standards and operational interoperability across the region.

The EO Services Development project complements the Panama Data Centre, which provides the regional processing infrastructure, and the Stakeholder Knowledge pillar, which delivers training, institutional capacity development and technology transfer. Collectively, these three pillars establish a sustainable regional Earth Observation capability, enabling countries in Latin America and the Caribbean to access Copernicus data, generate value-added information services, and strengthen evidence-based decision-making for environmental management, disaster risk reduction and climate adaptation.

The Role of EO Small Satellites in Strengthening Disaster Risk Management: Catalonia's Strategy and Use Cases

Dani Sors ⁽¹⁾, Estefania Blanch ⁽¹⁾, Jordi Corbera ⁽²⁾, Davoud Omarzadeh ⁽¹⁾, Albert Nicolás López ⁽¹⁾, Lluís Foreman Campins ⁽¹⁾

⁽¹⁾ Institut d'Estudis Espacials de Catalunya (IEEC), 08860 Castelldefels (Barcelona), Spain

⁽²⁾ Institut Cartogràfic i Geològic de Catalunya (ICGC), 08038 Barcelona, Spain

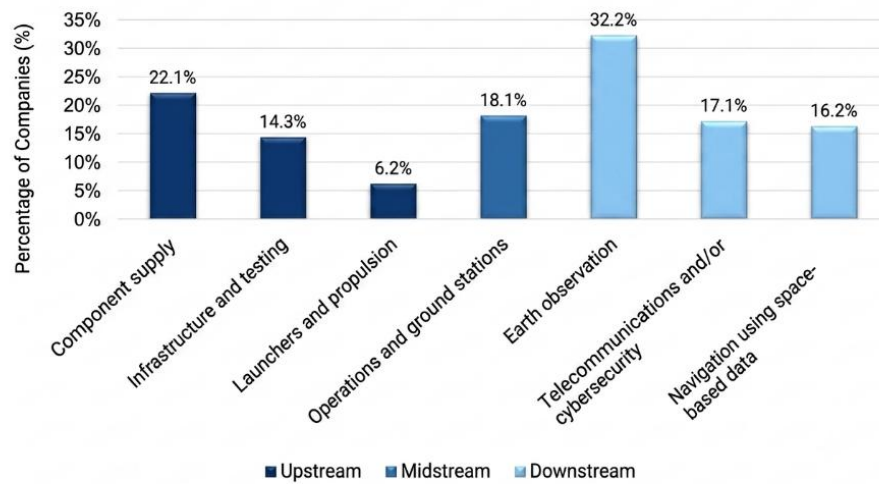
Over the past five years, the Government of Catalonia has made a firm and sustained commitment to developing a competitive and innovation-driven space sector. This effort has combined Catalonia's strong capabilities in digital technologies, scientific research and industrial engineering with coordinated collaboration across public institutions, universities, research centers and private companies.

As part of this strategy, several small satellite missions for communications and Earth Observation - such as the GENIOT and GENEEO series - alongside ground infrastructure, like teleport and data platforms, have been deployed [1]. These first missions were conceived and implemented as technology demonstrators, designed to test and validate operational capabilities, create and foster skills and competences and pave the way for future missions with enhanced performance and capacities.

This operational push is backed by a balanced and rapidly growing regional space ecosystem. As shown in Figure 1 [2], Catalonia's space sector features robust capabilities across the entire value chain, driven by a highly prominent downstream market, particularly in Earth Observation, alongside well-established upstream component supply and midstream ground operations.

The demonstrators have already delivered valuable services for disaster risk management, including burned area by wildfire (Figure 2a) and its damage assessment [3], drought prediction [4], flood impact evaluation, coastal dynamics (Figure 2b), state of crops [5], remote monitoring of water reservoirs for firefighting operations, among others. Furthermore, space technologies have been applied to improve prevention of forest fires through knowledge of the forestland status using Earth Observation imagery.

Value chain of the space sector in Catalonia (end of 2023 survey)



Source: IEEC-OSPI based on Catalonia Space Survey 2023

Figure 1. Value chain of the space sector in Catalonia (end of 2023 survey)

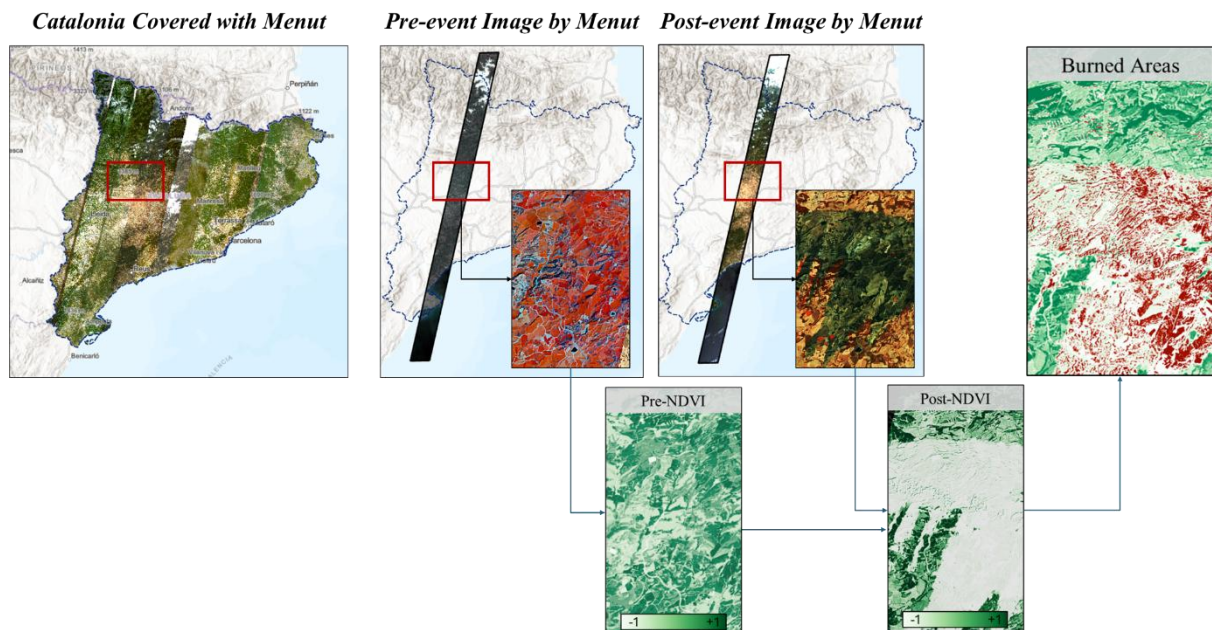


Figure 2a. Burned area detection after wildfire happened in Segarra region in Catalonia

This integrated approach showcases how regional space strategies can strengthen resilience and sustainability in critical sectors such as civil protection or territorial and emergency management, while also fostering technological innovation and supporting

the growth of competitive local public and private space actors both in the upstream and downstream markets.

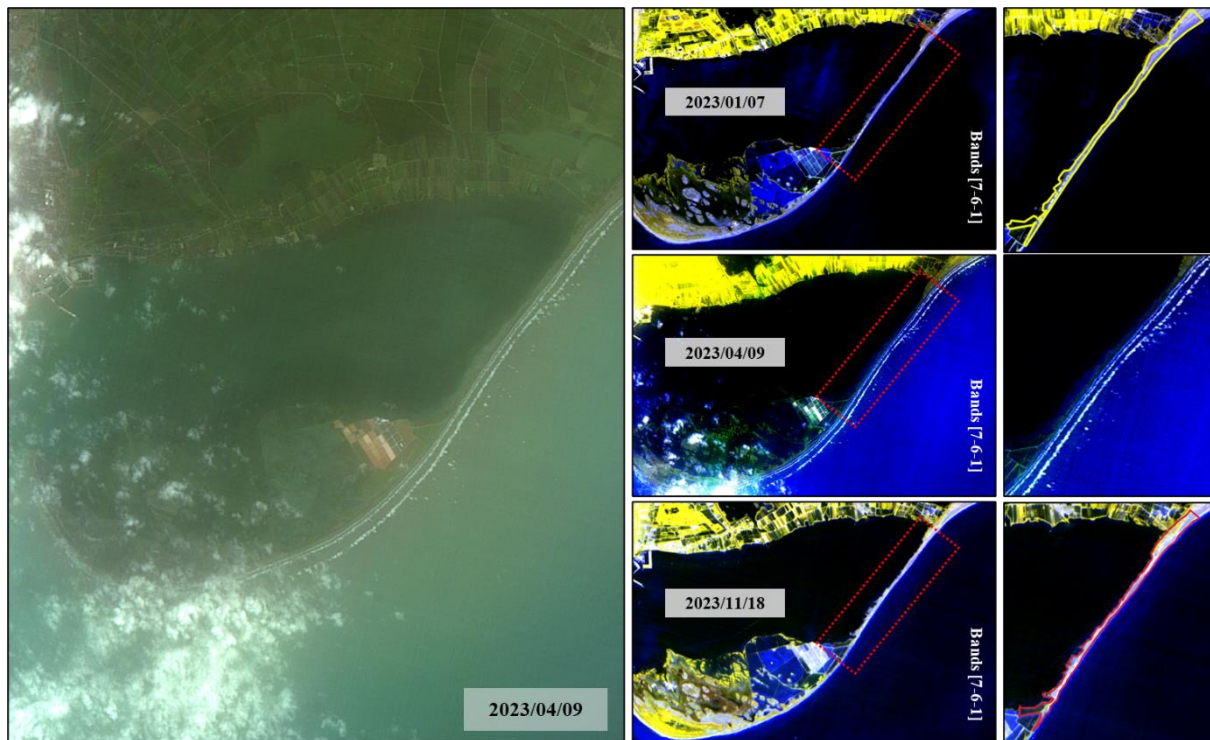


Figure 2b. Flooding impact in the Delta de l'Ebre (southern Catalonia) following the September 2023 storm. Menut imagery shows the complete submergence of the land corridor on 4 September and its recovery in subsequent days.

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NADI-RISK: Natural Disaster Risk Assessment in Cyprus using Earth Observation and geospatial datasets

Marios Tzouvaras ^(1,2), Nicholas Kyriakides ^(1,2), Kyriaki Fotiou ^(1,2), Marina Doukanari ⁽¹⁾, Maria Prodromou ^(1,2), Constantinos Panagiotou ⁽¹⁾

⁽¹⁾ ERATOSTHENES Centre of Excellence, Limassol, Cyprus

⁽²⁾ Department of Civil Engineering and Geomatics, Cyprus University of Technology, Limassol, Cyprus

Cyprus, situated in the Eastern Mediterranean, is prone to various natural hazards, including wildfires, floods, earthquakes, and landslides. An effective multi-hazard risk assessment is crucial for developing strategies that boost resilience against these threats. NADI-RISK utilizes Earth Observation (EO) and geospatial datasets to evaluate and mitigate risks, emphasizing the importance of remote sensing in vulnerability analysis. The methodology integrates satellite imagery from Copernicus Sentinel-1 and Sentinel-2 with additional data from local agencies, including the Department of Lands and Surveys, the Geological Survey Department, the Department of Forests, and the Water Development Department. Environmental variables derived from EO data—such as land use, vegetation indices, and topography—were analyzed to pinpoint areas vulnerable to hazards. Combining these datasets offers a comprehensive and precise understanding of the risks faced. The results demonstrate high accuracy when validated against ground truth data, confirming the effectiveness of EO techniques in multi-hazard risk assessments. This research underscores the critical role of geospatial technologies in disaster risk management and policymaking. By delivering high-resolution, near-real-time data, EO-based approaches empower decision-makers, stakeholders, and organizations to implement targeted and effective mitigation measures, ultimately enhancing the safety and resilience of communities in Cyprus and similar regions.

Regional Digital Public Infrastructure project on Human–Nature Security and Resilience in Africa

Remi Chandran ⁽¹⁾, Shadrack Ngene ⁽²⁾, Edward Phiri ⁽³⁾, Lóránt Czárán ⁽⁴⁾, Jumpei Takami ⁽⁴⁾, Werner Balogh ⁽⁵⁾, Kais Zoubi ⁽⁶⁾, Diego Gonzalez Ferreiro ⁽⁶⁾, Lara Prades ⁽⁶⁾

⁽¹⁾ Remote Sensing Technology Center of Japan (RESTEC), Japan

⁽²⁾ Ministry of Tourism and Wildlife of Kenya

⁽³⁾ Lusaka Agreement Task Force (LATF), Kenya

⁽⁴⁾ The United Nations Office for Outer Space Affairs (UNOOSA)

⁽⁵⁾ European Space Agency (ESA)

⁽⁶⁾ United Nations Global Service Center (UNGSC)

Africa faces increasingly interconnected disaster risks and human–nature challenges, including wildfires, floods and droughts, human–wildlife conflict, wildlife trafficking, zoonotic diseases, agropastoral conflict, land-use change and the impacts of climate change. These risks can cascade across ecosystems, communities and national borders, while the spatial and non-spatial information required for effective disaster risk reduction and response often remains fragmented across institutions and countries.

This presentation provides an overview of a proposed Regional Digital Public Infrastructure (DPI) for Human–Nature Security and Resilience in Africa, being advanced by the Lusaka Agreement Task Force, the Government of Kenya, UNOOSA, UNGSC and RESTEC. The initiative seeks to establish trusted and interoperable digital infrastructure that integrates Earth observation, geospatial information, ground observations and non-spatial data to support disaster-risk assessment, early warning, monitoring, coordinated response and longer-term resilience.

The proposed regional DPI will be developed through a Nairobi–Valencia–Vienna collaboration model. Nairobi will serve as the regional operational and Command and Control Centre, supporting participating African countries and institutions. Vienna will provide an important United Nations and international interface, including support for space-based information, governance and trusted digital infrastructure through UNOOSA and UNGSC. Valencia will contribute to scientific, technological and analytical capabilities, including geospatial intelligence, data integration and AI-enabled decision support.

Initially involving six East African countries associated with the Lusaka Agreement Task Force, the initiative aims to establish a scalable regional model for addressing disaster risks and interconnected human–nature challenges. The presentation will highlight the importance of interoperability, trusted data exchange, institutional coordination, capacity development, sustainable financing and long-term ownership.

The initiative proposes that Earth observation and Digital Public Infrastructure can provide a common regional foundation for disaster risk reduction and human–nature resilience, enabling timely information sharing across institutional and national boundaries and supporting more coordinated, evidence-based decision-making in Africa.

Session #2 “Wildfires & Forestry”

Session chaired by Antonio Montuori, Senior Technologist at the Italian Space Agency (ASI) and ASI Point of Contact and Vice-chair of the Committee on Earth Observation Satellites (CEOS) Working Group on Disasters (WGD), and Lóránt Czárán, Chief of the Space Applications Section at the United Nations Office for Outer Space Affairs (UNOOSA) and CEOS WGD Chair.

Spatio-Temporal and Seasonal Characterization of Global Fire Regimes

Athira V. Mukundan ⁽¹⁾, Harish Chandra Karnatak ⁽¹⁾, Arijit Roy ⁽¹⁾

⁽¹⁾ Indian Institute of Remote Sensing (IIRS), ISRO, India

Wildfire activity is undergoing substantial changes across the globe, yet many assessments continue to describe fire dynamics using individual fire characteristics or annual summaries, limiting the representation of their seasonal and spatial variability. This study presents a global assessment of fire regimes from 2001 to 2024 using fire frequency, fire intensity represented by Fire Radiative Power (FRP), and burned area extent derived from MODIS Active Fire, MODIS Burned Area, and ESA CCI Land Cover datasets. Fire characteristics were aggregated to a 0.25° spatial grid and analysed across four six-year periods (2001-2006, 2007-2012, 2013-2018, and 2019-2024) and four climatological seasons (DJF, MAM, JJA, and SON). Fire regimes were classified using K-means clustering based on the combined behaviour of frequency, intensity, and burned extent. The results reveal pronounced spatial and seasonal variability in global fire activity, with persistent concentrations of frequent, intense, and extensive fires across the savannah regions of central and southern Africa, northern Australia, and parts of South America, corresponding closely with regional dry seasons. Fire frequency increased in several fire-prone regions, particularly in Africa and Australia, whereas burned area generally declined after 2007-2012 despite persistent or increasing fire occurrence, indicating a decoupling between fire occurrence and landscape burned extent. Fire intensity remained highest within savannah ecosystems, with increasing FRP observed in northern Australia and parts of South America, consistent with enhanced fuel drying during recent decades. Eight distinct fire regime classes captured contrasting combinations of fire frequency, intensity, and burned extent, highlighting substantial spatial heterogeneity in fire behaviour across continents

and seasons. The study provides a seasonally explicit global characterization of fire regimes over the past two decades, enabling consistent comparison of fire regime dynamics across ecosystems and identifying regions undergoing contrasting trajectories in fire occurrence, intensity, and burned extent.

CEOS Wildfire Preparedness Pilot - Fuel Dryness

Marta Yebra ⁽¹⁾, Arijit Roy ⁽²⁾

⁽¹⁾ The Australian National University, Canberra, Australia

⁽²⁾ Indian Institute of Remote Sensing (IIRS), Indian Space Research Organisation (ISRO), India

This contribution will present the recently approved CEOS Wildfire Preparedness Pilot, a new international initiative focused on advancing the use of Earth observation (EO) for pre-fire fuel dryness monitoring and wildfire preparedness. Building on the first CEOS Wildfire Pilot, which primarily addressed active fire monitoring, the new pilot seeks to strengthen coordination around the pre-fire phase and accelerate the transition of EO-based fuel dryness information from research to operational use.

The presentation will introduce the pilot's objectives, proposed activities and emerging international collaboration. Key activities include reviewing existing EO-based fuel dryness methods and products; expanding and standardising field fuel moisture datasets and validation protocols; benchmarking existing products across global and regional conditions; assessing the capabilities of current and future satellite missions; and examining how fuel dryness information can be better integrated into operational fire danger assessment and management decisions.

The contribution will also present early progress in establishing the pilot, including the development of an international network of researchers, space agencies and operational fire management organisations, and the identification of regional demonstration opportunities. Key scientific and operational challenges will be discussed, including limited validation data in many regions, inconsistencies in benchmarking approaches, differences in product performance across ecosystems and scales, and barriers to operational implementation.

The pilot aims to provide a coordinated international framework for evaluating and advancing EO-based fuel dryness monitoring and to support the development of more

consistent, validated and operationally relevant information for wildfire preparedness worldwide.

Presentation of the new CEOS LSI-VC Wildfire Group - Objectives and Activity Scope

Steffen Dransfeld ⁽¹⁾, Mark De Jong ⁽²⁾, Catriona Armstrong ⁽²⁾, Cecilia Masemola ⁽³⁾, Denis Dufour ⁽⁴⁾, Joshua Johnston ⁽²⁾, Yann Denis ⁽⁴⁾

⁽¹⁾ European Space Agency (ESA), Frascati, Italy

⁽²⁾ Natural Resources Canada (NRC), Sault Ste. Marie, Canada

⁽³⁾ South African National Space Agency (SANSA), Pretoria, South Africa

⁽⁴⁾ Canadian Space Agency (CSA), Montreal, CanadaThe Australian National University, Canberra, Australia

Wildfires are increasing in frequency, intensity, and geographic extent, increasing risk to human life, ecosystems, and critical infrastructure around the world. Over the last twenty years, the proliferation of publicly available wildfire EO data products has become increasingly important for wildfire management. Coordinated Earth Observation (EO) data are critical to support wildfire preparedness, detection, monitoring, response, and recovery.

In 2021, the Committee on Earth Observation Satellites (CEOS) Working Group for Disasters (WG-D) initiated a Wildfire Pilot study to assess the future stability of existing public satellites critical for active fire monitoring, and the global end-user uptake of their data. Based on its findings, the Wildfire Pilot identified the need for increased international coordination and governance of global active fire monitoring satellites, and recommended establishing a new international wildfire EO monitoring coordination group. Despite the availability of multiple EO-based wildfire products, coordination across agencies remains fragmented. A dedicated coordination group will help improve interoperability, reduce duplication, and provide a sustained coordination mechanism for operational wildfire monitoring. This concept was further advanced at a seaside meeting during the 39th CEOS Plenary (November 2025, Bath, UK). In January 2026 the CEOS SIT Chair team, LSI-VC Co-Leads and WG-D Chairs agreed on the merits of creating a wildfire subgroup under the Land Surface Imaging Virtual

Constellation (LSI-VC). This group was consequently formalised during the last few months.

The Wildfire Subgroup will:

- Provide a forum for agencies and other stakeholders to exchange information on the use of EO data for wildfire monitoring;
- Support coordination between organisations providing EO data and those developing wildfire information products; and
- Support wildfire management by promoting the reliability and long-term sustainability of the virtual constellation of satellite missions used for fire monitoring.

This talk will provide an overview of the groups Terms of Reference, their activities and the key stakeholders the group is addressing.

How EO data are used by the National Fire Corps (CNVVF) of Italy to support urgent technical rescue during disaster response, fire prevention and surveillance

Francesco Biasci ⁽¹⁾, Rossella Simione ⁽¹⁾, Gianmarco Valletta ⁽¹⁾, Stefano Frittelli ⁽¹⁾

⁽¹⁾ Italian National Fire Corps (CNVVF)

The Italian National Fire Corps (CNVVF) increasingly integrates Earth Observation (EO) data into its urgent technical rescue, fire prevention, and surveillance activities. CNVVF has developed specialist expertise in processing multispectral, SAR, and hyperspectral satellite imagery — including data from ASI's PRISMA mission — to generate thematic products for wildfire susceptibility mapping, burned area assessment, and damage evaluation. These products are integrated into the cloud-based cartographic portal developed by the CNVVF Cartographic Office, supporting the analysis of operational scenarios and resource management.

Operational experience has highlighted the limitations of current polar-orbiting satellite systems, whose revisit frequency and data latency are not always compatible with the rapid evolution of active wildfires. Next-generation geostationary missions equipped with high-resolution thermal sensors — such as Meteosat Third Generation — could provide continuous monitoring, early fire detection, and near real-time support. In line with this interest, CNVVF has expressed interest in some of the project proposals submitted under the ESA "Wildfire Safety" call, aimed at developing pre-operational services combining satellite Earth Observation with complementary technologies for early fire detection and near real-time wildfire monitoring.

AI-Enabled Forest Structure Mapping from Multi-Channel SAR to Support Disaster Risk Management

Francesca Razzano ^(1,2), Wenyu Yang ⁽¹⁾, Sergio Vitale ⁽¹⁾, Giampaolo Ferraioli ⁽¹⁾, Silvia Liberata Ullo ⁽²⁾, Gilda Schirinzi ⁽¹⁾

⁽¹⁾ University of Naples ‘Parthenope’, Engineering Department, 80133, Naples, Italy

⁽²⁾ University of Sannio, Engineering Department, 82100, Benevento, Italy

Forests play a critical role in disaster risk reduction, while their three-dimensional structure strongly influences wildfire behaviour, windthrow susceptibility, biomass loss, surface runoff, and slope instability. Timely and spatially continuous information on canopy height and underlying terrain is therefore valuable for prevention, preparedness, and post-event assessment. Disaster-risk management in forested regions requires more than two-dimensional land-cover maps: it needs timely information on canopy structure and terrain, which conditions wildfire propagation and post-fire slope instability. Yet field surveys and airborne LiDAR cannot routinely provide wall-to-wall updates, while conventional tomographic SAR processing can be computationally demanding.

This contribution presents FGump, a lightweight machine-learning framework that transforms multi-polarimetric, multi-baseline SAR observations into continuous Canopy Height Models (CHMs) and Digital Terrain Models (DTMs). The method extracts a compact set of polarimetric and interferometric features from the SAR covariance matrix and uses CatBoost regression trained with LiDAR-derived references. Unlike classification-based solutions, FGump preserves continuous height information, avoids quantisation artefacts, and operates without explicit phase calibration, simplifying the processing chain.

The framework was evaluated over two contrasting tropical environments: Paracou, French Guiana, and Lopé, Gabon. At Paracou, the selected non-calibrated configuration achieved RMSE values of 1.83 m for canopy height and 1.96 m for terrain height. At Lopé, FGump obtained a canopy-height RMSE of 3.21 m, compared with 4.03 m for the deep-learning baseline. At model level, training and inference required 46 s and 0.04 s, respectively, compared with 5428 s and 1.68 s for the neural-network solution under the same hardware conditions.

These results position FGump as a candidate engine for producing risk-ready 3D forest layers. Integrated with fuel, exposure, and hazard information, such products could

support pre-event wildfire susceptibility assessment, prioritisation of monitoring areas, and post-event mapping of structural losses after fires or storms, while terrain estimates can contribute to identifying cascading hydrogeomorphic risks.

Session #3 “Landslides”

Session chaired by Deodato Tapete, Senior Researcher at ASI and ASI Deputy & Program Scientist for the Committee on Earth Observation Satellites (CEOS) Working Group on Disasters (WGD), and Andrew Eddy, President of Athena Global and Secretary of the CEOS WGD.

An Earth Observation based approach in characterization of selected landslides and debris flows in parts of the Indian Western Himalaya: From Causes to Early Warning

Shovan Lal Chatteraj ⁽¹⁾, Sourav Dutta ⁽²⁾, S Shyam Sundar ⁽³⁾, Anchal Rawat ⁽⁴⁾, Arijit Roy⁽¹⁾

⁽¹⁾ Indian Institute of Remote Sensing (ISRO), Geosciences and Disaster Management Group, Dehradun, India

⁽²⁾ Indian School of Mines, Department of Mining Engineering, Dhanbad, India

⁽³⁾ Indian Institute of Technology, Department of Geology and Geophysics, Kharagpur, India

⁽⁴⁾ HNB Garhwal University, Geography Department, Srinagar, India

Landslides pose a significant hazard in the Indian Western Himalayan region, particularly in Uttarakhand and Himachal Pradesh, where steep terrain, fragile geology, intense rainfall, and unplanned development converge. This study adopts a comprehensive approach to assess and model landslide dynamics in selected high-risk zones including the Mandakini, Alaknanda, and Bhagirathi valleys, Nainital and adjoining area as well as the Shimla–Kinnaur corridor. Using high-resolution Earth Observation data (ALOS-PALSAR, Cartosat, Sentinel-2), field-based geotechnical surveys, and historical records, the project integrates mapping, monitoring, simulation, and threshold modeling techniques.

Landslide susceptibility maps were generated using the Analytical Hierarchy Process (AHP) based on thematic layers such as slope, lithology, land use, proximity to faults, drainage density etc. Machine learning-based methods were also used to enhance the accuracy of landslide inventory mapping. To model debris flow dynamics, the RAMMS software was employed, enabling 3D simulation of flow velocity, runout distance, and impact zones using digital elevation models and rheological inputs.

Rainfall thresholds for landslide initiation were statistically derived using daily and antecedent rainfall data from CHIRPS and field-installed AWS stations. These threshold models aim to support early warning systems by correlating precipitation intensity with landslide occurrence. Field-based soil and rock strength data were used to validate slope stability and simulation results.

The study's multi-pronged methodology addresses a critical gap in process-based landslide modeling in the Indian Himalaya. The findings contribute to national disaster preparedness under ISRO's disaster management related programme and align with global frameworks such as the Sendai Framework and SDG-15. Ultimately, this work enhances scientific understanding and supports the development of practical, site-specific mitigation and planning strategies in vulnerable mountain regions.

Remote sensing solutions for heavy rainfall induced landslides detection and identification of slow landslides impacting on infrastructure

Daniele Giordan ⁽¹⁾, Martina Cignetti ⁽¹⁾, Davide Notti ⁽¹⁾, Davide Cardone ⁽¹⁾, Diego Reale ⁽²⁾, Gianfranco Fornaro ⁽²⁾, Eugenio Sansosti ⁽²⁾, Paolo Gamba ⁽³⁾, Dario Peduto ⁽⁴⁾, Settimio Ferlisi ⁽⁴⁾, Gianfranco Nicodemo ⁽⁴⁾, Davide Luongo ⁽⁴⁾, Giovanni Pisciotta ⁽⁵⁾, Giovanna De Chiara ⁽⁵⁾, Laura Candela ⁽⁶⁾, Alessandro Ursi ⁽⁶⁾, Manilo Monaco ⁽⁶⁾, Maria Elena Cianfanelli ⁽⁶⁾, Nicola Comparetti ⁽⁶⁾

⁽¹⁾ Institute of Geosciences (CNR-GEO), National Research Council (CNR) of Italy, Torino, Italy

⁽²⁾ Institute for Electromagnetic Sensing and Environment (IREA), CNR, Naples, Italy

⁽³⁾ Telecommunications and Remote Sensing Laboratory, University of Pavia, Italy

⁽⁴⁾ Interuniversity Center for the Forecasting and Prevention of Major Risks, Fisciano, Italy

⁽⁵⁾ Southern Apennines District Basin Authority, Caserta, Italy

⁽⁶⁾ Italian Space Agency (ASI), Rome, Italy

Slow-moving landslides are widespread in the Italian territory, in diverse geological and geomorphological contexts. These landslides often interact with anthropic structures and infrastructures, in particular with communication routes and other linear infrastructures. In this context, regional and national administrations have a concrete need to identify, often over vast territories, the potentially active and most critical

phenomena to appropriately plan more in-depth investigations, studies or monitoring. The availability of large archives of DInSAR ground deformation measurements, generated from large-scale free satellite (e.g., PST project or EGMS Copernicus), has the potential to enable the monitoring of a considerable number of phenomena over large areas. However, the growing amount of data availability requires dedicated methodologies and tools aimed at multi-sensor integration and with others informative and territorial archives, in order to ensure correct and effective interpretation. The MEASURES project aims to implement an advanced technical–operational service for analysing the interaction between slow-moving landslide phenomena and infrastructure networks. Through the synergistic integration of Earth Observation (EO) data, including displacement measurements derived from multi-temporal SAR interferometry (DInSAR) and multispectral optical sensors, with thematic geodatabases and landslide inventories, the project seeks to overcome the current fragmentation of data by providing a high-TRL (Technology Readiness Level) Decision Support System (DSS). The system, structured on two functional levels, was developed and tested in the District Basin Authority of the Southern Apennines. A baseline configuration for large-scale qualitative analysis and an advanced configuration for quantitative, site-specific characterisation of expected damage to critical infrastructure are foreseen. The project aims to develop a demonstrative technical–operational service capable of identifying infrastructure segments interacting with slow-moving landslide phenomena, namely those most likely to interfere with linear infrastructures and transportation networks, useful for identifying intervention priorities in the framework of risk mitigation and management.

MEASURES - iMpatto dElle frAne SU REti infraStrutturali” project, funded by the Italian Space Agency (ASI), Agreement n. 2025-11-HB.O - CUP F93C25000430001, under the ASI’s program “Innovation for Downstream Preparation for Public Administrations” (I4DP_PA).

The UGLC Global Landslide Catalogue: Building a Harmonized Data Foundation for AI-Driven Landslide Susceptibility and Hazard Modeling at Multiple Scales

Saverio Mancino ⁽¹⁾, Anna Sblano ⁽²⁾, Marina Zingaro ⁽²⁾, Michele Antonicelli ⁽²⁾, Francesco Paolo Lovergine ⁽³⁾, Tushar Sethi ⁽⁴⁾, Vincenzo Massimi ⁽²⁾, Domenico Capolongo ⁽¹⁾, Giuseppe Amatulli ^(4,5)

⁽¹⁾ Department of Earth and Geoenvironmental Sciences, University of Bari Aldo Moro, Bari, Italy

⁽²⁾ Planetek Italia, 70132 Bari, Italy

⁽³⁾ Institute for Electromagnetic Sensing of the Environment (IREA), National Research Council of Italy (CNR), Bari, Italy

⁽⁴⁾ Margosa Environmental Solutions Ltd., Chesham, United Kingdom

⁽⁵⁾ School of the Environment, Yale University, New Haven, CT, United States of America

The performance of Artificial Intelligence and Machine Learning models for landslide susceptibility and hazard assessment is fundamentally constrained by the quality, consistency, and completeness of the landslide inventories used for training.

Despite growing interest in AI-driven approaches to disaster risk management, progress in landslide modeling at large to global scale remains hindered less by algorithmic limitations than by the fragmented and heterogeneous nature of available data.

Existing catalogues differ widely in mapping criteria, spatial accuracy, temporal coverage, data consistency and geographic representativeness, undermining model robustness and transferability across regions.

We present the Unified Global Landslide Catalogue (UGLC, Mancino et al., 2025), developed to address this data bottleneck through the systematic harmonization of heterogeneous landslide inventories worldwide.

UGLC integrates approximately 1.1 million point-based and 0.9 million polygon-based landslide occurrences, standardized to resolve inconsistencies in spatial resolution, mapping conventions, and positional uncertainty, resulting in a coherent, analysis-ready dataset suitable for AI/ML applications at multiple scales.

Beyond describing the data retrieving and harmonization methodology, we discuss the broader implications of inventory quality for AI-based modeling, highlighting how data gaps and regional imbalances (particularly evident in under-mapped areas such as Africa, South America, and parts of the Russian territory) directly translate into reduced model reliability and limited operational applicability where risk information is often most needed.

These findings underscore data harmonization not as a preliminary technical step, but as a determining factor for the robustness, reliability and scalability of EO driven AI/ML solutions in disaster risk management.

We conclude by identifying key data-related gaps and user needs that the Earth Observation and disaster risk management community could address through coordinated, collaborative catalogue development, and by outlining how initiatives

such as UGLC can support more consistent, transferable, and operationally relevant landslide risk assessment.

Assessing the contribution of MT-DInSAR SAOCOM-1 L-band observations to the Italian landslide monitoring scenario

Manuela Bonano ⁽¹⁾, Francesco Casu ⁽¹⁾, Claudio De Luca ⁽¹⁾, Michele Manunta ⁽¹⁾, Yenni Lorena Belen Roa ⁽¹⁾, Pasquale Striano ⁽¹⁾, Giovanni Onorato ⁽¹⁾, Muhammad Yasir ⁽¹⁾, Ivana Zinno ⁽¹⁾, Francesco Poggi ⁽²⁾, Matteo Del Soldato ⁽²⁾, Federico Raspini ⁽²⁾, Nicola Casagli ⁽²⁾, Riccardo Lanari ⁽¹⁾

⁽¹⁾ Institute for Electromagnetic Sensing of the Environment (IREA), National Research Council of Italy (CNR), Naples-Milan, Italy

⁽²⁾ University of Florence, Department of Earth Sciences, Florence, Italy

Multi-Temporal Differential SAR Interferometry (MT-DInSAR) is a well-established Earth Observation technique for monitoring ground deformation associated with natural and anthropogenic hazards, providing spatially dense displacement time series over wide areas. However, its effectiveness in vegetated and geomorphologically complex environments is often limited by temporal decorrelation, particularly at C- and X-band wavelengths, where the density of coherent measurements significantly decreases with respect to urbanized areas.

In this scenario, the increasing availability of L-band SAR observations provides an opportunity to extend the Italian landslide MT-DInSAR monitoring capability towards environments that are only partially analyzed using shorter (i.e., C- and X-band) wavelength sensors. Indeed, thanks to their longer wavelength, the L-band systems preserve coherence more effectively over vegetated surfaces and exhibit lower sensitivity to phase unwrapping errors, enabling more reliable retrieval of long-term displacement time series, as well as of large and rapidly evolving deformation.

This work assesses the contribution of the Argentine SAOCOM-1 constellation to large-scale landslide monitoring over the Italian territory. In particular, MT-DInSAR analyses are performed using the Parallel Small Baseline Subset (P-SBAS) approach on temporally extended SAOCOM-1 datasets acquired between 2021 and 2026, over representative vegetated and landslide-prone areas. The resulting products are

systematically compared with Sentinel-1 observations to quantify the added value of L-band data in terms of coherent target density and spatial coverage

The presented results highlight the complementary role of SAOCOM-1 L-band observations for improving deformation monitoring in challenging environments, demonstrating their capability to enhance operational landslide hazard assessment and risk management services. This study also provides a valuable benchmark for the exploitation of forthcoming systematic L-band missions, including NISAR, ROSE-L, and the future Italian National L-band Radar Mission.

Sentinel-1 imagery for quantitative landslide vulnerability assessment of buildings at regional scale

Francesco Poggi ^(1,2), Francesco Caleca ⁽¹⁾, Olga Nardini ⁽¹⁾, Matteo Del Soldato ⁽¹⁾, Claudio De Luca ⁽²⁾, Manuela Bonano ⁽²⁾, Riccardo Lanari ⁽²⁾, Veronica Tofani ⁽¹⁾, Nicola Casagli ⁽¹⁾, Federico Raspini ⁽¹⁾

⁽¹⁾ University of Florence, Department of Earth Sciences, Florence, Italy

⁽²⁾ Institute for Electromagnetic Sensing of the Environment (IREA), National Research Council of Italy (CNR), Naples-Milan, Italy

Landslides can cause significant economic impact worldwide by damaging exposed structures, including buildings. In order to identify effective mitigation strategies, scientific community focuses on estimating the consequences of landslide activity. Vulnerability assessment is a key component of risk analysis and is addressed from both social and natural science perspectives.

In social sciences, vulnerability refers to socioeconomic factors influencing the ability of individuals or communities to cope with stress, whereas in natural sciences it represents the degree of potential loss of elements exposed to a landslide of a given intensity. Most existing methods are site-specific and applied at local scales, as they require detailed knowledge of landslide processes and exposed structures. However, data collection is often challenging and affected by uncertainty. To overcome data limitations, alternative approaches based on aggregated indicators, such as the percentage of landslide-affected area, or precautionary assumptions setting vulnerability equal to total loss, have been adopted.

This study proposes a quantitative procedure for assessing the vulnerability of buildings exposed to slow-moving landslides using empirical fragility and vulnerability curves. These curves describe the probabilistic relationship between landslide intensity and building damage severity, providing vulnerability values ranging from 0 (no loss) to 1 (total loss). The methodology is based on a catalogue of landslide-induced damage to more than 4,000 buildings in the Northern Apennines (central Italy), developed within the ASI-funded “DInSAR-3M” project. Landslide intensity is derived from freely available Sentinel-1 SAR data processed using the Small Baseline Subset (SBAS) technique. The Northern Apennines were selected due to their high susceptibility to slow-moving landslides, as documented by the Italian landslide inventory, which includes approximately 190,000 mapped events. A quantitative risk assessment integrating hazard, vulnerability, and exposure was performed for over 700,000 buildings. The total landslide risk for buildings in the study area is estimated at approximately 1.8 billion euros.

Session #4 “Floods & Drought”

Session chaired by Antonio Montuori, Senior Technologist at the Italian Space Agency (ASI) and ASI Point of Contact and Vice-chair of the Committee on Earth Observation Satellites (CEOS) Working Group on Disasters (WGD), and Marcelo Uriburu Quirno, Senior Hydrologist at the National Commission on Space Activities (CONAE, Argentina), former CEOS WGD Chair and Principal Investigator of the new CEOS WGD Drought Pilot Project.

Unsupervised Continuous Flood Mapping from Multi-temporal, Multi-view, and Multi-sensor SAR Sequences

Shafi Ullah Miakhil ⁽¹⁾, Wilson Andres Velasquez Hurtado ^(2,3), Deodato Tapete ⁽³⁾, Paolo Gamba ⁽¹⁾

⁽¹⁾ University of Pavia, Pavia, Italy

⁽²⁾ Sapienza University of Rome, Rome, Italy

⁽³⁾ Italian Space Agency (ASI), Rome, Italy

Floods are among the most disruptive natural hazards, requiring emergency managers and civil protection authorities to access timely and reliable information on flood extent and its evolution over time. Satellite-based flood mapping plays a critical role in supporting emergency response and preparedness, particularly when ground access is limited. Synthetic Aperture Radar (SAR) data are well suited for this purpose, as they provide day-and-night observations independent of cloud cover. However, continuous flood monitoring remains challenging due to irregular revisit times, limited availability of suitable pre-flood reference images, and the need to combine data from different sensors while ensuring fast product delivery to end users. To address these challenges, this paper presents an automated and sensor-flexible framework for continuous flood monitoring using multi-temporal SAR data. The methodology implements a unified workflow that exploits post-event feature-based mapping and change-detection analysis, allowing flood extent estimates when suitable pre-flood reference images are available as well as when such references are missing or inconsistent. The workflow operates directly on heterogeneous SAR acquisitions (e.g. Sentinel-1 GRD and COSMO-SkyMed Level-1D products) and is designed to remain robust under varying imaging geometries and operational constraints. To this aim, flood detection is performed

through unsupervised clustering of SAR backscatter features, with optical data used, without human intervention, to semantically guide the cluster interpretation. The methodology was tested on two contrasting flood scenarios characterized by different temporal dynamics. The May 2023 Emilia–Romagna flood represents a fast-onset event, with daily flood maps generated throughout the emergency period. The La Mojana floodplain in Colombia represents a markedly different setting, characterized by long-lasting and recurrent inundations. Validation against benchmarks shows high and consistent performance of the proposed approach, with overall accuracy close to 98% and F1-scores ranging from approximately 84% to over 91% across different flood scenarios and sensors. Overall, these results demonstrate that the proposed framework enables reliable and temporally consistent flood monitoring across sensors, time scales, and flood regimes.

Surface Water Monitoring for Hydrological Risk Forecasting: a Multisensor Earth Observation and Deep Learning Framework

Alessia Iannaccone ⁽¹⁾, Francesco Mauro ⁽¹⁾, Silvia Liberata Ullo ⁽¹⁾

⁽¹⁾ University of Sannio, Engineering Department, Benevento, Italy

Monitoring surface-water dynamics is essential for detecting anomalous hydrological conditions and supporting water-related disaster risk assessment and early-warning activities. Earth Observation (EO) enables systematic monitoring over large and geographically diverse areas, while deep learning can improve both water-body mapping and the prediction of their temporal evolution.

This study presents a multisensor and multitemporal EO framework for monitoring and forecasting river and lake dynamics. The dataset includes 382 water-body locations across Italy, Spain, Australia, Sweden, Ireland, United Kingdom, and France. For each location, 39 acquisitions collected every two months cover more than six years over a 3 km x 3 km area. The dataset combines Sentinel-1 radar data, Sentinel-2 multispectral imagery, slope, elevation, and 16 hydro-meteorological variables, including total precipitation, snowfall, snowmelt, surface and subsurface runoff, soil-water content in the upper soil layers, 2-m air temperature, potential evaporation, and open-water evaporation. These variables provide complementary information on the physical processes influencing water-body dynamics and can support the interpretation and consistency assessment of the predicted changes.

For surface-water segmentation, a U-Net architecture was trained using a multimodal stack combining despeckled Sentinel-1 VV and VH polarizations, Sentinel-2 red, green, blue, and near-infrared bands, slope, and elevation. Dynamic World water masks were used as reference data. The model achieved a precision of 0.96, a recall of 0.97, and an Intersection over Union of 0.94.

The segmented water masks were then organized into temporal sequences. ConvLSTM, Bidirectional ConvLSTM, and Time-Distributed CNN architectures were used to predict the water mask corresponding to the next acquisition from the preceding masks in the sequence. The Time-Distributed CNN achieved the best performance, with a structural similarity index of 0.81 and a peak signal-to-noise ratio of 29.98.

The framework can support the early detection of hydrological anomalies, water-related risk assessment, and operational early-warning services.

Reducing latency in flood monitoring: A Sentinel-2 Level 0 pipeline for on-board generation of water/land masks

Debhora Bonfiglio ^(1,2), Alessandro Togni ⁽¹⁾, Matteo Maragliano ^(1,3), Davide Carletto ^(1,4), Stefano Marangoni ⁽¹⁾, Giovanna Chiara Rodi ⁽¹⁾

⁽¹⁾ aizoOn Technology & Consulting, Torino, Italy

⁽²⁾ Università degli Studi di Torino, Dipartimento di Matematica, Torino, Italy

⁽³⁾ Università di Genova, Dipartimento di Ingegneria Navale, Elettrica, Elettronica e delle Telecomunicazioni (DITEN), Genova, Italy

⁽⁴⁾ Politecnico di Torino, Dipartimento di Automatica e Informatica (DAUIN), Torino, Italy

Traditional Earth Observation missions (e.g., Sentinel) transmit raw data to the ground for processing, introducing hours-long delays that hinder time-sensitive applications such as flood monitoring. Sentinel-2 produces Level 0 data that is processed to enable user access to Level 1C/2A only. Making raw Level 0 data available (e.g., through datasets like THRawS) would allow experts to develop and validate pipelines that can be migrated on-board, providing important low-latency operational solutions for time-critical phenomena.

For flood management, a processing pipeline is defined that outputs binary water/land masks from raw satellite images. The resulting masks are suitable for subsequent comparison with reference water maps to detect significant changes. Using the THRawS dataset, spectral bands are co-registered and a database of approximately 4000 possibly overlapping 512×512 tiles is created. Each tile has a water mask (ground truth derived from the Copernicus DEM Water Body Mask) and a cloud mask (from the L2A Scene Classification Layer) to exclude fully cloud-covered pixels during evaluation. The neural network used is WF2_unetv2_bgriswirs (E. Portalés-Julià et al, 2023).

The network is evaluated via two approaches, inference and fine-tuning, using the IoU and F1 metrics. Inference on LO data yields low performance (IoU = 0.33, F1 = 0.34), likely because LO pixels are represented as digital numbers while training was performed on orthorectified reflectance data. Consequently, the model is fine-tuned. The dataset is split 70%/15%/15% (train/validation/test), ensuring that intersecting tiles remained within the same split to prevent data leakage. The fine-tuned model reaches IoU = 0.64 and F1 = 0.78 on the test set, promising and consistent with the original UNet paper, suggesting that larger Level-0 datasets could yield even better performance toward low-latency on-board flood monitoring.

This work has been supported by the Italian Space Agency under the “Artificial Intelligence for Satellite Edge Computing – AI4SEC” contract (No. 2025-41.I.O).

The National Drought Monitoring Board (MNMS) of Argentina: an interinstitutional model for multi-index drought assessment and its integration with early warning systems

Analía Percíncula ⁽¹⁾, Mariano Quesada ⁽¹⁾, María de los Milagros Skansi ⁽²⁾

⁽¹⁾ Secretariat of Agriculture, Livestock and Fisheries (SAGyP), Argentina

⁽²⁾ National Meteorological Service (SMN), Argentina

Presentation made by Luciana D'Acunto, Instituto de Clima y Agua, CIRN, INTA, Argentina

The Mesa Nacional de Monitoreo de Sequía (MNMS – National Drought Monitoring Board) is an interinstitutional working group that has produced monthly drought reports in Argentina. It is coordinated by the National Secretariat of Agriculture, Livestock and Fisheries (SAGyP) and the National Meteorological Service (SMN), together with other

national scientific and technical institutions, including CONAE, INTA, FAUBA, INA, IANIGLA and ORSEP.

The MNMS is formally part of the Network of Scientific-Technical Organizations for Integral Risk Management (GIRCYT), supporting Argentina's National System for Integral Risk Management (SINAGIR), and channels its monthly report to the National Alert and Emergency Monitoring System (SINAME).

The MNMS meets monthly to conduct a multi-index analysis based on data from multiple sources: weather station networks, products from different satellite constellations, physical models combining hydrometeorological and agronomic variables, and field observations by technicians. This multi-index approach draws on regional experience, taking as reference the Monitor de Secas of Brazil and the Drought Monitor deployed in North America. At each meeting, a consensus drought map is produced, classifying drought intensity into different categories (mild, moderate, severe, or no drought) based on multiple indicators.

The MNMS constitutes a sustainable model built on trust among technicians from its member institutions, formalized through an information management protocol defining data responsibilities, contributed products, and delivery timeframes and formats. After nearly six years of continuous operation, it is evolving toward greater automation of the multi-index analysis and stronger institutional formalization, including the development of a web platform.

The MNMS is presented as a case study of interinstitutional coordination for drought early warning, highlighting lessons learned on data governance, sustainable information access, and pathways for integrating science-based monitoring networks with national disaster risk management systems.

A hierarchical robust combined index for agricultural drought detection and monitoring using EO big data

Filippo Bocchino ⁽¹⁾, Giulia Graldi ⁽¹⁾, Camillo Zaccarini ⁽²⁾, Deodato Tapete ⁽³⁾, Alessandro Ursi ⁽³⁾, Maria Virelli ⁽³⁾, Patrizia Sacco ⁽³⁾, Valeria Belloni ⁽¹⁾, Roberta Ravanelli ⁽⁴⁾, Mattia Crespi ⁽¹⁾

⁽¹⁾ Geodesy and Geomatics Division, Department of Civil, Building and Environmental Engineering (DICEA), Sapienza University of Rome, Rome, Italy

⁽²⁾ Risk Management Department, Institute of Services for Agricultural and Food Market (ISMEA), Rome, Italy

⁽³⁾ Italian Space Agency (ASI), Rome, Italy

⁽⁴⁾ Geomatics Unit, Department of Geography, University of Liège, Liège, Belgium

Agricultural drought poses a significant threat to crop productivity and food security. This study provides a detailed review of the approaches used to construct Combined Drought Indices (CDIs) in the existing literature and introduces the Hierarchical Robust Combined Drought Index (HRCDI) designed to improve agricultural drought assessment on a municipal scale, leveraging Earth Observation (EO) data freely available in Google Earth Engine. The HRCDI integrates meteorological and remote sensing indicators — including the Standardized Precipitation Evapotranspiration Index (SPEI), Soil Moisture (SM), Land Surface Temperature (LST) and Normalized Difference Vegetation Index (NDVI) — through a fuzzy logic-based decision framework. The methodology reflects the typical progression of drought impacts, from climatic drivers to biophysical responses, allowing for dynamic and temporally coherent detection and monitoring of drought severity. Applied to the Province of Foggia (southern Italy) from 2017 to 2022, the index provided monthly, municipality-level classifications that successfully captured the temporal evolution of drought events, particularly during the drought-affected years of 2017 and 2022, when yield losses of 5% (2017) and 22% (2022) were registered for the durum wheat, the main cultivated crop of the Province of Foggia. Key advantages of the approach include its scalability, the use of a robust z-score, and its operational relevance for national and local institutions in supporting drought compensation schemes. The results demonstrate the potential of the index as a robust and adaptable tool for early warning and monitoring of agricultural drought, and agricultural risk management under changing climate conditions.

This work was supported by the “Geomatics for Resilience Against Water scarcity” (GRAW) project under Grant 2023-1-HB.0 funded by the Italian Space Agency (ASI) in the framework of the “Innovation for Downstream Preparation for Science” (I4DP_SCIENCE) program. The work of Filippo Bocchino was supported by the grant for young researchers under Grant AR123188B3C1EB82 funded by Sapienza University of Rome, Italy, and by a Doctoral Program fellowship within the National PhD in Earth Observation funded by the Institute of Services for Agricultural and Food Market (ISMEA), Italy.

Modeling Alpine Glaciers Melting using GEDI and ICESat-2 Altimetry data

Sofia Pelosi ⁽¹⁾, Alireza Hamoudzadeh ⁽¹⁾, Roberta Ravanelli ⁽²⁾, Mattia Crespi ^(1,3)

⁽¹⁾ Geodesy and Geomatics Division, Department of Civil, Building and Environmental Engineering (DICEA), Sapienza University of Rome, Rome, Italy

⁽²⁾ Geomatics Unit, Department of Geography, Faculty of Sciences, University of Liège, Liège, Belgium

⁽³⁾ Sapienza School for Advanced Studies, Sapienza University of Rome, Rome, 00185, Italy

Mountain glaciers are highly sensitive indicators of climate change, making their monitoring essential for understanding ongoing cryospheric changes. Remote sensing, and particularly spaceborne LiDAR altimetry, provides an effective means of monitoring glacier surface elevation over large spatial and temporal scales. This research investigates the reconstruction of seasonal glacier surface elevation changes by integrating observations from two missions: the Global Ecosystem Dynamics Investigation (GEDI) and the Ice, Cloud and Land Elevation Satellite-2 (ICESat-2), over Rutor Glacier in the Italian Alps. A dedicated processing workflow was developed to retrieve, harmonize, and integrate GEDI and ICESat-2 observations. Satellite measurements were transformed into a common vertical reference system, and stable spatial locations were identified through orbital track intersections. A nonlinear seasonal model was subsequently developed to describe glacier surface evolution using a cosine formulation controlled by melt amplitude, melt-season onset, and duration, together with local reference elevations. Model parameters were estimated through nonlinear least-squares optimization using a Levenberg-damped Gauss-Newton approach. The methodology was applied to the 3 glacier sectors and to the glacier as a whole. Results showed that sector-based modelling provided more accurate reconstructions than the Global model, depending on observation availability. Estimated melt amplitudes increased coherently from the upper to lower sectors, while melt duration exhibited a similar tendency. Independent validation using UAV-derived Digital Surface Models from 2020 and 2021 confirmed the physical consistency of the reconstructed elevation trends. In the Global joint analysis, 301 observations were fitted using 91 unknown parameters, achieving an RMSE of 2.8 m and a validation RMSE of 2.5 m, with a formal melt-amplitude uncertainty of 0.1 m. Overall, the results demonstrate the potential of combining GEDI and ICESat-2 for reconstructing seasonal glacier elevation changes. Future improvements should incorporate elevation-

dependent melting, sensor-specific weighting, additional geomorphological variables, and improved use of available observations.

Session #5 “Earthquakes and building damage assessment”

Session chaired by Deodato Tapete, Senior Researcher at ASI and ASI Deputy & Program Scientist for the Committee on Earth Observation Satellites (CEOS) Working Group on Disasters (WGD), and Zachary Foltz, ACRI-ST c/ESA and CEOS WGD Seismic Risk Initiative.

The use of high-resolution satellite-derived elevation data in earthquake hazard identification and mitigation

Richard Walker ⁽¹⁾

⁽¹⁾ University of Oxford, United Kingdom

In this presentation I highlight several case studies where the use of high-resolution digital elevation products derived from stereo and tri-stereo Pleiades imagery have been used to identify active faults and to characterize the sources of past destructive earthquakes in proximity to towns, cities and major infrastructure developments. in central Asia, the South Caucasus, and North Africa. Modern approaches to hazard identification increasingly rely on the availability of detailed digital elevation datasets, such as those obtained through aerial LIDAR survey. However, in many earthquake-prone parts of the world such datasets are not available, leading to inequalities in hazard assessment that are at odds with the global SDGs. Stereo-imaging optical satellites offer an excellent means to develop appropriate datasets, which are necessary due to rapid urban and infrastructure growth in many of the countries discussed. I will show how the derived elevation datasets have been used to identify active faults that bring new knowledge related to the risk profile for urban centres and for major projects such as hydropower dam construction. I emphasise the need for regional programmes of active fault mapping in order to provide underpinning datasets that can then be incorporated into construction design at the earliest stage.

From Building Damage Assessment to Post-Disaster Recovery Monitoring: An Integrated Very High-Resolution SAR and Geospatial Workflow for the 2023 Türkiye–Syria Earthquake

Luigi Russo ⁽¹⁾, Deodato Tapete ⁽²⁾, Silvia Liberata Ullo ⁽³⁾, Paolo Gamba ⁽¹⁾

⁽¹⁾ University of Pavia, Department of Electrical, Computer and Biomedical Engineering, Pavia, Italy

⁽²⁾ University of Sannio, Engineering Department, Benevento, Italy

⁽³⁾ Italian Space Agency (ASI), Rome, Italy

The 2023 Türkiye–Syria earthquake sequence caused severe and spatially heterogeneous impacts on the built environment, requiring rapid damage assessment and long-term recovery monitoring. This contribution presents an integrated Earth Observation (EO) workflow linking Building Damage Assessment (BDA) and post-disaster recovery monitoring using Very High Resolution (VHR) Synthetic Aperture Radar (SAR) imagery and ancillary geospatial information.

First, a post-event-only BDA framework was developed using COSMO-SkyMed (CSK) VHR SAR imagery, building footprints, Digital Surface Model (DSM)-derived information, and exposure and vulnerability attributes [1]. It produces binary building-level damaged/intact information under emergency conditions, when comparable pre-event SAR imagery or cloud-free optical data may be unavailable. Geospatial information supports model inference and interpretation of the damage maps.

Second, the damage information was used as a spatial baseline for monitoring subsequent physical transformations [2]. Multitemporal CSK SAR observations were analysed using an unsupervised reconstruction-based framework to detect persistent anomaly patterns potentially associated with debris removal, temporary settlements, new construction, and other post-earthquake recovery processes. Optical imagery, Sentinel-2 time series, Nighttime Lights (NTL), and ancillary geospatial layers support interpretation of the detected changes.

The workflow demonstrates the value of connecting rapid BDA and recovery monitoring within a continuous EO-based information chain for Disaster Risk Management, emergency response, and reconstruction monitoring.

This work was supported by Next Generation EU, Action 4, DM n. 118, 02/03/2023 through the framework of a PhD program. The COSMO-SkyMed products used in this study were accessed under a license granted by the Italian Space Agency (ASI) through the Project Card “Turkey EQ2024”. Access to CartoSat-1 Euro-Maps 3D DSM data was

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Earthquake damage mapping by means of SAR and Super-resolution Optical images

Christian Bignami ⁽¹⁾, Giovanni Anconitano ⁽¹⁾, Serena Moretto ⁽²⁾, Stefano Scancella ⁽²⁾, Ferdinando Nunziata ⁽³⁾, Vito Romaniello ⁽¹⁾, Nazzareno Pierdicca ^(1,3), Emanuele Dalsasso ⁽⁴⁾

⁽¹⁾ National Institute of Geophysics and Volcanology (INGV), Rome, Italy

⁽²⁾ Serco Italia S.p.A., Rome, Italy

⁽³⁾ Sapienza University of Rome. Dip. of Information Engineering, Electronics and Telecommunications, Rome, Italy

⁽⁴⁾ Centre Inria de l'Université Grenoble Alpes, Montbonnot-Saint-Martin, France

Rapid damage assessment after an earthquake is crucial for saving lives, coordinating rescue operations, and supporting recovery planning. Compared with traditional ground surveys, satellite-based damage mapping provides a faster and safer solution for large-scale assessments.

We investigate the contribution of Synthetic Aperture Radar (SAR) and Optical data for earthquake damage detection and classification. The analysis encompasses multi-frequency, multi-polarization SAR with Sentinel-2 (S2) imagery, evaluating the benefits of super-resolution techniques to enhance the spatial resolution of S2 data. These methods achieve performance comparable to higher-resolution imagery while

avoiding the geometric distortions typical of VHR data, enabling fully automated building-scale analyses.

For SAR, we assess change detection approaches using C-band Sentinel-1 and high-resolution X-band COSMO-SkyMed Second Generation data, and evaluate an AI-based (convolutional neural network) despeckling method.

The study focuses on the 2023 Türkiye earthquakes (Mw 7.8 and 7.5) in the Kahramanmaraş and Hatay regions. Results are validated against Copernicus Emergency Management Service Rapid Mapping reference data, including four damage levels: Destroyed, Severe, Moderate, and Negligible-to-Slight Damage.

Extending VHR Optical/SAR Building Damage Assessment Benchmarks with Multi-Resolution TerraSAR-X Data: Impact of Sensor Variety on Model Robustness

Christian Hümmer ⁽¹⁾, Sandro Martinis ⁽¹⁾, Marc Wieland ⁽¹⁾

⁽¹⁾ German Remote Sensing Data Center (DFD), German Aerospace Center (DLR), Oberpfaffenhofen, D-82234 Wessling, Germany

Synthetic aperture radar (SAR) satellite sensors can provide essential all-weather, day-and-night capabilities for rapid building damage assessment (BDA) in time-critical natural disaster response scenarios. Besides the sensor-inherent challenges, limited availability of very high resolution (VHR) SAR datasets for training suitable machine learning models, however, has hampered wide adoption in rapid mapping operations so far. Recent datasets based on bi-temporal VHR satellite data address the aspect of multi-modal BDA (e.g. BRIGHT or DisasterM3) by pairing pre-event optical imagery with post-event SAR acquisitions. While these datasets offer a rich geographic variety, their associated benchmark results revealed strong limitations in transferability to unseen regions and disaster events, e.g. due to inconsistent damage patterns in the SAR backscatter signatures, especially in the case of zero-shot cross-event scenarios. Furthermore, their multi-sensor, multi-resolution generalization capabilities beyond the included X-band sensors (Capella, Umbra) remain unclear. In this study, we investigate an extended multi-modal (optical-SAR) VHR BDA dataset that expands the existing BRIGHT dataset with TerraSAR-X/TanDEM-X (TSX/TDX) data for ten additional disaster events to increase both sensor and geographic variability. We examine the effectiveness of transfer learning and domain adaptation techniques and present preliminary benchmarking results. Besides analyzing the transferability to another VHR

X-band SAR sensor and extending the geographic variety of publicly available benchmark datasets by additional globally distributed events, this work further examines the limitations of transferability in multi-resolution settings, including data from different TSX/TDX imaging modes like StripMap (up to 3m) and (High Resolution) SpotLight (up to 1m).

Session #6 “Processing and application platforms”

Session chaired by Simona Zoffoli, Responsible of “User Coordination, Data Policy and Downstreaming” Sector at the Italian Space Agency (ASI) and former Chair of the Committee on Earth Observation Satellites (CEOS) Working Group on Disasters (WGD), Deodato Tapete, Senior Researcher at ASI and ASI Deputy & Program Scientist for the CEOS WGD.

From Earth Observation to Institutional Decisions: Rheticus® Services for Disaster Resilience in Developing Countries

Daniela Drimaco ⁽¹⁾, Davide Oscar Nitti ⁽²⁾, Giulio Ceriola ⁽¹⁾, Raffaele Borrelli ⁽¹⁾, Raffaele Nutricato ⁽²⁾, Vincenzo Laurino ⁽¹⁾, Vincenzo Massimi ⁽¹⁾

⁽¹⁾ Planetek Italia, Bari, Italy;

⁽²⁾ Geophysical Applications Processing (GAP) Srl, Bari, Italy

Earth Observation (EO) is becoming an operational asset for Disaster Risk Management, supporting decision-makers from prevention and preparedness to recovery and reconstruction. This contribution presents Planetek Italia’s experience in translating EO-derived information into actionable evidence for International Financial Institutions and national authorities in developing countries, drawing on use cases implemented within ESA EO4SD Disaster Risk Reduction and ESA Global Development Assistance Disaster Resilience, in cooperation with these institutions.

The presentation will focus on three decision-making contexts. In Palu, Indonesia, after the 2018 Sulawesi earthquake and tsunami, EO-based ground motion mapping, reconstruction monitoring and building stability assessment supported authorities in understanding post-event land surface stability and informing redevelopment planning. In Cox’s Bazar, Bangladesh, ESA GDA Disaster Resilience supported the ADB Bangladesh Resident Mission with EO-derived indicators of land stability and flood susceptibility over a 2,500 km², combining flood mapping, surface-water seasonal trends, land cover, ground motion, landslide hazard assessment and subsidence-water table depletion analytics to improve water-resource management and disaster risk reduction in disaster-prone areas and informal settlements.

The third case addresses long-term subsidence and flood risk in Indonesian cities along the North Java. Through GDA Disaster Resilience and ADB-supported activities, Planetek contributed to implement subsidence hazard mapping and building stability analytics over Jakarta, Cirebon, Pekalongan, Semarang, Surabaya and Palu, using Sentinel-1 InSAR through Rheticus® Displacement and Rheticus® Building Check, integrated with building footprints, height and exposure information. These products helped identify movements over buildings and infrastructure, prioritise mitigation measures, and support strategic choices such as investing in protective works and resilient infrastructure in the most affected areas or considering alternative urban development pathways, including the relocation of capital functions.

The contribution will highlight lessons learned for future operational workflows: trusted EO services, capacity building, cloud platforms and co-designed analytics are essential to move from hazard maps to institutional decisions.

Empowering Disaster Risk Management through Earth Observation: The Role of GDA Analytics and Processing Platform

Alessia Cattozzo ⁽¹⁾, Noemi Fazzini ⁽¹⁾, Antonio Vecoli ⁽¹⁾, Maximilien Houel ⁽²⁾, Simone Mantovani ⁽¹⁾, Patrick Griffiths ⁽³⁾

⁽¹⁾ Meteorological and Environmental Earth Observation (MEEO), Ferrara, Italy

⁽²⁾ Beyond-EO (BEO), Paris, France

⁽³⁾ European Space Agency (ESA-ESRIN), Frascati, Italy

Disaster Risk Management (DRM) requires timely, data-driven insights to address the compounding vulnerabilities of global urbanization and climate-induced extreme events. Within the framework of the European Space Agency's (ESA) Global Development Assistance (GDA) programme, Earth Observation (EO) plays a crucial role in enabling evidence-based planning, preparedness, and response.

As the lead of the GDA Analytics and Processing Platform (APP) cross-cutting activity, MEEO (Meteorological and Environmental Earth Observation) has developed and is operating a flexible, cloud-powered analytical environment specifically tailored to bridge the gap between advanced satellite remote sensing and the operational requirements of International Financial Institutions (IFIs) and developing nations.

By leveraging European public cloud resources and cutting-edge processing workflows, the GDA APP facilitates the seamless integration of EO-based products into institutional DRM workflows. This presentation will demonstrate how the platform streamlines access to satellite data, environmental and climate indicators, empowers risk-informed decision-making, and supports the implementation of global frameworks such as the Sendai Framework for Disaster Risk Reduction. The case study “Improving Connectivity and Urban Infrastructure in Cabo Verde” will showcase how the GDA APP EO Capabilities have been used to provide insightful information to Instituto Nacional de Gestão do Território (INGT) for land and coastal applications on critical sites across six target islands in Cabo Verde: Santiago, Sao Vicente, Santo Antao, Boa Vista, Sal, and Maio.

Debris-Flow prediction using Digital Twins: the IRIDE Cyber Italy

Stefano Scancella ⁽¹⁾, Fabio Lo Zito ⁽¹⁾, Michele Ferri ⁽²⁾, Francesco Zaffanella ⁽²⁾, Rita Chirico ⁽³⁾, Enrico Cadau ⁽⁴⁾

⁽¹⁾ Serco Italia S.p.A., Rome, Italy

⁽²⁾ Autorità di Bacino Distrettuale delle Alpi Orientali, Venice, Italy

⁽³⁾ ATG Europe for ESA, Italy

⁽⁴⁾ European Space Agency, ESRIN, Italy

The Cyber Italy project represents a national step forward to develop and implement a scalable and interoperable PaaS enabling EO-based Digital Twins of the Earth. As part of the Italian EO space program funded by the EU’s National Recovery and Resilience Plan and managed by ESA and ASI, the Framework hosts multiple thematic DTs on a common cloud-based infrastructure, supporting Disaster Risk Management, environmental monitoring and territorial planning.

A DT recently integrated, and already used, is focused on rainfall-induced fast-moving landslides, particularly debris flows, a hazard of primary relevance for alpine and mountainous areas. Developed by Autorità di Bacino Distrettuale delle Alpi Orientali, and hosted on the Cyber Italy platform, the DT first Use Case has been deployed over the Dolomites, in the Cortina d’Ampezzo area, where extreme rainfall events can trigger debris flows, threatening roads, infrastructure and communities.

The DT architecture integrates numerical weather prediction, real-time in-situ telemetry, satellite imagery, digital elevation data, and debris-flow propagation

scenarios derived from national Flood Risk Management Plans. The workflow performs threshold-exceedance analysis, statistical matching against predefined scenarios generated with specific biphasic models, generation of impact layers and awareness reports, and "what-if" simulations, with custom alerts and daily reports supporting decision-makers and civil protection.

Earth Observation data from the IRIDE and Copernicus programmes supports vegetation and surface monitoring, as well as NDVI-based validation of debris-flow scenarios. The methodology has already been tested across additional alpine basins, confirming its portability across heterogeneous geomorphological contexts.

Cyber Italy represents a key milestone towards a comprehensive framework enabling the seamless integration of Digital Twins across multiple domains. Its architecture enables the implementation of a wide range of applications across sectors such as urban planning, agriculture, and natural resource management, contributing to the broader vision of exploiting EO technologies to improve Earth system understanding and support informed, sustainable decision-making.

From Earth Observation Data to Operational Decisions: Platform-as-a-Service Solutions for Geohazard and Infrastructure Risk Management

Alessandro Brunetti ⁽¹⁾, Vera Costantini ⁽¹⁾, Emanuela Valerio ⁽¹⁾, Paolo Mazzanti ⁽¹⁾

⁽¹⁾ NHAZCA

Earth Observation data provide valuable information for the prevention and long-term management of disasters associated with geohazards. However, the growing availability of satellite observations, in-situ sensors, and numerical models does not automatically translate into actionable information. Major challenges remain in data integration, interpretation, accessibility and incorporation into established operational procedures. This contribution presents three web-based Platform-as-a-Service solutions developed to support the transition from EO data to operational decision-making. SGAM™ – Smart Geotechnical Asset Management integrates satellite ground-motion measurements, geohazard databases and infrastructure information to identify and prioritise segments of linear assets (roads, highways, railways) that require further investigation. SGAM™ is designed to support the management of linear infrastructures exposed to landslides and other geohazards, combining AI and machine learning techniques to intelligently integrate geohazard geodatabases with the results of

satellite-based analyses, with the aim of generating susceptibility maps for different types of geohazards and, ultimately, classifying the linear infrastructure segments of interest according to their associated risk. ISABHEL combines satellite interferometry, contact sensors, Photomonitoring and digital twin within a single web environment. Applied to two use cases in Turin, the platform provides synthetic indicators and time-series information to support the interpretation of structural behaviour of bridges and the planning of inspections and maintenance activities. DEM-EO – Democratization of Earth Observation addresses barriers that currently limit the uptake of EO technologies by non-specialist users. The platform provides guided access to radar and optical satellite data, ready-to-use processing modules, exportable products, training and expert support. The three experiences highlight the importance of user-oriented interfaces, multi-source data integration, transparent indicators and capacity-building activities. They also show that the effective adoption of EO services depends not only on algorithmic performance, but on their ability to respond to operational requirements, integrate with existing workflows and provide information that users can understand, validate and translate into risk-management actions.

Climate Hazard Data to Decision Support: A Settlement-Level Interactive Climate Hazard Atlas for Armenia

Lilit Minasyan ^(1, 2)

⁽¹⁾ Climate Change and Disaster Risk Management Specialist, Armenia

⁽²⁾ University of Lisbon, Portugal

Climate-related physical risks are becoming increasingly important for financial stability, investment planning and risk-informed decision-making. Yet climate information often remains difficult to use in practice because relevant datasets are technically complex, fragmented across institutions and insufficiently localized for operational decisions.

This work presents a settlement-level climate and physical hazard assessment and interactive mapping platform developed in Armenia within an assignment commissioned by the Asian Development Bank (ADB) for the Central Bank of Armenia. Its objective is to transform climate, Earth observation and geospatial information into an operational decision-support tool for assessing physical risks affecting territories, assets and economic activities.

The methodology integrates GIS, remote sensing, national and international geospatial datasets, climate observations and projections, and spatial modelling. Multiple climate-related and physical hazards are assessed at settlement level and complemented by indicators describing vulnerability and water accessibility. The resulting framework enables users to move from separate thematic datasets toward an integrated understanding of local risk conditions.

A key output is an interactive GIS-based climate hazard atlas. Users can select a settlement, explore current and projected hazard information, compare thematic layers and access localized risk information through a user-oriented interface. The platform is designed not only for visualization, but also for practical climate-risk screening and evidence-based decision-making in the financial sector.

The work demonstrates how Earth observation, GIS and climate modelling can bridge the gap between technical hazard information and operational decision-making, while providing a scalable approach for broader applications in territorial planning, disaster risk management and climate adaptation.

Abstracts of the poster session

Topic “Wildfires & Forestry”

Poster board #1

ComeOnboard Project: How to empower PRISMA Second Generation Mission with AI-driven Onboard Edge Computing for Real-Time disasters detection

Dario Spiller ⁽¹⁾, Angela Cratere ⁽²⁾, Iaria Cannizzaro ⁽¹⁾, Filippo Sarvia ⁽¹⁾, Stefania Amici ⁽³⁾, Andrea Carbone ⁽³⁾, Mark Anthony De Guzman ⁽³⁾, Kathiravan Thangavel ⁽⁴⁾, Matteo Picchiani ⁽⁴⁾, Antonio Montuori ⁽⁴⁾

⁽¹⁾ School of Aerospace Engineering, Sapienza University of Rome, Rome, Italy

⁽²⁾ Department of Electrical and Information Engineering, Polytechnic University of Bari, Bari, Italy

⁽³⁾ National Institute of Geophysics and Volcanology (INGV), Rome, Italy

⁽⁴⁾ Khalifa University, Abu Dhabi UEA

⁽⁵⁾ Italian Space Agency (ASI), Rome, Italy

The ComeOnBoardPSG!Autonomous computing with on-board machine learning for optimized acquisition and real-time analysis of hyperspectral data on PRISMA Second Generation (PSG) – is a project funded by the Italian Space Agency (ASI). It aims to explore new autonomous capabilities to enhance the upcoming PRISMA Second Generation (PSG) hyperspectral operational satellite constellation. PSG will enable enabling the systematic use of hyperspectral data for environmental monitoring and the timely generation of warnings to support emergency response during natural disasters. The project leverages commercial off-the-shelf hardware, edge computing (EC), and deep learning (DL) to increase the autonomy and efficiency of the mission. It addresses key challenges in Earth observation, including real-time onboard data processing for early alert systems, data-rate reduction through EC, and autonomous operations enabled by adaptive mission planning. The aims are: (i) EC solutions for optimizing data transmission; (ii) autonomous operations and decision-making; and (iii) real-time onboard data processing for early alert systems.

This study presents the results of the three components. The results also confirm the potential of onboard EC and DL for timely wildfires lines delineation detection, supporting rapid planning of emergency response in operational satellite missions.

Poster board #2

Cross-Sensor Portability of On-Board Wildfire Detection: Towards Cooperative Satellite Constellations

Alvise Ferrari ⁽¹⁾, Lorenzo Manunza ⁽¹⁾, Chiara Clementini ⁽¹⁾, Marcello Maranesi ⁽¹⁾, Martina Frezza ⁽¹⁾, Paolo Soresina ⁽¹⁾, Tanya Scalia ⁽²⁾, Angelo Daniele Ciminelli ⁽²⁾

⁽¹⁾ GMATICS srl, Rome, Italy

⁽²⁾ Italian Space Agency (ASI), Rome, Italy

Wildfires evolve over minutes, and the interval between acquisition and alert directly conditions emergency response. Conventional workflows downlink raw imagery for ground processing, introducing delays incompatible with that timescale. This work investigates on-board edge processing that autonomously detects fire-affected areas and transmits only alerts and segmentation masks, reducing latency from hours to minutes while cutting downlink volume and RF power demand.

A central design choice is detecting active fire without a dedicated thermal channel, relying instead on spectral bands common to multispectral and hyperspectral payloads. A model depending only on these channels can be deployed across a wide range of satellites, shortening effective revisit over the same area. Sub-hourly revisit is today achieved only at kilometre-scale sampling, too coarse to resolve small ignitions.

Because such payloads are general-purpose rather than fire-dedicated, cross-sensor transferability becomes the enabling condition for cooperative, multi-mission constellations, in which a coordinating platform re-tasks heterogeneous assets according to priorities inferred from on-board detections.

Starting from two datasets with comparable annotation philosophy — SegTHRawS (Castro Traba et al., 2026; Sentinel-2-LO) and ActiveFire (Pereira et al., 2021; Landsat-8-L1T) — we quantified the instrumental and processing-level domain gap and corrected it through radiometric harmonization, obtaining a new harmonized multi-sensor dataset. Lightweight U-Net variants (~2M parameters, compatible with CubeSat-class accelerators) were trained on original and harmonized data, evaluating

zero-shot transfer, and dual-sensor training. Harmonization recovers a substantial share of the transfer gap, while multi-source training surpasses the weaker single-sensor baseline by learning sensor-invariant fire features.

Memory footprint and inference latency are compatible with edge accelerators; INT8 quantization and deployment on heterogeneous hardware are the next steps toward new advanced cooperative missions which GMATICS is pursuing with other European partners.

This work has been supported by the Italian Space Agency under the "Artificial Intelligence for Satellite Edge Computing – AI4SEC" contract (No. 2025-41.I.O).

Poster board #3

Machine Learning for Super Resolution Burned Area Mapping

Isabelle Adorisio ⁽¹⁾, Giulia Cammarata ⁽¹⁾, Elisa Molinari ⁽¹⁾, Riccardo Orsi ⁽¹⁾, Pablo Marzioletti ⁽¹⁾

⁽¹⁾ Serco Italia S.p.A., Italy

Increasing wildfire frequency and severity, driven by intensifying heatwaves and extreme climate conditions, have created an urgent need for accurate and timely burned area mapping to support emergency response, damage assessment, and ecosystem recovery. Current operational approaches often struggle to accurately delineate burned area boundaries and frequently generate false positives caused by heat-stressed vegetation.

This work presents an end-to-end Machine Learning pipeline for burned area mapping from a single post-event Sentinel-2 acquisition, reducing the dependence on conventional change detection methods based on pre- and post-fire imagery. Freely available Sentinel-2 multispectral imagery is enhanced through a super-resolution process, increasing the native spatial resolution (10–60 m) to 5 m and 2.5 m. More than twenty vegetation, moisture, and soil spectral indices are then derived and used as input features for supervised classification.

The proposed workflow covers the entire processing chain, including automated feature extraction, training dataset generation, image classification, and burned area map reconstruction, using open-source tools (Python, Orange, and QGIS).

The methodology was developed and validated using a database of more than one hundred wildfire events documented by the European Forest Fire Information System (EFFIS). Two supervised training strategies were investigated: one combining pre- and post-fire imagery and another relying exclusively on post-fire acquisitions.

The proposed approach achieved high classification performance, with Precision ranging from 0.85 to 0.96, Recall from 0.77 to 0.95, F1-score from 0.86 to 0.97, and AUC from 0.76 to 0.99. Results also demonstrate improved burned area boundary delineation compared with conventional threshold-based methods.

The pipeline is scalable and can be continuously enhanced by incorporating additional wildfire events into the training database, improving model robustness and generalization. The resulting burned area products can support public authorities in emergency management, damage assessment, and post-fire ecosystem recovery planning.

Poster board #4

SFIDE and the EOSIAL Viewer: Multi-Source Near-Real-Time Fire Detection from MTG-FCI and other Satellite Platforms for Disaster Risk Management

Valerio Pampanoni ⁽¹⁾, Giovanni Laneve ⁽¹⁾

⁽¹⁾ School of Aerospace Engineering, Sapienza University of Rome, Rome, Italy

Timely detection of active fires is a critical component of disaster risk management, directly affecting response times and resource allocation during emergencies. This contribution presents SFIDE (Satellite Fire DETection), a thermal anomaly detection algorithm developed by the EOSIAL laboratory (Sapienza University of Rome) and recently adapted to exploit the Flexible Combined Imager (FCI) onboard the new-generation geostationary satellite Meteosat Third Generation (MTG). The 1 km sub-satellite resolution of the FCI thermal channel is the finest ever achieved from geostationary orbit, and combined with a 10-minute repeat cycle, it enables continuous, low-latency fire monitoring at national and continental scale with unprecedented sensitivity compared to previous geostationary systems.

To make these detections accessible and to support their operational evaluation, the laboratory has developed the EOSIAL Viewer, a web-based geospatial platform that

displays near-real-time SFIDE detections from both MSG (HRIT and RSS) and MTG alongside independent hotspot products (NASA FIRMS NRT thermal anomalies, Sentinel-3 SLSTR FRP product, and the official EUMETSAT MTG-FIR product), allowing direct visual and quantitative comparison between systems based on both geostationary and polar-orbiting satellite data.

The presentation will describe the SFIDE algorithm and its adaptation to MTG-FCI data, the architecture and functionality of the EOSIAL Viewer, and a set of Italian case studies from the 2026 fire season illustrating the system's detection performance, including its ability to identify fires ahead of, or otherwise undetected by, reference products and ground-based reporting. These results are discussed in the context of pre-operational readiness for supporting civil protection and early warning activities.

Poster board #5

P-Band TomoSAR and Machine Learning for Forest Disaster Risk Assessment

Francesco Buonavolontà ⁽¹⁾, Francesco Mauro ⁽¹⁾, Silvia Liberata Ullo ⁽¹⁾

⁽¹⁾ University of Sannio, Engineering Department, Benevento, Italy

Forests act as protective infrastructure by storing carbon, intercepting rainfall, stabilizing soils, and reducing hydrogeological impacts. After wildfires, severe storms, or landslides, however, damage is not limited to canopy removal. Forest structure may be reorganized in three dimensions, while conventional two-dimensional maps may still classify an area as forested despite losses in canopy height, woody volume, and vertical continuity. These changes can increase soil exposure, surface runoff, erosion, and cascading risk.

This study investigates P-band synthetic aperture radar tomography (TomoSAR) and machine learning as tools for retrieving three-dimensional forest structure in support of disaster risk management. Eleven multibaseline P-band SAR acquisitions collected over the Mondah forest in Gabon during the AfriSAR campaign were integrated with NASA LVIS terrain and canopy-height products.

After geometric preprocessing and flat-Earth phase compensation, vertical reflectivity profiles were reconstructed using Fourier beamforming and Capon methods. An ExtraTrees model was trained on features derived from SAR covariance matrices to estimate canopy height. The machine-learning approach achieved an RMSE of

approximately 14–15 m, compared with 23–43 m for classical tomographic methods, while maintaining near-zero bias and stable performance with fewer acquisition tracks.

Although the dataset represents an undisturbed forest, the workflow provides a structural digital baseline for pre- and post-event comparisons. Such analyses could reveal damage not captured by optical or two-dimensional SAR products, quantify the severity of vertical damage, identify areas where canopy collapse exposes the ground, and assess whether recovery restores only vegetation cover or also structural complexity. Combined with hazard and exposure layers, these products could support wildfire impact assessment, post-storm damage mapping, landslide susceptibility updates, and cascading-risk analysis.

Poster board #6

Automated detection of active mass movements in SAR wrapped interferograms using CNN

Fabio Bovenga ⁽¹⁾, Alessandro Mondini ⁽²⁾, Alessandro Simoni ⁽³⁾, Cristina Reyes-Carmona ⁽⁴⁾, Alessandro Mercurio ⁽³⁾, Federico Agliardi ⁽⁴⁾

⁽¹⁾ National Research Council of Italy (CNR), Institute for Electromagnetic Sensing and Environment (IREA), Bari, Italy

⁽²⁾ National Research Council of Italy (CNR), Institute of Applied Mathematics and Information Technologies "E. Magenes" (IMATI), Genova, Italy

⁽³⁾ University of Bologna, Department of Biological, Geological, and Environmental Sciences, Bologna, Italy

⁽⁴⁾ University of Milano-Bicocca, Department of Earth and Environmental Sciences, Milano, Italy

Slow mass movements are critical to slope dynamics, posing threats to lives and infrastructure. Regional-scale assessments of mass movement activity rely on geomorphological methods aided by remote sensing, accurate but time-consuming. Artificial intelligence with optical and multitemporal InSAR data offers promising solutions, yet some movements are too fast for InSAR and too slow for optical or amplitude-based SAR. Raw DInSAR phase information preserved in raw SAR interferograms may represent a valuable alternative.

We propose a deep learning framework for automated detection and classification of slow mass movements, based on a YOLO CNN with inputs including DInSAR wrapped phase, a SAR reliability index, and a PCA-derived geomorphometric variable.

About 1300 SAR interferograms were generated from Sentinel-1 acquisitions capturing mass movements across multiple spatial and temporal scales. To train a deep learning model, a geomorphologically constrained library of about 5000 labelled wrapped-phase signals was built from expert interpretation across two study areas: a 1900 km² sector of the Italian Central Alps (rock glaciers, rockslides, deep-seated deformations, and debris slides) and a 1200 km² sector of the Italian Apennines (earthflows, earth

slides, and rockslides). This diversity supported robust training and generalization testing.

Data augmentation and splitting strategies maximized training data while limiting semantic leakage and overfitting. The model outputs objectness scores, bounding box offsets, and class probabilities, refined via thresholding into final predictions. It successfully detects mass movement signals directly in raw interferograms, with detection precision of 0.75–0.8 and classification performance often exceeding expectations, with many false positives stemming from training data gaps rather than model errors.

Results show potential for automated landslide mapping and classification, thereby enhancing local monitoring strategies, civil protection responses, and landslide modelling.

To improve generalisation, future developments will exploit larger and more diverse training datasets and integrate multi-frequency observations from X- and L-band SAR missions.

Poster board #7

From Landslide Detection to Multi-Source LLM-Based Reporting: A Complete Earth Observation Framework for Rapid Assessment of Post Disaster Scenarios

Mohammed Alruqimi ⁽¹⁾, Abdelkader Riche ⁽²⁾, Pierluigi Confuorto ⁽²⁾, Mawloud Guermoui ⁽¹⁾, Silvia Bianchini ⁽²⁾, Farid Melgani ⁽¹⁾

⁽¹⁾ Department of Information Engineering and Computer Science, University of Trento, Trento, Italy

⁽²⁾ Department of Earth Sciences, University of Florence, Florence, Italy

Timely landslide detection and rapid post-disaster assessment are fundamental components of Earth Observation (EO)-based disaster risk management. However, current practices that rely on on-site surveys and manual expert assessment remain risky, costly, and time-consuming, resulting in significant delays before actionable information becomes available. This study presents a hybrid multi-model Earth Observation framework that integrates high-resolution RGB satellite imagery, geospatial information, and artificial intelligence to enable automated landslide detection and structured technical reporting for rapid post-disaster assessment. The

proposed pipeline combines an enhanced SegFormer model (SDF-SegFormer-B2) for landslide localisation, a geospatial feature extraction module for per-landslide terrain attribute computation, and a lightweight instruction-tuned large language model (Mistral-7B-Instruct v0.3) for generating structured, expert-style reports. While previous studies have explored either landslide detection or image captioning, to our knowledge this is the first framework that integrates Earth Observation imagery, geospatial analysis, and LLM-based reporting into a unified end-to-end workflow capable of producing structured technical reports enriched with terrain interpretation and qualitative intervention-priority indicators.

The framework was evaluated using 26,758 georeferenced RGB image tiles (64 × 64 pixels; 3 m spatial resolution) acquired from PlanetScope imagery over the Emilia-Romagna region, Italy, following the May 2023 rainfall-induced landslide events. The proposed SDF-SegFormer B2 achieved a precision of 85.54%, a recall of 72.31%, and an F1-score of 78.39% on an unseen test dataset. To assess the quality of the generated reports, 100 detected landslides were independently evaluated by domain experts. Overall, 58% of the reports were rated as Very Good, 30% as Good, 8% as Acceptable, and 4% as Poor. When considering only reports generated from complete and accurate inputs, 81.48% were rated Very Good, while 96.30% achieved ratings of Good or Very Good.

By integrating Earth Observation data, geospatial analysis, computer vision, and large language models within a unified operational framework, the proposed approach automates the transition from landslide detection to structured technical reporting. The framework provides terrain aware landslide summaries that can support rapid post-disaster screening, improve situational awareness, and assist emergency managers and civil protection authorities during the critical early stages of disaster response.

Poster board #8

From rapid screening to landslide evolution monitoring. Multispectral satellite Earth Observation workflows for landslide emergency response and post-event analysis

Davide Notti ⁽¹⁾, Davide Cardone ⁽¹⁾, Martina Cignetti ⁽¹⁾, Niccolò Dematteis ⁽¹⁾, Danilo Godone ⁽¹⁾, Daniele Giordan ⁽¹⁾

⁽¹⁾ Institute of Geosciences (CNR-GEO), National Research Council (CNR), Torino, Italy

Optical satellite imagery is central to Earth Observation support for Disaster Risk Management (DRM), enabling rapid, wide-area screening of shallow landslide emergencies and detailed kinematic reconstruction of large landslide reactivations. This contribution addresses both needs using freely available Sentinel-2 and PlanetScope imagery.

The core of the work is PANDA (Notti et al., 2024), an unsupervised, two-phase methodology for shallow-landslide mapping using Sentinel-2 NDVI changes with geomorphological and slope filters to detect bare-soil disturbances from shallow failures over large areas at low cost. The emergency phase delivers a rapid reconnaissance map within days; the post-emergency phase refines it with cloud-free imagery, a finer terrain model, and iterative thresholding to suppress land-cover-change false positives, yielding a high-accuracy inventory for recovery planning. Applied to the May 2023 rainfall events in the northeastern Apennines (about 4,000 km²), PANDA mapped about 80'000 potential landslides (PL) (up to PL 50/km² in the worst-hit sectors) with good accuracy against an independent inventory. Though not machine-learning-based, PANDA is low-cost, fast, and usable by non-specialists, making it a scalable, evidence-based DRM tool.

As a complementary case for a single, rapidly evolving landslide, we present the spring 2025 Boccassuolo earthflow (northern Apennines). Combining Sentinel-2 and PlanetScope imagery (Notti et al., 2026) with optical image correlation, the study reconstructed the landslide's evolution from a rotational failure into a fast earth flow and then an earth slide, reaching velocities above 80 m/day and damaging infrastructure while forming landslide-dammed lakes. This shows how event-focused monitoring can capture a flagged hazard's fine-scale evolution using accessible tools like IMCORR.

Together, the two examples outline a scalable optical-EO workflow spanning the DRM cycle: rapid mapping for emergency response, refined inventories, and kinematic monitoring of high-impact landslides, achievable with freely or commercially available multispectral data. The new ASI-IRIDE constellation should further enhance this capability over Italy.

Poster board #9

Long-term investigation of the Mendatica landslide through the integration of MT-InSAR measurements, building damage surveys, and ancillary data

Davide Cardone ^(1,2), Davide Notti ⁽¹⁾, Martina Cignetti ⁽¹⁾, Dario Peduto ⁽³⁾, Gianfranco Nicodemo ⁽³⁾, Davide Luongo ⁽³⁾, Settimio Ferlisi ⁽³⁾, Diego Reale ⁽⁴⁾, Simona Verde ⁽⁴⁾, Fabiana Calò ⁽⁴⁾, Eugenio Sansosti ⁽⁴⁾, Gianfranco Fornaro ⁽⁴⁾, Daniele Giordan ⁽¹⁾

⁽¹⁾ National Research Council of Italy (CNR), Institute of Geosciences (CNR-GEO), Torino, Italy

⁽²⁾ Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente, Enschede, the Netherlands

⁽³⁾ Department of Civil Engineering, University of Salerno, Fisciano, Italy

⁽⁴⁾ National Research Council of Italy (CNR), Institute for Electromagnetic Sensing of the Environment (IREA), Naples, Italy

Earth Observation (EO) is increasingly supporting disaster risk management by providing continuous and spatially distributed measurements to monitor dangers, characterize their evolution, and support procedures aimed at estimating the risk to exposed facilities (e.g., buildings). Multi-Temporal Interferometric Synthetic Aperture Radar (MT-InSAR) enables systematic observation of ground displacements over large areas and wide time spans, making it suitable for investigating the long-term evolution of specific dangers, such as slow-moving landslides. This study presents a multi-source approach centred on MT-InSAR observations to investigate landslide evolution and support the assessment of damage to affected buildings by integrating satellite-derived displacement measurements with ground-based observations and ancillary datasets. The proposed approach was applied to the Mendatica landslide (Ligurian Alps). Recent MT-InSAR products derived from COSMO-SkyMed Second Generation and Sentinel-1 data provided by the European Ground Motion Service constitute the core datasets for the deformation analysis. To extend the interferometric observation record to approximately three decades (1992–2023), these data are complemented by archive MT-InSAR datasets derived from ERS, Radarsat-1, and COSMO-SkyMed. MT-InSAR-derived displacement measurements and deformation indicators, including velocity along the steepest slope direction (V_{slope}), gradients of V_{slope} , and building-scale differential displacement, were compared with multi-temporal building damage surveys. Their interpretation was strengthened by the integration of geological and geomorphological information, rainfall records, and inclinometer measurements. The

integrated analysis reconstructed the long-term evolution of landslide kinematics, identified temporal variations in displacement associated with prolonged rainfall periods and the presence of mitigation works. The results reveal a consistent relationship between MT-InSAR-derived deformation indicators and the spatial distribution of building damage, while highlighting the role of landslide geometry, movement depth, local geological conditions, and building characteristics beyond ground deformation. The proposed approach illustrates the value of integrating long-term EO with complementary ground-based information to improve landslide characterization and support damage assessment and disaster risk management applications.

This research was carried out under ASI contract No. 2021-10-U.O CUP F65F21000630005 MEFISTO—Metodi di Elaborazione di dati SAR multi-Frequenza per Il monitoraggio del disseSTO idrogeologico—Multi-frequency SAR data processing methods for the hydrogeological instability monitoring.

Poster board #10

Integrating Multi-Sensor Satellite Observations to Reconstruct the Complete Evolution of the Niscemi Landslide

Nicola Casagli ⁽¹⁾, Jacopo Allievi ⁽²⁾, Francesco Becattini ⁽¹⁾, Tommaso Beni ⁽¹⁾, Silvia Bianchini ⁽¹⁾, Manuela Bonano ⁽³⁾, Tommaso Carlà ⁽¹⁾, Francesco Casu ⁽³⁾, Pierluigi Confuorto ⁽¹⁾, Claudio De Luca ⁽³⁾, Matteo Del Soldato ⁽¹⁾, Alessandro Ferretti ⁽²⁾, Gabriele Fibbi ⁽¹⁾, Alfio Fumagalli ⁽²⁾, Chiara Giannico ⁽²⁾, Giovanni Gigli ⁽¹⁾, Alessandro Innocenti ⁽¹⁾, Riccardo Lanari ⁽³⁾, Xhenis Lazri ⁽²⁾, Michele Manunta ⁽³⁾, Camilla Medici ⁽¹⁾, Olga Nardini ⁽¹⁾, Massimiliano Nocentini ⁽¹⁾, Teresa Nolesini ⁽¹⁾, Onorato G. ⁽³⁾, Veronica Pazzi ⁽¹⁾, Piombino A. ⁽¹⁾, Francesco Poggi ⁽¹⁾, Federico Raspini ⁽¹⁾, Yenni Roa ⁽³⁾, Mattia Russo ⁽²⁾, Pasquale Striano ⁽³⁾, Andrea Uttini ⁽²⁾, Ivana Zinno ⁽³⁾

⁽¹⁾ Department of Earth Sciences, University of Florence, Florence, Italy

⁽²⁾ TRE ALTAMIRA, Milan, Italy

⁽³⁾ National Research Council of Italy (CNR), Institute for Electromagnetic Sensing of the Environment (IREA), Naples-Milan, Italy

Large deep-seated landslides affecting urban areas represent critical natural hazards due to their complex kinematics, evolving from imperceptible long-term creep to catastrophic collapse threatening settlements, critical infrastructure and human lives.

The January 2026 Niscemi landslide (Sicily, Italy), a historically recurrent deep-seated landslide system, provides a unique opportunity to reconstruct the full evolution of a catastrophic urban landslide from pre-failure creep to post-failure dynamics. Mobilising over 80 million m³ of material along a 4.7 km front, the landslide developed through two main failure phases on 15-16 and 25-26 January 2026. The adopted framework integrates complementary satellite SAR radar and optical observations from Sentinel-1, COSMO-SkyMed, TerraSAR-X, SAOCOM, Capella Space and Pléiades. Pre-failure multi-temporal analyses revealed persistent slow deformation along the northwestern and southern surrounding slopes, whereas the main urban area remained largely stable. Although these signals reveal a long-term mechanically active slope system, they do not provide clear short-term precursors to the catastrophic collapse, highlighting the challenge of forecasting rapid tertiary creep acceleration in deep-seated landslides. Given the rapid deformation on 25-26 January 2026, exceeding the conventional phase limits of multi-temporal interferometry, co-event analyses integrated SAR single-pair interferometry and high-resolution optical pixel tracking. Post-event analyses distinguished ongoing residual deformation on the failed slopes from the stability of the evacuated urban sector and provided critical insights for emergency management and residual risk assessment, including the refinement of urban exclusion zones. The Niscemi case study demonstrates that large urban landslides can develop slowly, fail rapidly and maintain post-failure activity. In this context, while slow antecedent motion alone may be insufficient to predict catastrophic failure, integrating complementary satellite multi-technique observations successfully resolves the complete deformation evolution. This framework represents a significant advance in understanding landslide dynamics. It supports the development of operational monitoring strategies that improve risk assessment and civil protection decision-making for large-scale slope instability.

Poster board #11

Dynamic Assessment of Landslide Activity along Road Corridors Using Multi-Mission SAR Interferometry

Cristiano Lanni ⁽¹⁾, Deodato Tapete ⁽²⁾

⁽¹⁾ Direzione Technology, Innovation & Digital Spoke, Anas SpA – Gruppo FS, Rome, Italy

⁽²⁾ Italian Space Agency (ASI), Rome, Italy

Landslide inventories are essential for disaster risk management, especially in the preparedness, prevention and mitigation phases, but their activity information may become outdated as slope conditions evolve. This work presents a reproducible workflow for dynamically assessing slow-moving landslides potentially affecting road corridors by integrating multi-mission Persistent Scatterer Interferometry (PSI), terrain information and existing landslide inventories.

The methodology adapts principles established by Cigna et al. (2013) and developed in subsequent PSI-based landslide studies. The implemented workflow expands this methodological basis through multi-sensor and multi-geometry observations, geometric compatibility screening, and parallel estimates of representative deformation velocity.

The developed algorithm selects, from the official regional landslide inventories, slow-kinematics landslides that fall within the road-corridor study area and assesses their suitability according to Persistent Scatterer coverage and density. For each eligible polygon, mean and peak line-of-sight velocities are derived and projected along the downslope direction. An R-index filter excludes landslides for which the satellite viewing geometry is insufficiently sensitive to the expected movement direction, preventing geometrically unobservable slopes from being incorrectly classified as inactive. Activity and intensity are then assigned using sensor-specific velocity thresholds, while agreement across independent products strengthens the identification of priority candidates for further inspection.

The workflow was tested along the SS65 “della Futa” road corridor in Tuscany using eight ascending and descending PSI products from Sentinel-1, COSMO-SkyMed and SAOCOM. The PSI data were accessed from Lot 2 Living Lab (i.e. Lot 2 IRIDE Precursor Service Segment implementation) developed by e-GEOS S.p.A. under the IRIDE Programme, i.e. the Earth Observation programme managed by the European Space Agency (ESA) with the support of the Italian Space Agency (ASI) and funded through the National Recovery and Resilience Plan (PNRR) and the National Complementary Plan (PNC). The undertaken experiment aimed to mock what technical officers from organizations in charge of road and motorway network management and maintenance could do if provided such PSI data to support their institutional activities.

The results highlight the complementary contribution of C-, X- and L-band observations, the strong influence of acquisition geometry, and the value of comparing mean- and peak-based indicators for detecting both polygon-scale and localized deformation.

The proposed approach provides a scalable framework for updating landslide inventories and translating multi-mission Earth Observation data into operational

information for road-network risk screening, field verification and monitoring prioritization.

This research was carried out during the internship of C. Lanni at the Italian Space Agency (ASI) under the supervision of D. Tapete, in the framework of the II Level Master in Space Science and Technology at the University of Rome Tor Vergata (Italy).

Poster board #12

Beyond Classical Change Detection: A COSMO-SkyMed and Machine Learning Framework for Multiscale Post-Disaster Landslide Mapping and Environmental Recovery

Gabriele Punzo ⁽¹⁾, Pietro Di Stasio ⁽¹⁾, Deodato Tapete ⁽²⁾, Silvia Liberata Ullo ⁽¹⁾

⁽¹⁾ University of Sannio, Engineering Department, Benevento, Italy

⁽²⁾ Italian Space Agency (ASI), Rome, Italy

Landslide mapping in tropical post-disaster scenarios faces severe operational bottlenecks due to persistent cloud cover and solar illumination dependencies, which frequently make optical Earth Observation (EO) datasets unsuitable during critical emergency phases.

Synthetic Aperture Radar (SAR) helps to overcome this gap, offering weather-independent imaging. However, classical multi-temporal change detection relies heavily on uninterrupted pre-event archives, which are often unavailable.

This research presents an automated, multi-modal geospatial framework designed to overcome archival constraints by detecting co-seismic landslides triggered by severe earthquakes.

The study was applied to the Magnitude 7.2 Nippes earthquake in Haiti (August 2021) using post-event-only SAR imagery coupled with geomorphological parameters. Leveraging high-resolution X-band COSMO-SkyMed (CSK) Stripmap (3 m) and Spotlight (1 m) acquisitions. The pipeline integrates Digital Elevation Model (DEM)-derived slope and aspect filters into Random Forest (RF) and Convolutional Neural Network (CNN) paradigms.

While traditional landslide mapping typically focuses on initial event detection or kinematic displacement tracking, long-term monitoring of landslide presence and

surface stabilization through vegetation regrowth is rarely addressed. For landslides in tropical environments like Haiti, the aim is the environmental recovery, assessing how rapidly the dense ecosystem naturally restores itself. Addressing this gap, this study investigates whether machine learning models trained for landslide identification can also track natural landscape recovery over time using high-resolution SAR data.

By deploying a multi-year time-series of COSMO-SkyMed Spotlight acquisitions (sampled at 6 months, 1 year, 2 years, and 3 years post-event), the framework evaluates environmental restoration by comparing traditional Amplitude Change Detection against a novel multi-temporal machine learning subtraction approach. Validated against Sentinel-2 NDVI trends, this dual capability bridges the gap between rapid emergency mapping and long-term environmental recovery monitoring.

This research was carried out during the internship of G. Punzo at the Italian Space Agency (ASI) under the supervision of D. Tapete, P. Di Stasio and S.L. Ullo in the framework of the Master's Degree in Electronics Engineering for Automation and Sensing, University of Sannio, Engineering Department, Benevento, Italy.

Poster board #13

High altitude slope instabilities: detection, monitoring and challenges

Chiara Crippa ⁽¹⁾, Mattia Callegari ⁽¹⁾, Giovanni Cuozzo ⁽¹⁾, Claudia Notarnicola ⁽¹⁾

⁽¹⁾ Eurac Research, Institute of Earth Observation

High-altitude alpine environments are among the regions most affected by climate change, where glacier retreat, permafrost degradation, and changing precipitation regimes are driving rapid geomorphological change. These interconnected processes increase the occurrence of slope instabilities, landslides, debris flows, and other cascading hazards. On glacier surfaces, debris cover modifies the surface energy balance, influencing melt rates while increasing hazards along alpine routes (Domej, 2005). Permafrost landforms, such as rock glaciers and protalus ramparts, rarely evolve into catastrophic failures but remain important sediment sources through frontal erosion. Their gradual deformation can also alter groundwater pathways, affecting spring discharge and potentially mobilizing naturally occurring heavy metals (Brighenti et al., 2026). At the catchment scale, prolonged droughts followed by intense rainfall further enhance debris-flow activity, hillslope erosion, and channel adjustment.

The remoteness and spatial extent of these processes make remote sensing essential for their detection, characterization, and long-term monitoring. Synthetic Aperture Radar (SAR) enables the detection of surface deformation and debris redistribution independently of cloud cover or daylight, while multispectral missions such as Sentinel-2, Landsat, and Planet provide high-temporal-resolution and multi-decadal observations for mapping glacier extent, snow cover, surface change, and vegetation dynamics. Integrating radar and multispectral datasets allows comprehensive monitoring of glacier evolution, slope deformation, and sediment availability across alpine catchments.

Here, we present case studies demonstrating the complementary use of SAR interferometry and multispectral image analysis to detect and monitor geomorphological changes in alpine environments. We highlight the strengths of different Earth observation datasets for investigating diverse geomorphic processes and discuss key monitoring challenges, including steep topography, adverse weather, and the spatial resolution limits of current satellite sensors, which can hinder the detection of localized processes characteristic of complex alpine landscapes.

Poster board #14

Spatio-Temporal Hazard Monitoring for Disaster Risk Management of Transport Infrastructures through Multi-Source Remote Sensing and Intelligent Data Analytics

Mattia Reale ⁽¹⁾, Simona Reale ⁽¹⁾, Silvia Liberata Ullo ⁽¹⁾

⁽¹⁾ University of Sannio, Engineering Department, Benevento, Italy

Transport infrastructures — bridges, viaducts, roads, railways, and tunnels — are critical assets exposed to increasing natural hazard (i.e. landslides, ground deformations, floods, etc.) and climate change pressures, requiring innovative approaches for continuous monitoring, risk assessment, and resilience-oriented disaster risk management.

This ongoing project proposes an integrated Earth Observation (EO) framework supporting the prevention, preparedness, and recovery phases of disaster risk management for transport infrastructure, exploiting multi-source remote sensing and intelligent data analytics. The approach integrates heterogeneous EO datasets, including Synthetic Aperture Radar (SAR) and optical satellite imagery, to characterize

both the structural condition of infrastructure assets and the environmental hazards affecting their surroundings.

SAR-based interferometric and time-series techniques will be employed for early detection of structural deformations, displacements, and anomalous behaviours in bridges and railway networks — key indicators for pre-event risk reduction. Complementary optical data will support analysis of land-cover dynamics, vegetation evolution, and surface changes contributing to infrastructure vulnerability, with particular attention to landslides, floods, ground deformation, erosion, and other hazards threatening transport networks.

Multi-temporal, multi-sensor observations will be combined with Machine Learning, Deep Learning, and AI techniques for automatic feature extraction, anomaly detection, hazard classification, and predictive risk modelling. These approaches will enable dynamic risk indicators and forecasting capabilities to anticipate critical scenarios before they affect infrastructure functionality and safety.

The expected outcome is a scalable, transferable monitoring framework supporting infrastructure managers, civil protection authorities, and decision-makers in prioritizing interventions and enhancing long-term resilience. By combining EO technologies with intelligent analytics, the project contributes to the transition from reactive to proactive, risk-informed management of transport infrastructures — offering a replicable use case for the wider disaster risk management community.

Poster board #15

Rheticus® Safeland: New Frontiers in Hydro - Geomorphological Risk Management

Anna Sblano ⁽¹⁾, Michele Antonicelli ⁽¹⁾, Marina Zingaro ⁽¹⁾, Vincenzo Laurino ⁽¹⁾, Raffaele Borrelli ⁽¹⁾, Antonello Aiello ⁽¹⁾, Khalid Tijani ⁽²⁾, Davide Oscar Nitti ⁽²⁾, Alessandro Parisi ⁽²⁾, Raffaele Nutricato ⁽²⁾, Vincenzo Massimi ⁽¹⁾

⁽¹⁾ Planetek Italia, Bari, Italy

⁽²⁾ Geophysical Applications Processing (GAP) Srl, Bari, Italy

Extreme events, increasingly frequent and intense due to climate change, contribute to environmental instability with significant impacts on infrastructure, ecosystems, and human safety. Slope instability, river dynamics, wildfires, and soil erosion often share common triggering factors, generating cascading effects that can initiate or amplify

hazards. Understanding these interactions is crucial for realistic risk assessment. In this context, territorial monitoring requires integrated, data-driven approaches. Remote sensing plays a key role by providing continuous, multi-source satellite observations. A multi-hazard perspective is essential, as surface processes are interconnected in space and time. However, integrating heterogeneous datasets remains challenging due to differences in spatial and temporal resolution, data structure, and processing methods. This work presents a tool for multi-hazard risk assessment that combines remote sensing products with ancillary data to identify areas exposed to interacting hazards. The approach is based on the subdivision of the territory into hexagonal cells, for each of which an Inspection Priority Score (IPS) is computed. The IPS integrates ground deformation data derived from persistent and distributed scatterers with hazard layers such as landslide and flood hazards and burned areas. Components are aggregated using Ordered Weighted Averaging (OWA) and then combined through linear weighting. Results from multiple study areas demonstrate good performance and potential for operational applications, confirming the capability to identify both persistent instability patterns and potentially evolving conditions. The concept has already been implemented and tested within IRIDE EOS4LPA Lot 3 services involving Champion Users from regional public administrations, metropolitan cities, and municipalities, who assessed its functionalities and validated the integrated datasets through territorial analyses and operational use cases. Their feedback confirmed the tool's ability to support the automatic prioritization of areas requiring inspection and decision-making activities, while demonstrating its operational relevance, scalability, and transferability to different public administrations and territorial contexts.

Poster board #16

DeepHail: Hail Monitoring and Nowcasting Using AI applied to geostationary satellite observations in combination with auxiliary data

Emanuela Vessichelli ^(1,2), Alessandro Sebastianelli ⁽²⁾, Ilenia Manco ⁽²⁾, Mario Raffa ⁽²⁾, Paola Mercogliano ⁽²⁾, Silvia Liberata Ullo ⁽¹⁾

⁽¹⁾ University of Sannio, Engineering Department, Benevento, Italy

⁽²⁾ CMCC Foundation - Euro-Mediterranean Center on Climate Change, Italy

Hail is one of the most impacting and destructive among the convective weather hazards, with high impacts on agriculture, urban areas, transport infrastructure, and human life. In Italy, for instance, severe hail outbreaks have almost tripled in recent years. These kinds of events are creating a serious economical and societal challenge, since they are a complex phenomenon to monitor and model. In fact, hailstorms have a short spatial and temporal extension, making them sometimes hard to catch with only observational networks. Additionally, microphysics-related aspects of hail formation are governed by highly non-linear physical processes hard to model.

To respond to this necessity, we developed DeepHail, a novel machine learning-based framework that estimates the occurrence of hail based on multi-channel geostationary satellite observations (e.g. MSG-SEVIRI), together with a digital elevation mode and auxiliary variables (e.g. day-of-year encoding).

The algorithm has two operation modalities, 1) monitoring, which estimates hail occurrence at a given point in time based on time-aligned satellite observations, and 2) nowcasting, which uses 45 minutes of satellite data to forecast the next 15 minutes. DeepHail's training data were obtained using 18 disdrometer stations from the GID network in combination with independent ESWD (European Severe Weather Dataset) data.

The results, which covered a 2-yr period, demonstrate that DeepHail provides accurate and reliable estimates of hail occurrence in Italy, performing consistently well across different validation folds. Specifically, DeepHail achieved an accuracy/F1 score of 0.91/0.90 in the monitoring mode and 0.89/0.89 in the nowcasting mode. When using a 5-fold cross-validation procedure, the results remained consistent, with an accuracy/F1 score across all five folds ranging from 0.88 to 0.90 for monitoring and from 0.88 to 0.90 for nowcasting.

Given that, DeepHail can be considered a promising candidate for operational use, informing rapid response to hail events. When combined with exposure and vulnerability information, these estimates can be used to prioritize areas under threat of hailstorms, as well as facilitate rapid impact assessment in support of disaster recovery.

Poster board #17

Large-scale delineation of flood prone areas and risk estimation: Results from the RESCUE_SAT project

Elena Volpi ⁽¹⁾, Stefano Cipollini ⁽¹⁾, Luciano Pavesi ⁽¹⁾, Valerio Gagliardi ⁽¹⁾, Giorgia Sanvitale ^(1,2), Irene Pomarico ⁽¹⁾, Deodato Tapete ⁽³⁾, Maria Virelli ⁽³⁾, Patrizia Sacco ⁽³⁾, Alessandro Ursi ⁽³⁾, Andrea Benedetto ⁽¹⁾, Aldo Fiori ⁽¹⁾

⁽¹⁾ Department of Civil, Computer Science and Aeronautical Technologies Engineering, Roma Tre University, Rome, Italy

⁽²⁾ Department of Civil, Building and Environmental Engineering, University La Sapienza, Rome, Italy

⁽³⁾ Italian Space Agency (ASI), Rome, Italy

Flood risk assessment at large spatial scales remains challenging, despite recent advances in hydrology and hydrodynamic modelling that have improved the representation of flood hazards—from empirical methods to sophisticated simulations. Yet, flood hazard estimates still carry substantial uncertainty. In this context, simple and computationally efficient large scale models are essential for parametric uncertainty analyses. The geomorphologic–hydrologic–hydraulic framework RESCUE (laRgE SScale inUndation model) addresses this need by combining a geomorphology based river network with simplified hydrological and hydraulic formulations to estimate water levels and inundation extents probabilistically.

However, RESCUE’s performance is limited by the availability of high resolution topographic data and spatially consistent information on hydraulic infrastructures (levees, bridges, dams), which are not yet explicitly represented. Overcoming this limitation is the goal of RESCUE_SAT (Agreement n. 2025 2 HB.0), funded by the Italian Space Agency (ASI) under the “Innovation for Downstream Preparation for Science” (I4DP_SCIENCE) program. RESCUE_SAT extends the large scale inundation model by integrating high resolution spatial and spectral Earth Observation data—specifically

COSMO-SkyMed SAR imagery and PRISMA hyperspectral data—to produce enhanced Digital Elevation Models and land cover maps with improved spectral class separability.

The workflow transforms interferometric COSMO-SkyMed DEMs into hydrologically consistent DTMs using supervised deep learning, merges them with national high resolution DTMs, resamples them to a computationally efficient 10 m grid, and applies hydrological conditioning to derive reliable flow directions, flow accumulations, and drainage networks. Results show significant improvements in river connectivity and contributing areas, especially in low relief coastal zones where topographic errors strongly affect flood modelling. Moreover, RESCUE_SAT incorporates distributed and local hydraulic controls (levees, bridges) through modified stage–discharge relationships while preserving basin topology. Finally, PRISMA land cover maps will support risk estimation by linking hazard maps with vulnerability curves.

Poster board #18

On-board flood segmentation under edge constraints: automated architecture search and quantization

Alessandro Togni ⁽¹⁾, Matteo Maragliano ^(1,2), Debhora Bonfiglio ^(1,3), Davide Carletto ^(1,4), Stefano Marangoni ⁽¹⁾, Lia Morra ⁽⁴⁾, Tatiana Tommasi ⁽⁴⁾, Nicoletta De Palma ⁽⁴⁾, Alvisè Ferrari ⁽⁵⁾, Lorenzo Manunza ⁽⁵⁾, Martina Frezza ⁽⁵⁾, Paolo Soresina ⁽⁵⁾, Chiara Clementini ⁽⁵⁾, Giovanna Chiara Rodi ⁽¹⁾, Tanya Scalia ⁽⁶⁾, Angelo Ciminelli ⁽⁶⁾

⁽¹⁾ aizoOn Technology & Consulting, Torino, Italy

⁽²⁾ Università di Genova, Dipartimento di Ingegneria Navale, Elettrica, Elettronica e delle Telecomunicazioni (DITEN), Genova, Italy

⁽³⁾ Università degli Studi di Torino, Dipartimento di Matematica, Torino, Italy

⁽⁴⁾ Politecnico di Torino, Dipartimento di Automatica e Informatica (DAUIN), Torino, Italy

⁽⁵⁾ GMATICS S.r.l., Rome, Italy

⁽⁶⁾ Italian Space Agency (ASI), Rome, Italy

The operational value of Earth Observation data during flood emergencies largely depends on the end-to-end latency of the acquisition, transmission, and processing chain. Generating segmentation masks on board reduces the volume of data to be

downlinked but requires the model and inference pipeline to operate within edge-computing constraints.

The AI4SEC project targets on-board processing across two Earth observation use-cases, among which flood detection, leveraging neural network models trained on public multispectral datasets for semantic segmentation of flooded areas.

To identify the best-performing architectures under on-board computational constraints, a genetic algorithm evolves a population of U-Nets encoded as a token-based genotype. Candidates are ranked by the multi-objective criterion of NSGA-II on water-class IoU and computational cost, while the parameter budget acts as a constraint rather than as a further objective. Zero-cost proxies discard the least promising candidates before training.

Architectural compactness is complemented by weight quantization, in both post-training and quantization-aware forms, which reduces the memory footprint fourfold and enables integer arithmetic on edge CPUs. The conversion chain is verified end-to-end, and ONNX export preserves hardware neutrality: the same model can be deployed on different edge backends.

This compactness has a physical basis: water/land discrimination in multispectral imagery is largely a spectral, low-dimensional problem, almost separable through band ratios such as MNDWI, built on B3 and B11, suggesting that the task may be effectively addressed using relatively compact architectures.

Tests to date verify feasibility and framework correctness; a systematic comparison with the state of the art is ongoing. Preliminary results indicate architectures with substantially fewer parameters than the reference U-Net (Portalés-Julià et al., 2023), with accuracy of the same order and no appreciable loss from quantization.

This work has been supported by the Italian Space Agency under the "Artificial Intelligence for Satellite Edge Computing – AI4SEC" contract (No. 2025-41.I.O).

Poster board #19

From Orbit to Action: AquaCubeAI for Onboard Coastal Water-Quality Alerts and Disaster Risk Management

Francesca Razzano ^(1,2), Pietro Di Stasio ^(2,3), Elisa Liparulo ⁽²⁾, Gabriele Meoni ^(4,5), Nicolas Longépé ⁽⁴⁾, Deodato Tapete ⁽³⁾, Paolo Gamba ⁽⁶⁾, Gilda Schirinzi ⁽¹⁾, Silvia Liberata Ullo ⁽²⁾

⁽¹⁾ University of Naples 'Parthenope', Engineering Department, Naples, Italy

⁽²⁾ University of Sannio, Engineering Department, Benevento, Italy

⁽³⁾ Italian Space Agency (ASI), Via del Politecnico, Roma, Italy

⁽⁴⁾ Φ -lab, European Space Agency (ESA), Frascati, Italy

⁽⁵⁾ Advanced Concepts and Studies Office, European Space Agency (ESA), Frascati, Italy

⁽⁶⁾ University of Pavia, Department of Electrical, Computer and Biomedical Engineering, Pavia, Italy

When a flood, landslide, sediment pulse, or accidental discharge occurs, one of the most immediate consequences, beyond casualties and physical damage, is the degradation of water quality, with potential impacts on drinking-water safety and essential coastal activities. The first satellite imagery may already contain the information needed to recognize the emerging plume or contamination event in the waters. Yet, in conventional Earth Observation chains, that information remains locked in the data until the next ground-station contact, downlink, and terrestrial processing are completed. For rapidly evolving emergencies, this latency can separate timely action, such as targeted sampling, from delayed awareness.

This contribution presents AquaCubeAI, a lightweight onboard artificial-intelligence framework designed to turn multispectral observations into actionable water-quality information directly in orbit. The work evolves from an initial proof of concept over the Ligurian coast, where turbidity and pH were estimated from simulated Φ sat-2 data, toward a scalable multi-region system focused on turbidity monitoring across the Mediterranean Sea, Black Sea, Iberian coast, and North-West Shelf.

AquaCubeAI combines simulated Φ sat-2 imagery with Copernicus Marine Service high-resolution turbidity products. A leakage-aware spatial block split is adopted to evaluate geographic generalization realistically, while a compact regression model is reformulated for dense prediction, producing both turbidity maps and threshold-based anomaly masks. These lightweight products can be prioritized for downlink, allowing the satellite to transmit where and when attention is most needed instead of routinely sending complete scenes.

The selected model achieved $R^2 = 0.995$ and RMSE = 2.78 FNU over turbidity values up to 140 FNU, while reducing the parameter count to approximately 401,000. Deployment on the flight-proven Intel Myriad 2 processor demonstrated an average inference latency of 8.51 ms per patch. In conclusion, AquaCubeAI offers a pathway toward lower-latency support for coastal pollution events and flood-driven water-quality emergencies.

Poster board #20

TALOS: An End-to-End AI Framework for Operational SAR Oil Spill Monitoring

Vito Moliterni ⁽¹⁾, Andrea Cavallini ⁽¹⁾, Salvatore Prochilo ⁽¹⁾

⁽¹⁾Starion Group Italia S.p.A., Frascati, Italy

Marine oil spills are among the most critical environmental emergencies, requiring rapid and reliable Earth Observation (EO) services to support timely response, environmental protection and damage assessment. While recent advances in Artificial Intelligence (AI) have significantly improved individual EO capabilities, most existing approaches remain focused on isolated tasks, such as image classification or semantic segmentation. Operational monitoring, however, requires complete processing workflows capable of automatically transforming Synthetic Aperture Radar (SAR) imagery into structured and actionable information.

This work presents TALOS, a modular end-to-end AI framework designed to automate the complete SAR oil spill monitoring workflow, from data preparation to scene-level analysis. The framework combines specialized AI modules within a unified processing chain, including AI-based SAR denoising, AI-based binary oil/non-oil classification, AI-based semantic segmentation, scene reconstruction, connected oil slick extraction and quantitative geospatial analysis, enabling a fully AI-driven operational workflow.

To maximize the effectiveness of the downstream AI modules, different SAR representations were systematically evaluated during the framework development. The analysis demonstrated that the optimal representation depends on the specific AI task: dual-polarization imagery provides the highest classification performance, whereas AI-denoised single-polarization imagery achieves the most accurate oil spill delineation. These findings directly guided the configuration of the final processing chain.

Beyond automatic detection, TALOS transforms pixel-level predictions into meaningful scene-level information by automatically identifying individual oil slicks and generating quantitative analytics, including spatial extent, geometry, morphology, confidence indicators and scenario-based oil quantity estimates, together with structured metadata and interactive visualization for rapid inspection and reporting.

The framework has already been evaluated on selected real-world oil spill events, including preliminary assessments on historical International Charter activations.

Future work will extend this validation to a broader set of Charter cases, providing representative operational scenarios for assessing the robustness, generalization and potential integration of TALOS within AI-enabled EO services for marine pollution response.

Poster board #21

Earth Observation for Disaster Risk Management: Monitoring Coastal Erosion on Ko Phi Phi Don, Thailand, Using Multi-Temporal Satellite Imagery

Sara Aharon ⁽¹⁾

⁽¹⁾ Alexandru Ioan Cuza University of Iași (UAIC), Faculty of Geography and Geology (FGG), Department of Geography, Iași, Romania

Coastal erosion represents a growing natural hazard for tropical islands, threatening infrastructure, ecosystems, tourism-dependent economies, and coastal communities. Continuous monitoring of shoreline dynamics is essential for supporting disaster risk reduction and sustainable coastal management. This study presents a twenty-year assessment (2004–2024) of shoreline change on Ko Phi Phi Don, Thailand, using freely available Earth Observation data processed in Google Earth Engine and Geographic Information Systems (GIS).

Multi-temporal Landsat and Sentinel-2 imagery were analysed using the Normalized Difference Water Index (NDWI) to extract shoreline positions and quantify patterns of erosion and accretion. Spatial analyses identified significant shoreline retreat along the western, north-eastern, and south-western coasts, while only limited localized accretion was observed. Overall, approximately 1.01 km² of coastal land experienced erosion compared with only 0.25 km² of shoreline advance, indicating a clear net trend toward coastal retreat. These erosion hotspots coincide with areas of intensive tourism development, suggesting that anthropogenic pressures may increase the vulnerability of already dynamic coastal environments.

The study demonstrates how freely available satellite imagery and cloud-based processing platforms can provide cost-effective, reproducible, and scalable tools for long-term coastal hazard monitoring. The results highlight the value of Earth Observation for identifying vulnerable coastal sectors, supporting evidence-based planning, and informing disaster risk management strategies in tropical island environments. The presented workflow is transferable to other coastal regions and

illustrates the potential of operational Earth Observation services to strengthen resilience against coastal hazards under increasing environmental and climate-related pressures.

Poster board #22

A novel approach for estimating water level changes through SAR amplitude data

Lorenza Ranaldi ⁽¹⁾, Valeria Belloni ⁽¹⁾, Andrea Nascetti ⁽²⁾, Mattia Crespi ^(1,3)

⁽¹⁾ Geodesy and Geomatics Division, Sapienza University of Rome, Rome, Italy

⁽²⁾ Division of Geoinformatics, KTH Royal Institute of Technology, Stockholm, Sweden

⁽³⁾ Sapienza School for Advanced Studies, Sapienza University of Rome, Rome, Italy

Traditional in situ monitoring of water resources is often limited to large basins, making remote sensing an essential alternative for smaller water bodies. At this stage, satellite altimetry faces spatial resolution constraints, while current SAR techniques have limitations: interferometry is restricted by phase unwrapping, and amplitude-based methods require highly accurate Digital Elevation Models (DEMs).

This research introduces an innovative approach to estimate water level changes using SAR amplitude data, requiring approximate morphological information. The method assumes that the horizontal displacement of the shoreline and the water level change are geometrically linked by the local coastal slope, which is approximated as a plane. From the satellite's perspective, this variation is detected as a change in the sensor-to-target distance. By combining this distance with geometric parameters (e.g. satellite azimuth, SAR local incidence angle, coastal aspect), an observation equation is formulated that links the unknown water level change to the measured distance.

The model employs an image-matching technique on coregistered SAR images to detect shoreline displacements. Subsequently, a least squares algorithm processes these displacements to estimate both the water level changes between epochs and the local slope.

The method was tested using Sentinel-1 SLC data. At Lake Trasimeno (2022–2024), comparisons with in situ data demonstrated an accuracy of 7 cm and an NMAD of 4 cm. At Lake Monterosi (2024–2025), a small basin with no measuring stations, the results showed a good agreement with precipitation and temperature trends. Further tests using higher-resolution data are currently under development.

This work was supported by the “Geomatics for Resilience Against Water scarcity” (GRAW) project under Grant 2023-1-HB.0 funded by the Italian Space Agency (ASI) in the framework of the “Innovation for Downstream Preparation for Science” (I4DP_SCIENCE) program.

Poster board #23

Harvesting Heat: Agricultural Cycles as Hidden Drivers of Heat Risk

Davoud Omarzadeh ⁽¹⁾, Estefania Blanch ⁽¹⁾, Daniel Sors Raurell ⁽¹⁾

⁽¹⁾ Institute of Space Studies of Catalonia (IEEC), Area for the Promotion of the Space Sector of Catalonia, Castelldefels (Barcelona), Spain

Extreme heat is the deadliest weather-related hazard globally, yet the role of agricultural land management, specifically post-harvest transitions from dense vegetative canopies to exposed bare soil, in amplifying urban heat exposure remains critically unquantified in disaster risk management (DRM) frameworks.

This study investigates Land Surface Temperature (LST) dynamics before and after the annual harvest season across seven consecutive years (2020–2026) at the interface between an agricultural plain and the city of Lleida, Catalonia, Spain. Framing the analysis explicitly within the Sendai Framework for Disaster Risk Reduction 2015–2030¹, we utilize open-access Landsat 8/9 Collection 2 Level 2 surface temperature products alongside Sentinel-2 Level-2A surface reflectance imagery to derive LST, Normalized Difference Vegetation Index (NDVI), Normalized Difference Moisture Index (NDMI), and Short-Wave Infrared (SWIR) reflectance at a co-registered 20-meter spatial resolution. Across all seven years, post-harvest mean city LST consistently exceeded pre-harvest baselines by 16.4°C to 38.1°C, surpassing local emergency thermal risk thresholds in every year evaluated. Strong, spatially co-registered pixel-wise correlations between LST and NDMI (mean $r \approx -0.74$) and LST and NDVI (mean $r \sim -0.70$), along with positive correlations with SWIR (mean $r \approx +0.74$), confirm that rapid loss of canopy moisture and soil evapotranspiration drives severe microclimatic heating beyond natural background summer warming.

Since agricultural harvest dates follow highly predictable calendar windows, this phenomenon represents a unique class of predictable spatial hazards. We demonstrate how integrating satellite-tracked agricultural phenology into urban early

¹ The Sendai Framework for Disaster Risk Reduction 2015-2030 is a 15-year international agreement adopted by UN Member States on March 18, 2015. It aims to prevent new risks, reduce existing disaster losses, and build socioeconomic resilience across natural, technological, and biological hazards [\[Link\]](#).

warning systems and spatial planning directly advances Sendai Framework Priorities 1 and 4.

Introduction

Extreme heat is among significant weather-related natural hazards globally, responsible for more human fatalities annually than floods, storms, or earthquakes in many temperate and semi-arid regions (Oke, 1982; IPCC, 2022). The 2003 European heatwave alone caused more than 70,000 excess deaths (Robine et al., 2008), and global climate projections indicate that the frequency, intensity, and duration of extreme thermal events will continue to escalate under all future emissions scenarios (IPCC, 2022). In response, the Sendai Framework for Disaster Risk Reduction 2015–2030 explicitly identifies extreme thermal events as a priority hazard and calls for enhanced risk assessment, early warning capabilities, and spatial governance to mitigate heat exposure (UNDRR., 2015; Aitsi-Selmi et al., 2021). However, extreme heat remains systematically under-represented in national disaster risk management (DRM) frameworks compared to rapid-onset hydro-meteorological hazards such as flash floods or tropical cyclones (Berrang-Ford et al., 2021; Campbell et al., 2018).

The Urban Heat Island (UHI) effect, wherein built environments exhibit persistently higher temperatures than surrounding rural landscapes, is a well-established driver of urban heat vulnerability (Oke, 1982; Voogt & Oke, 2003; Imhoff et al., 2010). Broad remote sensing literature has extensively documented how urban impervious surfaces alter surface radiative balance, energy partitioning, and local atmospheric dynamics (Peng et al., 2012; Zhou et al., 2019; Zhao et al., 2014). Yet, while urban core properties are widely studied, the thermal dynamics occurring at the peri-urban and agricultural fringe have received disproportionately little attention in both thermal remote sensing and DRM policy (Berrang-Ford et al., 2021; Peng et al., 2012; Zhang et al., 2010). This oversight represents a critical gap. Globally, hundreds of medium and large cities are embedded within extensive agricultural basins where seasonal land management practices abruptly alter land surface characteristics across thousands of hectares adjacent to high-density populations.

In agricultural systems dominated by winter cereals or seasonal cash crops, the annual harvest marks an extreme biophysical transition. Prior to harvest, dense vegetative canopies maintain low surface temperatures through shading and robust rates of evapotranspiration, the dominant latent heat flux mechanism transferring energy from the terrestrial surface to the atmosphere as water vapor (Kustas & Norman, 1996; Kalnay & Cai, 2003). Following harvest, the rapid removal of vegetation exposes dry, unshaded soil and crop residue. This sudden transition severely reduces latent heat

flux, increases sensible heat flux, intervenes in surface albedo, and results in a rapid surge in Land Surface Temperature (LST) (Peng et al., Kustas & Norman, 1996; Zhang et al., 2009).

From a disaster risk perspective, the critical paradigm shift lies in recognizing that post-harvest thermal surges are not accidental, unpredictable weather events. Instead, they represent predictable spatial hazards tied directly to local agricultural calendars and phenology. Because crop maturity and harvest dates can be anticipated weeks in advance, the resulting spatial heat footprint can be integrated into proactive disaster preparedness and public health intervention frameworks, a temporal advantage rarely available for other natural hazards.

Satellite remote sensing provides the necessary spatial and temporal capabilities to monitor these fine-scale surface transitions (Voogt & Oke, 2003; Wan, 2014). Instruments such as the Landsat 8/9 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) deliver 30-meter thermal retrievals optimal for evaluating field and neighborhood-level temperature variations (Roy et al., 2014). Concurrently, European Space Agency (ESA) Sentinel-2 Multispectral Instrument (MSI) data provide high-resolution spectral indices, including the Normalized Difference Vegetation Index (NDVI) and Normalized Difference Moisture Index (NDMI) (Strashok et al., 2022; Gao, 1996). Cloud computing platforms like Google Earth Engine (GEE) further enable multi-year, open-access, and globally reproducible spatiotemporal processing across these large Earth observation data streams (Feizizadeh et al., 2023, Omarzadeh et al., 2021).

Despite growing recognition of urban-rural thermal interactions, multi-year empirical studies that quantitatively link agricultural harvest transitions to urban heat exposure within an explicit DRM and Sendai Framework context remain scarce. To address this gap, this study investigates the multi-year (2020–2026) pre- and post-harvest thermal dynamics around the city of Lleida, Spain as a representative Mediterranean city embedded within an intensive agricultural plain.

The specific objectives of this study are:

- **Quantify LST Surges:** Evaluate the magnitude and inter-annual variability of LST change in the peri-urban agricultural matrix before and after harvest across seven consecutive years (2020–2026).
- **Identify Thermodynamic Drivers:** Conduct co-registered, pixel-wise correlation analyses between LST and multi-spectral indicators of canopy density (NDVI), surface moisture (NDMI), and bare soil exposure (SWIR) to isolate the biophysical drivers of heating.

- **Assess Urban Exposure:** Measure city-level thermal exposure relative to local emergency public health risk thresholds.
- **Advance DRM Practice:** Translate empirical satellite observations into actionable early warning and spatial governance recommendations aligned with Sendai Framework Priorities 1 and 4.

Study Area

The study area is centered on the city of **Lleida** and its surrounding agricultural hinterland, located in the western region of Catalonia ([Figure 1](#)). Lleida is a mid-sized European city with a municipal population of approximately 140,000 residents. The urban area is situated in the central depression of the Ebro River basin, sitting along the Segre River at an average elevation of 150 meters above sea level.

The surrounding plain (the Pla de Lleida) is one of Spain's most intensive agricultural hubs. The agricultural landscape is dominated by winter cereal crops, primarily barley (*Hordeum vulgare*) and wheat (*Triticum aestivum*), interspersed with irrigated fruit orchards. Winter cereals follow a strict annual phenological cycle: sowing occurs between October and December, rapid vegetative growth and canopy closure peak between April and May, and harvest takes place rapidly between late June and mid-July. This phenological sequence causes an abrupt, spatially broad transformation from dense green canopies (high NDVI, high evapotranspiration) to fully exposed bare soil and crop stubble across thousands of contiguous hectares adjacent to the urban fringe ([Kalnay and Cai, 2003](#)).

Climatically, the region falls under a **semi-arid Mediterranean climate** ([Köppen-Geiger, 2006](#); [Martinez et al., 2008](#)), characterized by hot, dry summers and low annual precipitation. Summer maximum air temperatures frequently exceed 35°C during synoptic heatwaves, creating elevated baseline thermal stress for urban residents (WHO, 2023; IPCC, 2022). The region's low cloud cover during summer months ensures high thermal infrared clarity for satellite remote sensing acquisitions ([Roy et al., 2014](#); [Wan, 2014](#)).

From a DRM perspective, Lleida serves as an ideal representative benchmark. Hundreds of small to medium-sized cities globally, across the Po Valley (Italy), the Ebro Basin (Spain), the Central Valley (USA), the Indo-Gangetic Plain (India), and the Nile Basin (Egypt), share this similar urban-agricultural layout where post-harvest land management directly borders vulnerable urban populations ([Peng et al., 2012](#); [Zhou et al., 2019](#)).

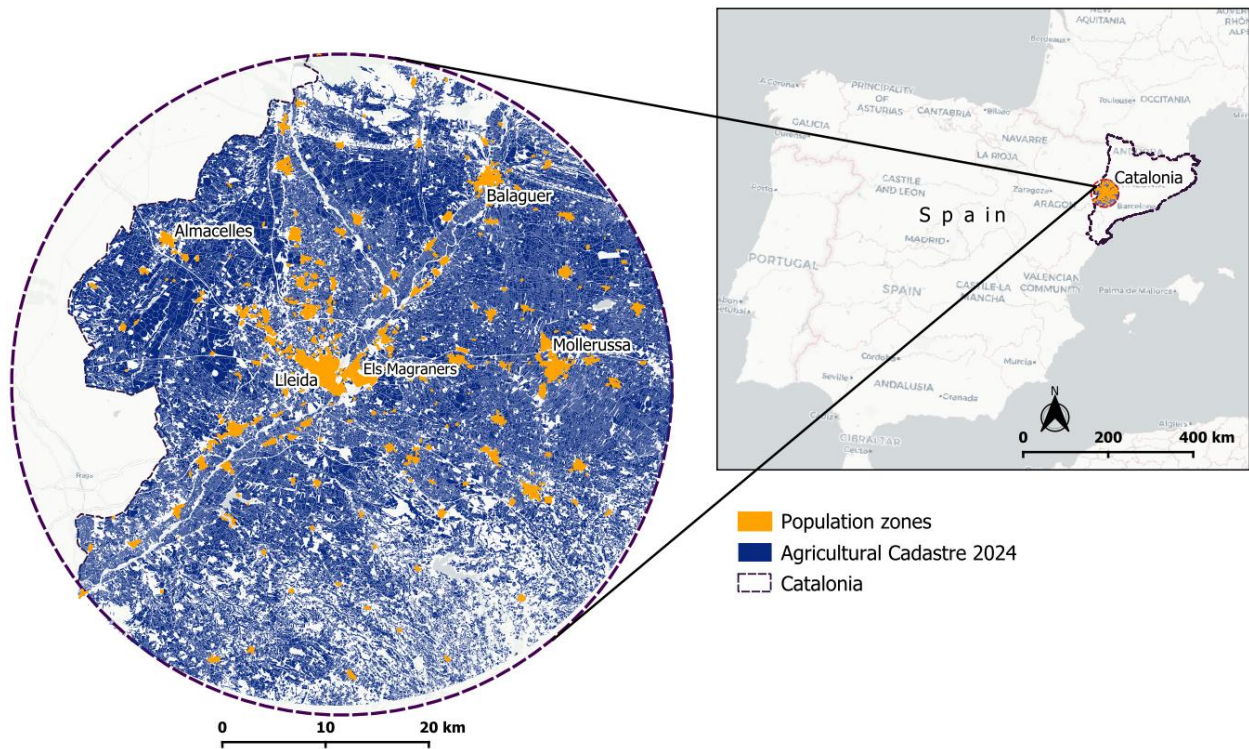


Figure 1. Study area

Methodology

To capture the biophysical conditions before and after the annual harvest, a multi-sensor dataset spanning seven consecutive years (2020–2026) was constructed using open-access Earth Observation data.

Landsat 8 and 9 Collection 2 Level 2 Surface Temperature products were acquired via USGS EarthExplorer and Google Earth Engine (Gorelick et al., 2017; Roy et al., 2014). Atmospheric corrections were performed using the USGS internal algorithm based on MODIS atmospheric profiles and the MODTRAN radiative transfer model (Wan, 2014). Scenes were selected for two distinct phenological windows each year:

- **Pre-Harvest (Vegetated Baseline):** Late April to mid-May (peak canopy cover and maximum evapotranspiration).
- **Post-Harvest (Bare Soil Transition):** Early July to late July (complete vegetative removal).

To derive high-resolution vegetation and canopy moisture metrics, European Space Agency (ESA) Sentinel-2 Level-2A (MSI) Surface Reflectance imagery co-located within ± 5 days of the Landsat acquisitions was ingested (Lastovicka et al., 2020).

Land Surface Temperature (LST) Calculation

Digital numbers from Landsat Thermal Infrared Sensor Band 10 (ST_B10) were converted to physical units of Land Surface Temperature (LST , in °C) using the official USGS Collection 2 linear transformation parameters (Roy et al., 2014; Wan, 2014):

$$LST = (DN_{ST_B10} \times 0.00341802 + 149.0) - 273.15$$

where DN_{ST_B10} is the raw digital number of the thermal band, 0.00341802 is the multiplicative scale factor, 149.0 is the additive offset factor, and 273.15 converts absolute temperature from Kelvin to Celsius.

Spectral Index Computation

Three complementary optical indices were derived from Sentinel-2 Surface Reflectance (ρ) bands:

1. **Normalized Difference Vegetation Index (NDVI):** Quantifies canopy greenness using Red (ρ_{B4} , 665 nm) and Near-Infrared (ρ_{B8} , 842 nm) reflectance (Gao, 1996):

$$NDVI = \frac{\rho_{B8} - \rho_{B4}}{\rho_{B8} + \rho_{B4}}$$

2. **Normalized Difference Moisture Index (NDMI):** Measures canopy liquid water content by contrasting Near-Infrared (ρ_{B8}) with Short-Wave Infrared 1 (ρ_{B11} , 1610 nm) (Gao, 1996):

$$NDMI = \frac{\rho_{B8} - \rho_{B11}}{\rho_{B8} + \rho_{B11}}$$

3. **Short-Wave Infrared Reflectance (SWIR-2):** Serves as a direct proxy for exposed dry bare soil and crop residue abundance using Band 12 (ρ_{B12} , 2190 nm) (Zhang et al., 2009).

Because Sentinel-2 spectral indices are produced at native 10 m resolution, while Landsat thermal retrievals are resampled to 30 m spatial resolution, spatial harmonization was necessary to perform valid pixel-by-pixel comparisons. All Sentinel-2 derived rasters were reprojected onto the Landsat reference grid (UTM Zone 31N, WGS84 Datum) at a uniform 30 m pixel spacing using bilinear spatial interpolation.

Statistical Analysis and Thermal Drivers

To isolate the biophysical factors governing the post-harvest heat surge, bivariate Pearson correlation coefficients (r) were computed across all the study domain:

$$r_{x,y} = \frac{\sum_{i=1}^n (x_i - \bar{x}) (y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2 \sum_{i=1}^n (y_i - \bar{y})^2}}$$

where x_i represents the target Land Surface Temperature (LST), y_i represents the co-registered biophysical spectral index ($NDVI$, $NDMI$, or $SWIR$), and $\bar{x}$ and $\bar{y}$ denote their respective spatial means across all valid pixels.

Disaster Risk Management (DRM) Integration Framework

To translate thermal remote sensing measurements into actionable disaster risk intelligence aligned with the Sendai Framework for Disaster Risk Reduction 2015–2030 ([UNDRR, 2015](#)), post-harvest LST values were cross-referenced against regional public health emergency thresholds:

Moderate Thermal Stress: $LST \geq 35^\circ\text{C}$

Severe Heat Warning: $LST \geq 40^\circ\text{C}$

Extreme Thermal Hazard: $LST \geq 45^\circ\text{C}$

Results

The spatial maps consistently reveal a coherent and physically interpretable pattern of land surface change across all years studied ([Figure 2 1 to 7](#)). In the pre-harvest period, the agricultural zone surrounding the city was characterized by dense, spatially extensive green canopy cover, reflected in high $NDVI$ values that dominate the landscape. This vegetated state is mirrored in the $NDMI$ maps, which show broadly positive moisture values across the same agricultural parcels, confirming that canopy water content is high during the growing season. Correspondingly, $SWIR$ reflectance remains low and spatially homogeneous before harvest, consistent with the strong absorption of shortwave infrared radiation by moist, healthy vegetation. Pre-harvest LST follows the same spatial logic, with the agricultural zone exhibiting relatively cool surface temperatures and only the urban core of Lleida standing out as a marginally warmer patch against the surrounding vegetated landscape.

Following harvest, every variable undergoes a striking and spatially coherent reversal that is visually unambiguous across all seven years of the study period. $NDVI$ collapses across the agricultural parcels, with the dense green canopy replaced by sparse, fragmented green patches concentrated in irrigation canals, orchards, and un-harvested remnants, the contrast between pre and post-harvest $NDVI$ is among the most visually compelling features of the maps and requires no statistical analysis to perceive. $NDMI$ follows $NDVI$ closely in both spatial pattern and direction of change showing the high-moisture agricultural zone transitions to predominantly dry, low-moisture values after harvest, making $NDMI$ effectively a spatial mirror of the $NDVI$ signal throughout the study period. $SWIR$ reflectance behaves as the inverse of $NDMI$, increasing markedly across the harvested zone as dry soil and cereal residue replace

moist green canopy, the spatial alignment between SWIR increase and NDMI decrease is tight and consistent across all years, confirming that the two indices are measuring opposite ends of the same vegetation-moisture continuum at the landscape scale.

LST tells the same story from a thermal perspective. The post-harvest LST maps show a dramatic and spatially extensive increase across the agricultural zone in every single year studied, with the heating pattern aligning almost precisely with the areas of greatest NDVI and NDMI decline and greatest SWIR increase. The correspondence between LST and SWIR is particularly striking in the spatial maps, the two variables track each other consistently year after year, with the warmest pixels coinciding with the highest SWIR reflectance values and the lowest vegetation/moisture index values. This spatial alignment is not a statistical abstraction; it is directly visible in the maps as a coherent, landscape-scale pattern repeated reliably across the entire study period, providing strong visual corroboration of the pixel-wise correlation analysis and underpinning the central argument that harvest-driven vegetation and moisture loss is the primary spatial driver of post-harvest surface heating in the study area.

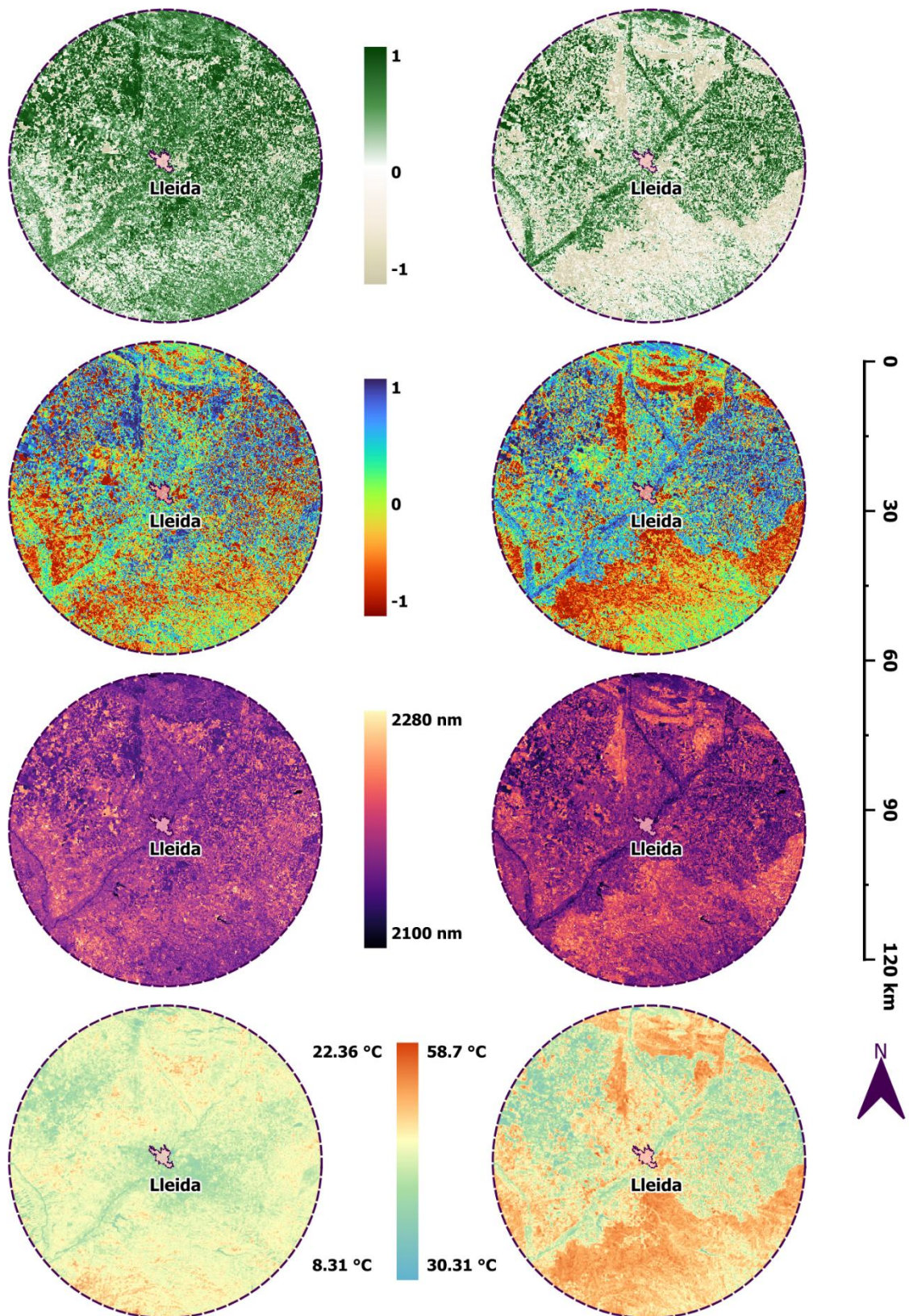


Figure 2.1. 2020

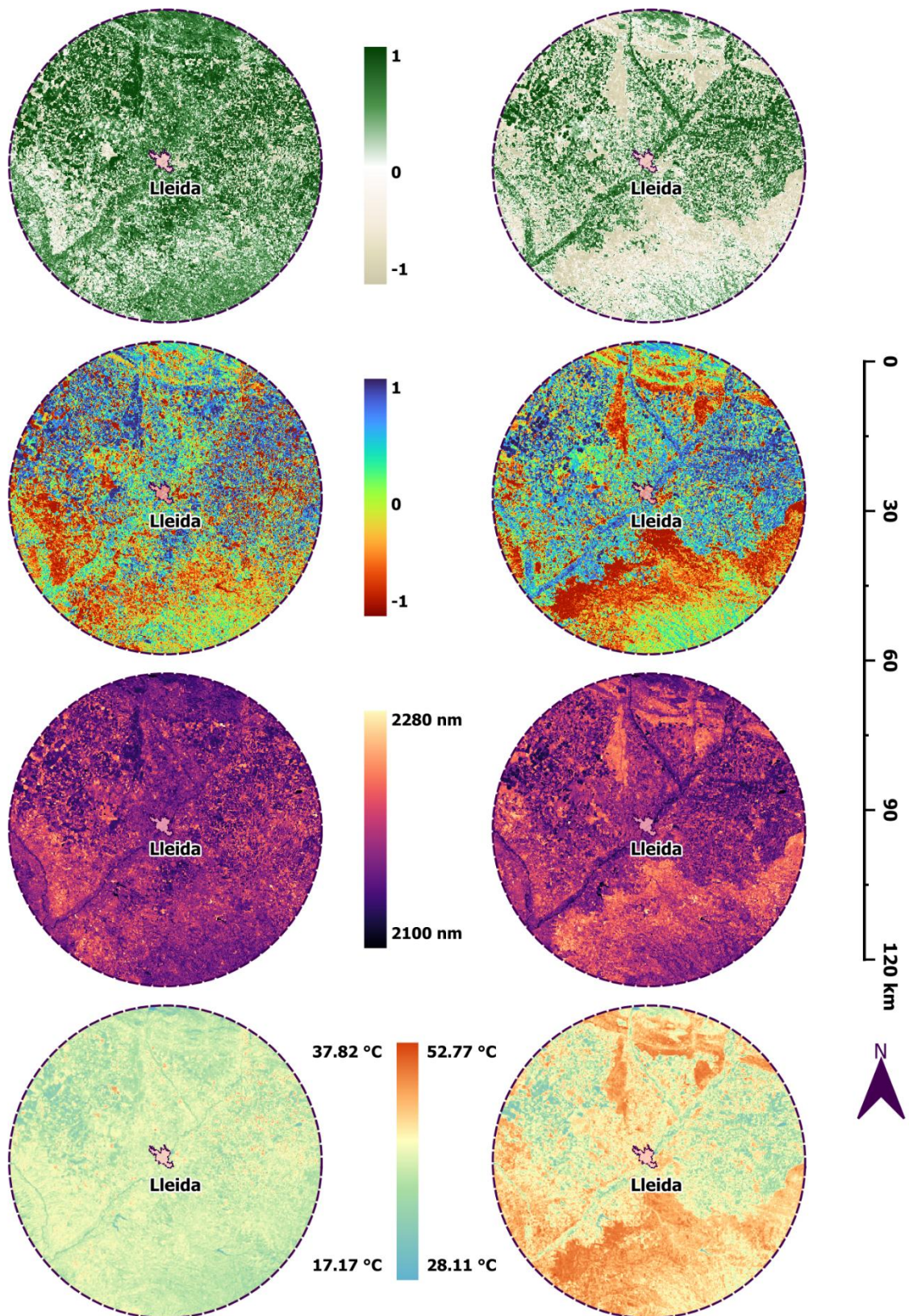


Figure 2.2. 2021

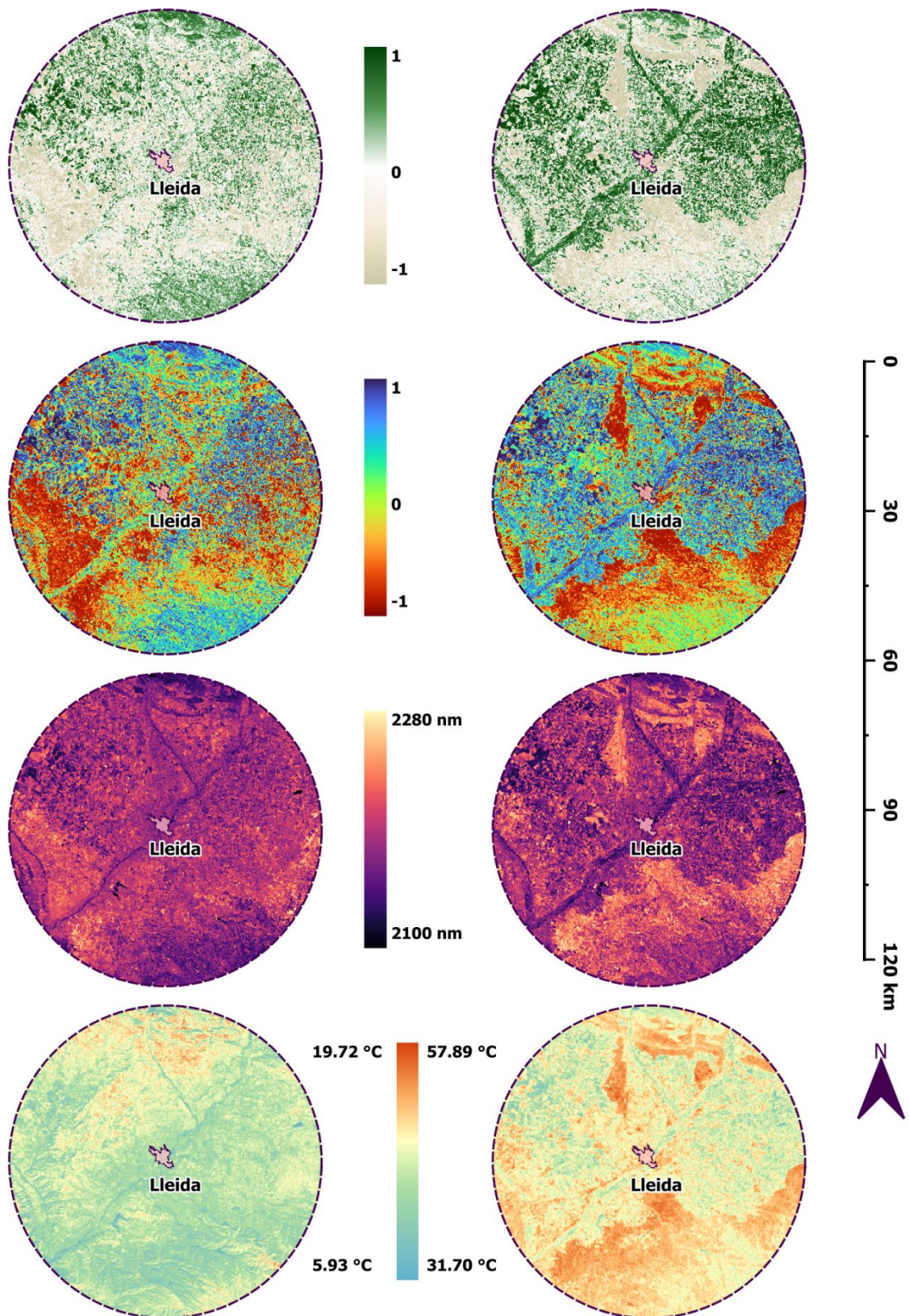


Figure 2.3. 2022

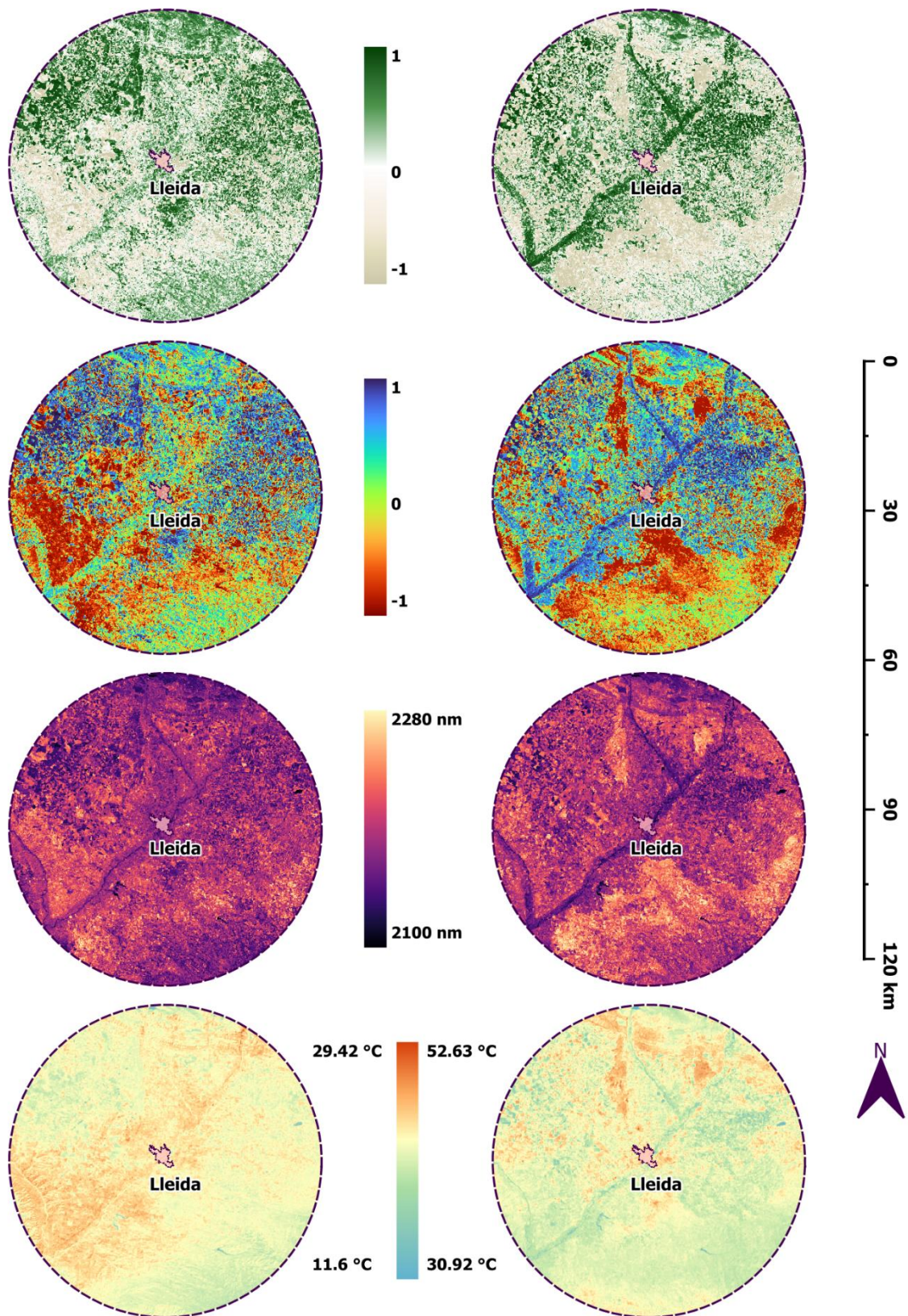


Figure 2.4. 2023

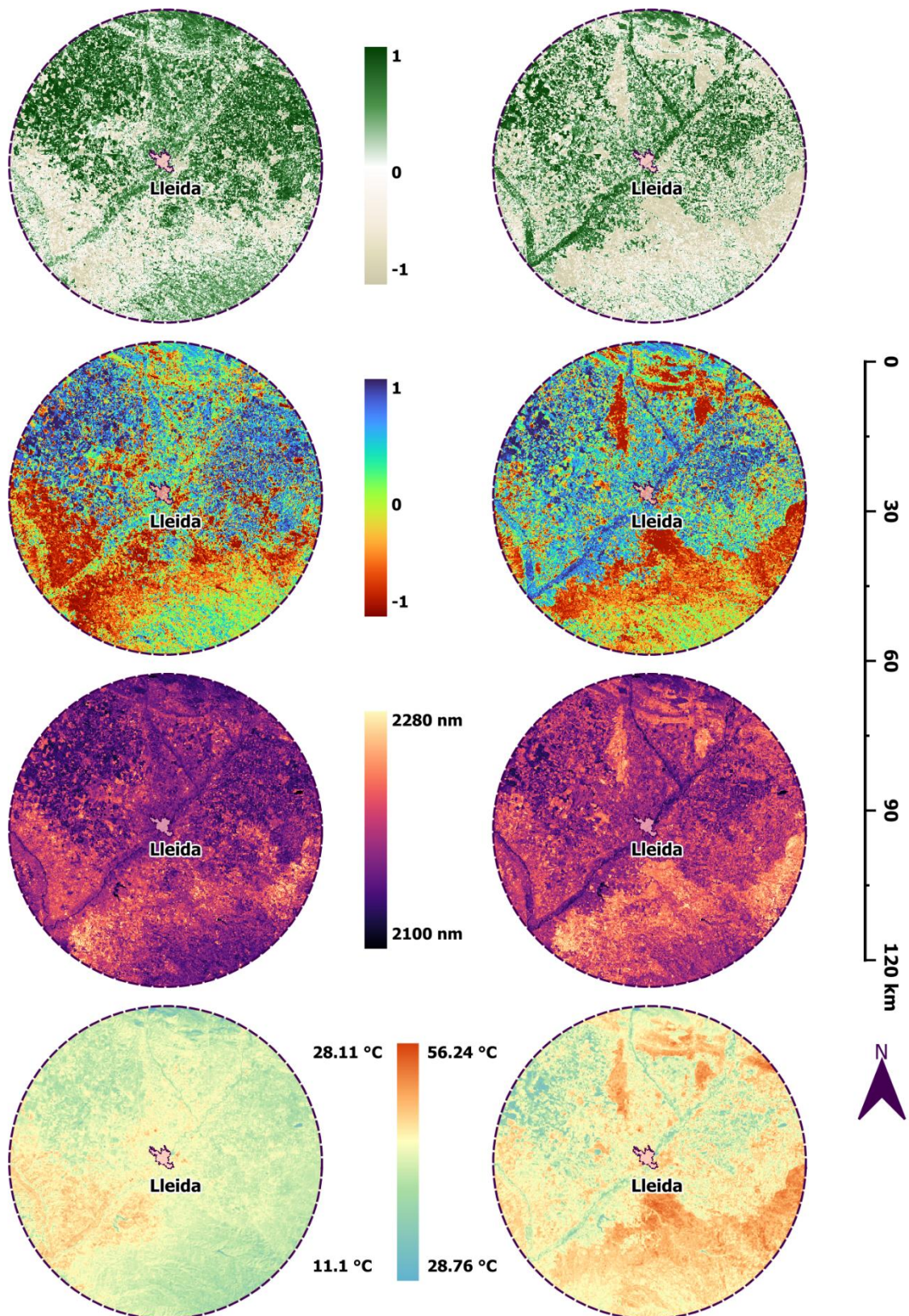


Figure 2.5. 2024

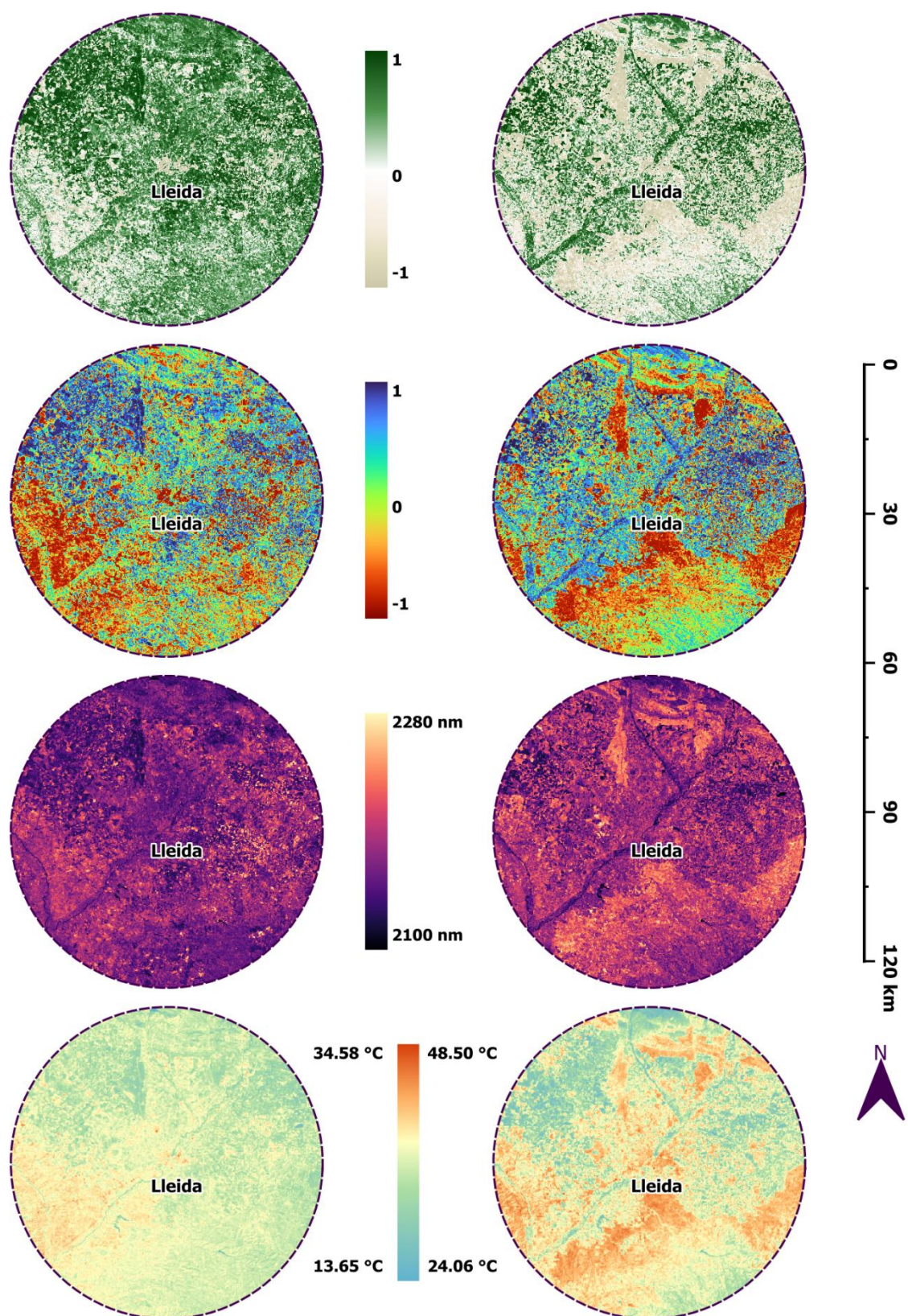


Figure 2.6. 2025

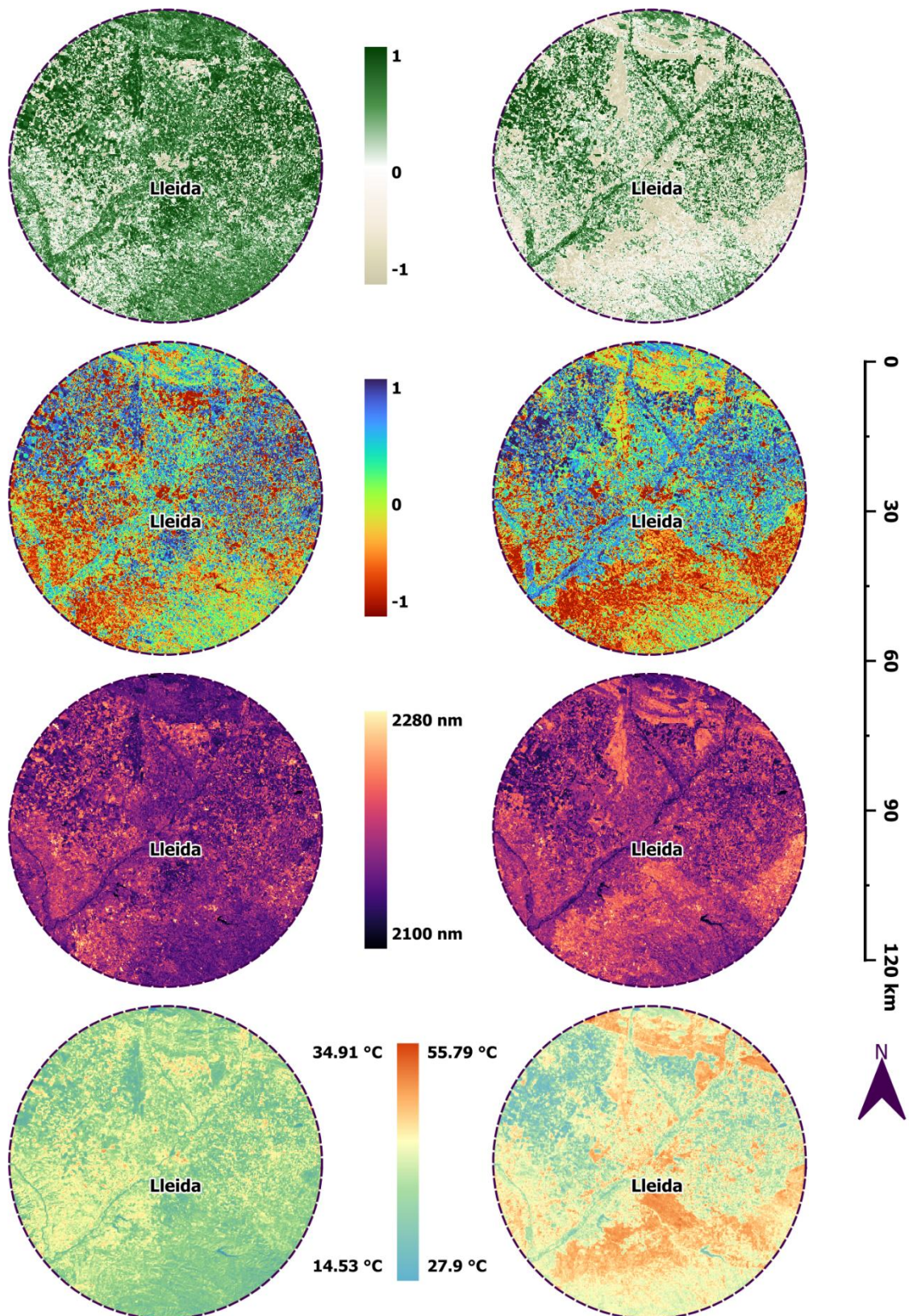


Figure 2.7. 2026

The seven-year satellite evaluation reveals a striking and highly consistent post-harvest thermal transformation across both the agricultural hinterland and the urban core of Lleida (Figure 3).

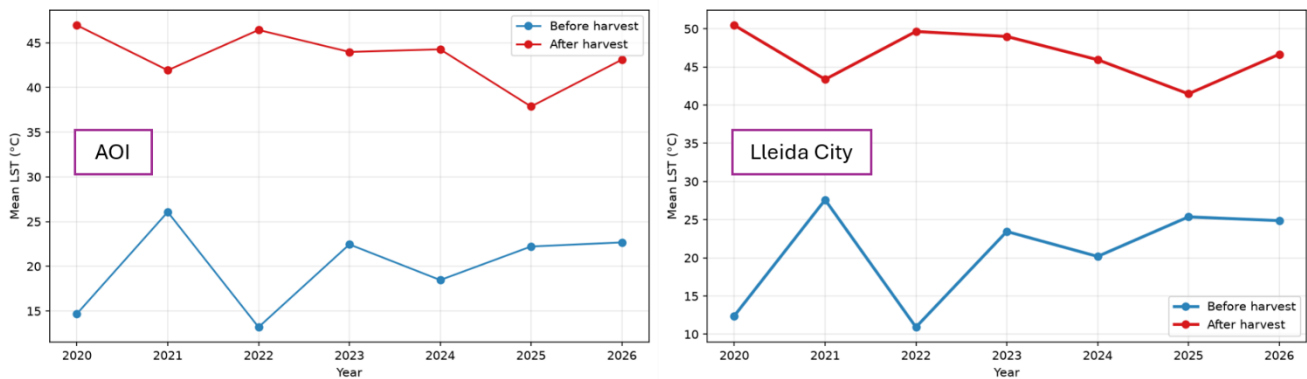


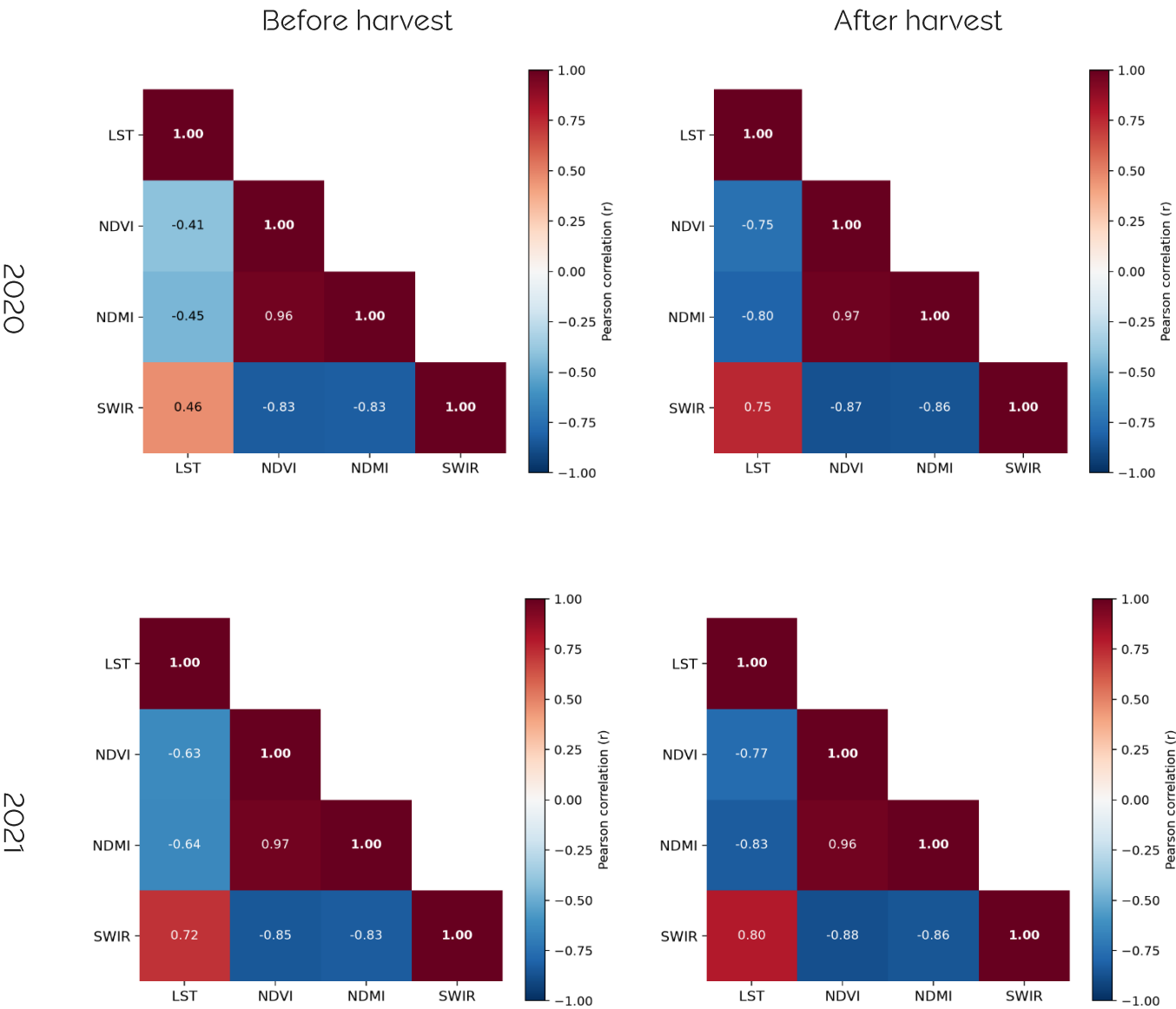
Figure 3. City and AOI-level Land Surface Temperature (LST) statistics for before and after harvest across 2020–2026. Across every single year evaluated, the city mean LST for the post-harvest exceeded the critical severe heat warning threshold of 40°C.

Pixel-by-pixel correlation analysis confirmed that moisture depletion (NDMI) is the single strongest driver of post-harvest LST elevation (mean $r = -0.74$), followed closely by vegetative removal (NDVI, mean $r = -0.70$) and bare soil exposure (SWIR, mean $r = +0.74$) (Figure 4). This proves that severe loss of evapotranspirative cooling is the primary engine behind harvest-induced heating.

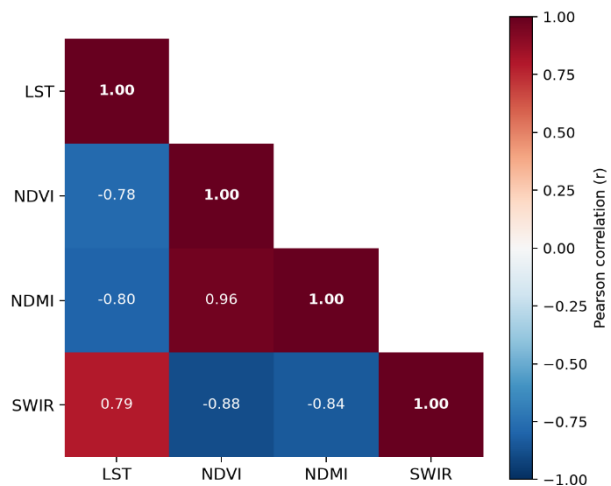
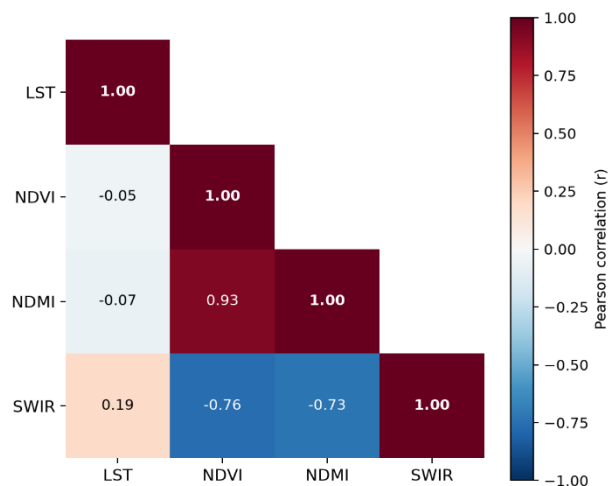
Discussion

The empirical findings of this study challenge a deeply embedded assumption in urban disaster risk management: that extreme heat is primarily an unpredictable atmospheric phenomenon driven by large-scale meteorological conditions beyond local governance control. By demonstrating that peri-urban agricultural harvesting induces large-scale, spatially extensive surface temperature surges exceeding 40 °C (repeatedly, consistently, and across seven independent annual observations) this research reframes post-harvest land surface change as a predictable, recurring, and spatially mappable heat hazard. This reframing has profound consequences for how

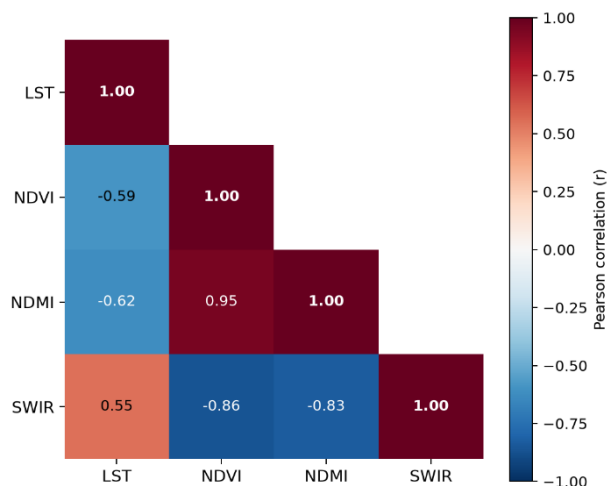
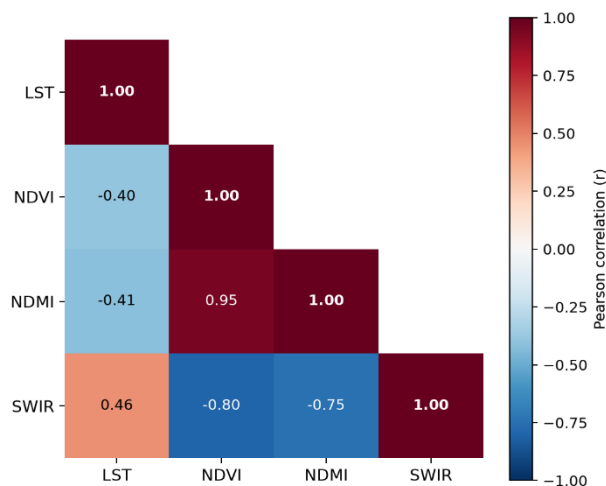
cities surrounded by agricultural land should approach heat risk governance, emergency preparedness, and long-term climate adaptation planning.



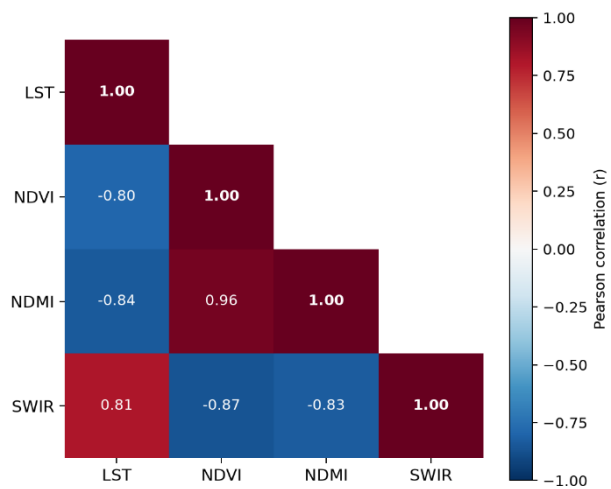
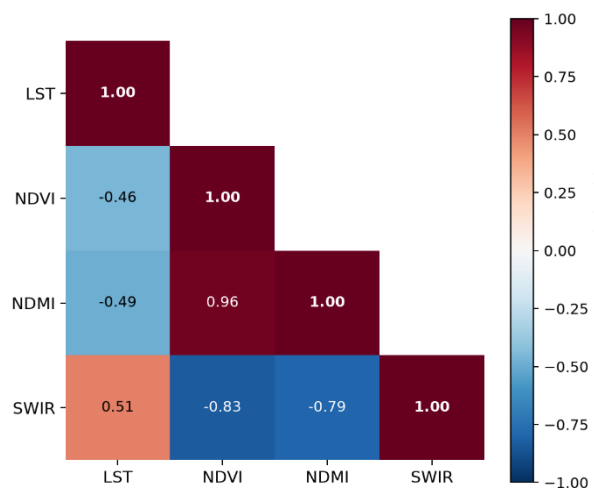
2022



2023



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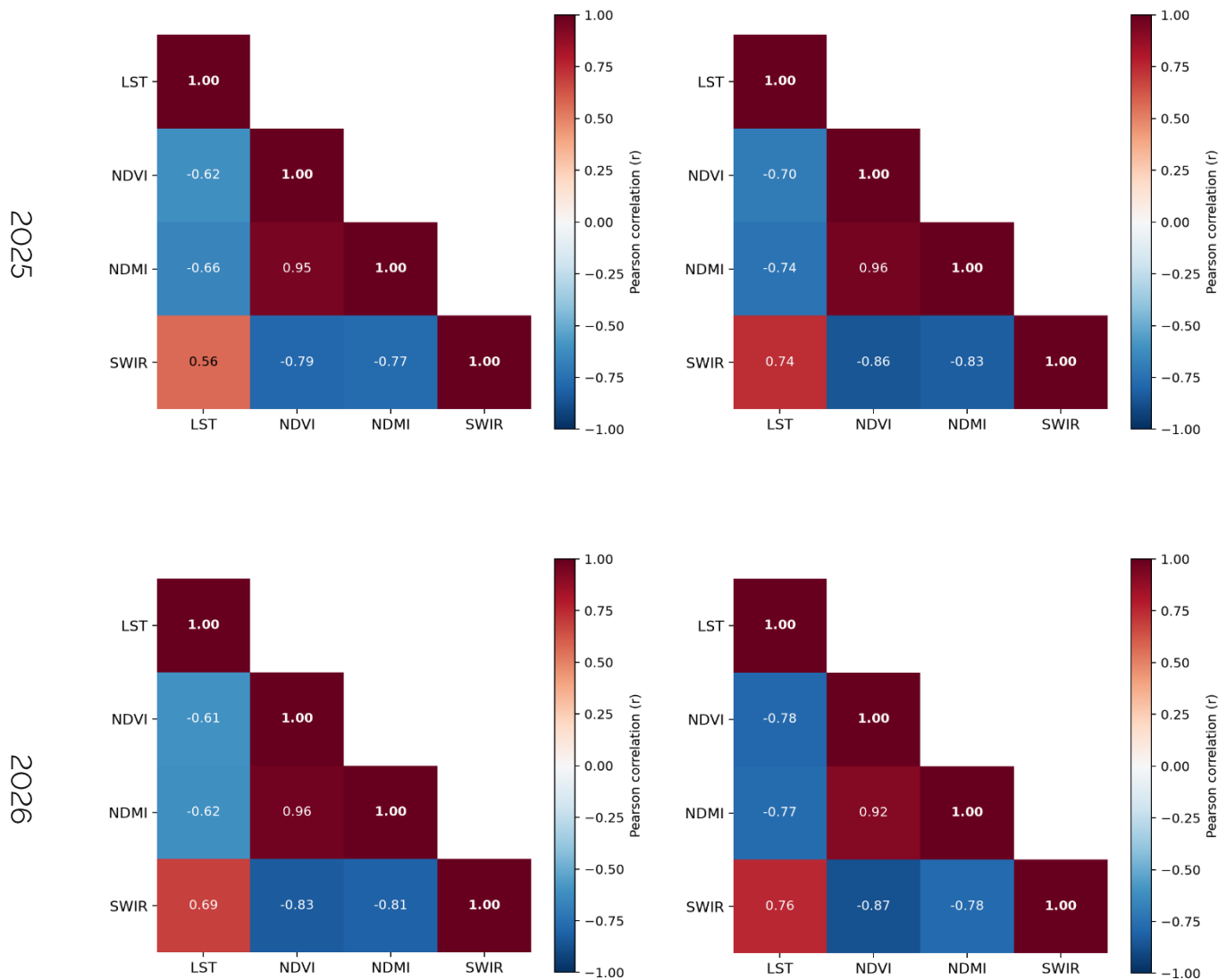


Figure 4.

The predictability of the hazard is its most operationally significant characteristic. Unlike flash floods, earthquakes, or convective storm events, which offer warning windows measured in hours or days at best, the harvest-driven heat surge follows an agricultural calendar that is known weeks to months in advance. Farmers, agricultural cooperatives, and regional land management authorities possess this calendar as routine operational knowledge. What has been missing, and what this study provides for the first time in a systematic, multi-year, open-data framework, is the quantitative evidence linking harvest timing to urban thermal exposure at sufficient spatial resolution and temporal consistency to justify its integration into formal disaster risk governance structures.

The findings align directly and substantively with three Priority Areas of the Sendai Framework for Disaster Risk Reduction 2015–2030 ([UNDRR, 2015](#)), which remains the primary international framework guiding national and subnational disaster risk policy through 2030 and beyond.

Under Sendai Priority 1 (Understanding Disaster Risk), the study contributes a multi-year, pixel-level characterization of a heat hazard profile that is currently absent from most national risk atlases and urban vulnerability assessments. The consistent post-harvest city-level LST values exceeding 40° C across all seven years, the strong spatial correlation between vegetation/moisture loss and surface heating ($r \sim -0.70$ to -0.74), and the clear visual correspondence between NDVI collapse and LST surge together constitute a robust, evidence-based characterization of the hazard. Crucially, this characterization is not site-specific, the methodology requires only freely available open data and open-source tools, meaning any municipality adjacent to agricultural land anywhere in the world can generate an equivalent hazard profile for its own territory without specialist infrastructure, proprietary software, or international technical assistance. This directly addresses the data and knowledge gap that Sendai Priority 1 identifies as the foundational barrier to effective risk governance, particularly in low- and middle-income countries where official heat risk assessments remain largely absent.

Under Sendai Priority 2 (Strengthening Disaster Risk Governance), the findings point to a structural gap in how urban heat governance is currently organized. In most jurisdictions, heat emergency management sits within meteorological services and public health authorities, while land use and agricultural policy sits within entirely separate ministries and regulatory bodies. The harvest-urban heat connection identified in this study cuts directly across this institutional divide: effective governance of harvest-driven heat risk requires coordination between agricultural extension services, land management authorities, civil protection agencies, and municipal health departments as a multi-sector integration that is rarely formalized in current governance arrangements. Addressing this gap need not require new legislation or institutional restructuring; it requires, at minimum, the inclusion of harvest phenology data in municipal heat vulnerability mapping, and the establishment of formal information-sharing protocols between agricultural and civil protection authorities ahead of the harvest season each year. The open methodology demonstrated here provides the technical basis for such protocols, supplying spatially explicit, annually updatable heat hazard maps that can serve as a shared evidence base across institutional boundaries.

Under Sendai Priority 4 (Enhancing Disaster Preparedness for Effective Response and to "Build Back Better"), the calendrical nature of the hazard enables a level of

anticipatory preparedness that reactive heat monitoring systems cannot provide. A harvest-linked heat early warning system, triggered not by exceeding a meteorological temperature threshold, but by satellite-detected vegetation senescence in the peri-urban agricultural zone in the weeks preceding peak harvest, would allow public health authorities to activate cooling centers, issue targeted advisories to outdoor workers and elderly residents in the urban fringe, and coordinate with agricultural operators on irrigation scheduling or post-harvest residue management before the thermal peak occurs rather than in response to it. This anticipatory logic is already embedded in flood risk management (where rising river stages trigger staged response protocols days before peak flow) and wildfire risk management (where fuel moisture monitoring triggers pre-emptive resource pre-positioning); there is no technical or conceptual barrier to applying the same anticipatory framework to harvest-driven heat risk, and this study provides the empirical foundation to do so.

Beyond the Sendai Framework, the findings carry important implications for urban climate adaptation planning under the Paris Agreement and national adaptation plans increasingly required of signatory countries. As background temperatures continue to rise under even moderate emissions scenarios, the absolute magnitude of the harvest-driven heat surge will increase, because it is superimposed on a rising seasonal baseline. A post-harvest LST peak that currently reaches 50° C in the hottest years will, under mid-century warming projections, reach values with no historical precedent in this landscape. Early integration of harvest phenology into urban heat adaptation strategies is therefore not merely a near-term operational improvement but a long-term resilience investment, buying lead time before the hazard escalates to magnitudes that overwhelm reactive response capacity.

Finally, the strong and consistent alignment between LST and SWIR across all seven years of the study deserves specific attention from a monitoring and early warning perspective. SWIR reflectance responds to surface moisture and vegetation status faster and more sensitively than thermal infrared retrievals under some atmospheric conditions, and Sentinel-2's 10-meter SWIR products are available at higher spatial resolution and shorter revisit frequency than Landsat thermal data. The demonstrated spatial correspondence between SWIR and LST suggests that SWIR-based vegetation moisture monitoring could serve as a leading indicator of impending thermal stress as a proxy early warning signal available before the full thermal signature develops, providing an additional operational tool for disaster risk managers seeking to maximize lead time before harvest-driven heat peaks.

Conclusion

This study establishes, through seven years of consistent, spatially explicit, multi-sensor satellite evidence, that agricultural harvesting constitutes a major, highly predictable, and currently underappreciated driver of extreme heat hazard in urban areas surrounded by agricultural land. The post-harvest transition from dense crop canopy to bare soil drives dramatic surface temperature increases, exceeding 40° C at the city scale in every year studied, whose spatial structure is directly and consistently linked to the loss of vegetation cover and surface moisture, as evidenced by strong pixel-wise correlations between LST, NDVI, NDMI, and SWIR across all years and both study periods. These are not marginal or statistically borderline findings, but they are visually unambiguous in the spatial maps, numerically robust in the correlation analysis, and temporally consistent across an observation record long enough to rule out inter-annual atmospheric variability as an alternative explanation.

The methodological contribution of this study is as significant as the empirical one. By implementing the entire analytical pipeline using freely available satellite data (Landsat 8/9 Collection 2, Sentinel-2 Level-2A) and open-source processing tools (Google Earth Engine, Python, QGIS), and by requiring only a study-area shapefile and two acquisition dates per year as site-specific inputs, this study demonstrates a globally scalable workflow for identifying, characterizing, and monitoring post-harvest thermal surges at any agricultural-urban interface in the world. The barrier to replication is deliberately minimal since any national meteorological service, regional environmental agency, or municipal planning authority with internet access and basic geospatial literacy can generate an equivalent analysis for their own territory, without proprietary data, without specialist computing infrastructure, and without international technical assistance.

The disaster risk management implications of these findings are direct and actionable. Harvest-driven heat amplification is a predictable hazard, governed by an agricultural calendar that is known in advance, spatial in character (and therefore mappable), consistent in its annual recurrence (and therefore insurable and plannable), and physically linked to land management decisions that are, at least in part, subject to policy influence. This combination of predictability, spatial explicitness, and policy relevance makes it an ideal candidate for integration into the anticipatory governance frameworks that the Sendai Framework for Disaster Risk Reduction 2015–2030 calls for, but which, in the domain of heat risk, remain underdeveloped relative to other hazard types such as flooding and seismic risk.

The path forward requires action at multiple scales simultaneously. At the local level, municipalities should incorporate harvest phenology into annual heat emergency preparedness cycles, establishing formal coordination with agricultural authorities and activating heat risk protocols ahead of the harvest-period thermal surge. At the

national level, disaster risk registers and heat vulnerability assessments should explicitly recognize the urban-agricultural interface as a primary heat hazard zone, integrating remote-sensing-based harvest monitoring into national heat early warning systems. At the international level, the open methodology demonstrated here offers a practical contribution to the Sendai Framework's call for globally accessible, evidence-based disaster risk information, one that is immediately deployable in the regions where heat risk is rising fastest, and risk governance capacity remains most constrained.

Agricultural land and urban settlements have coexisted and co-evolved for centuries. The thermal consequences of their interaction have always existed; what has changed is our capacity to observe, quantify, and act on them at the resolution and consistency required for effective governance. This study demonstrates that the observational capacity is now available, freely, to anyone who needs it. The remaining task is institutional to ensure that the evidence reaches the decision-makers who can translate it into the anticipatory, cross-sectoral, spatially informed heat risk governance that the scale of the challenge demands.

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Topic “Earthquakes and building damage assessment”

Poster board #24

From Multimodal Building Damage Assessment to Preliminary Recovery Monitoring after the 2025 Myanmar Earthquake Using CSG SAR, Pléiades Imagery and Building Footprints

Luigi Russo ⁽¹⁾, Deodato Tapete ⁽²⁾, Silvia Liberata Ullo ⁽³⁾, Paolo Gamba ⁽¹⁾

⁽¹⁾ University of Pavia, Department of Electrical, Computer and Biomedical Engineering, Pavia, Italy

⁽²⁾ Italian Space Agency (ASI), Rome, Italy

⁽³⁾ University of Sannio, Engineering Department, Benevento, Italy

The 2025 Myanmar earthquake provides a recent case study for satellite-based damage assessment and post-event monitoring in a complex urban and cultural-heritage context. This contribution presents ongoing activities linking rapid Building Damage Assessment (BDA) with preliminary recovery monitoring using COSMO-SkyMed Second Generation (CSG) Synthetic Aperture Radar (SAR), very-high-resolution (VHR) Pléiades optical imagery from CNES, and ancillary geospatial information.

The first stage focuses on BDA in Mandalay. Post-event CSG SAR imagery, VHR optical data, and building footprints were integrated within a multimodal deep-learning framework for binary damaged/intact classification [1]. Building footprints provide an explicit spatial prior for building-level analysis and facilitate the fusion of radar and optical features.

The second stage extends the analysis toward temporal monitoring of post-earthquake transformations. Preliminary anomaly maps derived from multitemporal CSG SAR observations are analysed to identify coherent changes potentially associated with debris removal, demolition, temporary structures, new construction, or other post-event processes. Their interpretation, however, is not straightforward: the absence of detected change may represent either an intact stable structure or a collapsed structure where no reconstruction is yet visible.

To address this ambiguity, SAR-based anomaly detection is interpreted together with post-event VHR Pléiades imagery, which provides additional interpretation examples

of intact stable structures, collapsed but unchanged structures, reconstructed areas, temporary settlements, and changes not clearly related to recovery. Myanmar is therefore presented as an ongoing recovery-monitoring case study, highlighting both the potential and the semantic limitations of SAR-based temporal analysis.

This work was supported by Next Generation EU, Action 4, DM n. 118, 02/03/2023 through the framework of a PhD program. The COSMO-SkyMed products used in this study were accessed under a license granted by the Italian Space Agency (ASI) through the Project Card “MyanmarEQ2025”. Pléiades data were provided under a license to use by CNES within the CEOS WGD Seismic Risk Initiative.

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Poster board #25

Monitoring Urban Change and Post-Earthquake Recovery Using Deep Learning and Sentinel-2 Time Series: The Osmaniye Case Study

Pietro Di Stasio ^(1,2), Antonino Pigna ^(1,2), Deodato Tapete ⁽²⁾, Paolo Gamba ⁽³⁾, Silvia Liberata Ullo ⁽¹⁾

⁽¹⁾ University of Sannio, Engineering Department, Benevento, Italy

⁽²⁾ Italian Space Agency (ASI), Rome, Italy

⁽³⁾ University of Pavia, Department of Electrical, Computer and Biomedical Engineering, Pavia, Italy

Disaster risk management requires Earth Observation (EO) approaches capable of capturing not only the immediate effects of hazardous events, but also the longer-term evolution of exposed urban areas. This study presents a multi-temporal framework based on Sentinel-2 imagery and Deep Learning techniques to investigate urban change and post-earthquake recovery in Osmaniye, Turkey, following the 6 February 2023 earthquake sequence.

A decade-long archive of Sentinel-2 Level-2A imagery covering 2015–2025 was analysed using the blue, green, red, and near-infrared bands at 10 m spatial resolution. World Settlement Footprint products for 2015 and 2019 were employed as reference masks to train a U-Net Convolutional Neural Network for binary segmentation of built-up and non-built-up areas. After validation, the model was applied to the complete time series to generate annual urban maps and identify gradual and abrupt changes in the built environment.

The model achieved an overall accuracy of 0.873, an F1-score of 0.579, and an Intersection over Union of 0.407 for the built-up class. The temporal analysis revealed a substantial expansion of the predicted urban footprint, with the share of the study area classified as built-up increasing from approximately 13.3% in 2015 to 35.1% in 2025. Within this long-term trajectory, a decline in detected built-up extent was observed after the 2023 earthquake, followed by a marked increase in 2025, consistent with an intense reconstruction phase. Spatial change maps further highlighted peripheral expansion, persistent urban areas, and localized urban loss.

The workflow relies on open-access EO data and reproducible AI methods, making it scalable to other hazard-prone cities. The results demonstrate how multi-temporal satellite observations can support disaster risk management beyond immediate damage mapping by documenting pre-event urban growth, post-event disruption, and recovery trajectories, thereby contributing to risk-informed reconstruction and resilient urban planning.

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Poster board #26

Inflation Dynamics and Magma Recharge within the Svartsengi Volcanic System (SW Iceland) Inferred from GNSS and InSAR Data

Chiara Lanzi ⁽¹⁾, Michelle Parks ⁽¹⁾, Vincent Drouin ⁽¹⁾, Freysteinn Sigmundsson ⁽²⁾, Halldór Geirsson ⁽²⁾, Andrew Hooper ⁽³⁾, Benedikt Gunnar Ófeigsson ⁽¹⁾, Hildur María Friðriksdóttir ⁽¹⁾

⁽¹⁾ Veðurstofa Íslands, Icelandic Meteorological Office, Reykjavík, Iceland

⁽²⁾ Nordic Volcanological Center, Institute and Faculty of Earth Sciences, University of Iceland, Reykjavík, Iceland

⁽³⁾ COMET, School of Earth and Environment, University of Leeds, UK

Ground observations have detected almost continuous inflation since October 2023 within the Svartsengi Volcanic System (SW Iceland). Inflation was interrupted by rapid deflation and concurrent dike intrusions, resulting in a total of nine eruptions (as of summer 2026, the time of writing) within the Sundhnúkur crater row and its extension.

We focus on inflation events to understand magma supply and the evolution of the magmatic system after each diking event or eruption. InSAR data from Sentinel-1, TerraSAR-X, and COSMO-SkyMed, together with GNSS observations, were jointly modeled using spherical, sill-type, and ellipsoidal sources in an elastic half-space. This allowed us to assess how source geometry affects estimates of inflation depth and volume.

The modeling results reveal a clear pattern. Early inflation episode (up to March 2024) were short, lasting several weeks, with variability in inferred source depth and recharge volume before each dike intrusion or eruption. Estimated depths were 3.6–4.3 km for spherical sources, 3.4–3.8 km for ellipsoidal sources, and 4.4–5.4 km for sill-type sources. Corresponding volumes were approximately $(4-20) \times 10^6 \text{ m}^3$, $(4-17) \times 10^6 \text{ m}^3$, and $(5-19) \times 10^6 \text{ m}^3$. Inflation volumes generally decreased with successive events.

Since March 2024, the system has become more stable. While depth and volume estimates vary with source geometry, values for each geometry remain relatively consistent across successive events. Depths are approximately 3.8–4 km for spherical

sources, ~3.4–3.6 km for ellipsoidal sources, and 4.6–5.0 km for sill-type sources, for sill-type sources, while inflation volumes generally increase with each episode.

A detailed study of the volcanic system and its evolution can provide insights into magma accumulation processes. Geodetic data, combined with seismic and petrological/geochemical observations, help characterize changes in the system over time. Integrating these observations improves our understanding of inflation episodes and supports more reliable volcanic hazard assessment and forecasting.

Poster board #27

Tracking volcanic unrest episodes at Campi Flegrei and Fentale calderas using long (≥ 25 years) time series of thermal infrared data from ASTER and Landsat satellites

Federico Galetto ⁽¹⁾, Malvina Silvestri ⁽¹⁾, Federico Rabuffi ⁽¹⁾, Maria Fabrizia Buongiorno ⁽¹⁾

⁽¹⁾ National Institute of Geophysics and Volcanology (INGV), Rome, Italy

Large felsic calderas often experience unrest episodes, which are periods with changes in the baseline monitoring parameters. Detecting and monitoring unrest episodes is important for the evaluation of volcanic hazard. Surface temperature (Ts) is one of the monitoring parameters detected from satellites that has been less used to monitor non-eruptive unrest so far. Here we used the Ts derived from ASTER and Landsat 5-9 data to develop long (≥ 25 year) time series of thermal anomalies to monitor and detect thermal unrest episodes in two large and restless felsic calderas that have not erupted recently: Campi Flegrei (Italy) and Fentale (Ethiopia). We also developed a Google Earth Engine script to automatically process the long time series of Landsat 5-9 data. Results highlight how these calderas experienced periods of thermal unrest with an increase of Ts above the background level, which often relates to changes in other monitoring parameters (e.g., ground deformation, seismicity and degassing). At Campi Flegrei, the thermal unrest becomes evident only by processing long time-series since the increase-decrease of thermal anomalies slowly occurs over the time, highlighting the importance of the long Landsat and ASTER datasets to monitor calderas. At Fentale, thermal anomalies relate with some of the main seismic swarms. These results show the importance to include long-time series of Ts in the analysed monitoring parameters of large felsic calderas, also highlighting the importance of recent (e.g., ECOSTRESS) and planned future missions with thermal infrared data, which allow to increase the number of available TIR data.

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Poster board #28

A novel risk assessment workflow for differential land subsidence based on satellite InSAR and urban settlement data: present-day risk scenario in the metropolitan cities of Italy

Francesca Cigna ⁽¹⁾, Roberta Paranunzio ⁽¹⁾, Roberta Boni ⁽²⁾, Pietro Teatini ⁽³⁾

⁽¹⁾ Institute of Atmospheric Sciences and Climate (ISAC), National Research Council (CNR), Italy

⁽²⁾ Department of Science, Technology and Society (STS), University School for Advanced Studies (IUSS) Pavia, Italy

⁽³⁾ Department of Civil, Environmental and Architectural Engineering (ICEA), University of Padua (UNIPD), Italy

Many world metropolises are affected by differential land subsidence, with impacts on their public and private infrastructure and, in turn, socio-economic consequences. This work presents an innovative workflow based on geospatial data for exposure-vulnerability rating, hazard quantification and risk assessment. The methodology integrates InSAR-derived information on ground displacement from Copernicus' European Ground Motion Service, with land cover and settlement characteristics from global datasets (e.g. Copernicus' Global Human Settlement Layer and DLR's World Settlement Footprint), enabling the generation of actionable risk information layers. Land subsidence-induced structural stress on urban assets are quantified within the 15 Italian metropolises, along with the distribution and amount of residential/non-residential infrastructure and population exposed. Deformation-induced risk is assessed with a tailored risk matrix enabling the geospatial intersection of hazard and exposure-vulnerability, and the consequent classification of risk. A total of 1.44 out of 2665 km² urbanised land within the 15 cities is found at high risk due to significant angular distortions (and, sometimes, additive threat from horizontal strain) affecting very high exposure-vulnerability infrastructure. It is estimated that, for over 2700 buildings within the 15 cities, there is high likelihood of already occurred/incipient structural damage. The reference knowledge-base on present-day subsidence-induced risk can inform land and risk management at national scale, and provides a baseline for future assessments to build upon with a look to the next decades and sustainable urban development.

This work was funded by the European Union – Next Generation EU, component M4C2; project SubRISK+ (<https://www.subrisk.eu/>), 2023–2026 (CUP B53D23033400001). Risk mapping outputs and statistics are openly available via the SubRISK+ ‘Control Room’ web platform (<https://controlroom.subrisk.eu/>).

Full details about the workflow and results are available in the full paper: Cigna F., Paranunzio R., Boni R., Teatini P. 2025. Present-day land subsidence risk in the metropolitan cities of Italy. Scientific Reports, 15, 34999, <https://doi.org/10.1038/s41598-025-18941-8>.

Poster board #29

Multi-Hazard Risk Mapping for Power Grid Resilience

Sara Ciaccia ⁽¹⁾, Elisa Ilardi ⁽¹⁾, Walter De Simone ⁽¹⁾, Davide Passarelli ⁽¹⁾, Andrea Piccolo ⁽¹⁾

⁽¹⁾ Planetek Italia, Bari, Italy

Climate change is increasing the frequency and severity of natural hazards, posing significant challenges to the resilience and reliability of energy distribution networks. This work presents a scalable and data-driven methodology for the generation of wildfire and flood risk maps specifically designed to support power grid planning, maintenance, and risk mitigation activities.

The proposed approach combines Copernicus Earth Observation data, other open geospatial datasets, and utility network information to produce hazard, vulnerability, and risk assessments over large areas. Two dedicated workflows were developed and demonstrated in Spain across selected areas in Aragón, Catalunya, and Andalucía. For flood risk assessment, environmental and geomorphological factors such as elevation, slope, land cover, and historical flood records were integrated through a Frequency Ratio model. Wildfire risk mapping was based on a multi-criteria framework that combines vegetation, climatic, topographic, anthropogenic, and historical fire indicators using the Analytic Hierarchy Process (AHP).

To move from hazard to operational risk, the methodology incorporates exposure and vulnerability components, including population density, critical infrastructure, environmental assets, and utility-specific network characteristics. Dedicated vulnerability models were developed for power lines and substations, enabling the production of risk indicators directly linked to grid assets and service continuity.

Model validation demonstrated strong predictive performance, with flood hazard maps achieving accuracies between 80% and 86%, while wildfire hazard maps reached validation scores of 80% and 91% in the study areas. The resulting products are delivered through a web-based GIS platform, supporting interactive visualization, querying, and decision-making.

The proposed framework demonstrates how open Earth Observation data can be transformed into actionable intelligence for utility operators, providing a scalable and customizable solution for multi-hazard risk assessment and resilient infrastructure management in a changing climate.

Poster board #30

Leveraging Observation Networks for Space Weather Disaster Risk Management: The INGV Operational Experience

Claudio Cesaroni ⁽¹⁾, Luca Spogli ⁽¹⁾, Vincenzo Romano ⁽¹⁾, Emanuele Pica ⁽¹⁾

⁽¹⁾ National Institute of Geophysics and Volcanology (INGV), Rome, Italy

Space weather events constitute an emerging natural hazard capable of significantly affecting critical technological systems, including satellite navigation, aviation, and infrastructures relying on space-based services. Severe ionospheric disturbances and scintillation can degrade GNSS positioning accuracy and disrupt HF communications, creating large-scale operational and disaster risks.

In alignment with the core objectives of the ASI-CEOS WGD International Workshop on Earth Observation for Disaster Risk Management (DRM), this contribution highlights the critical role of continuous observation data in addressing space weather hazards. To mitigate these threats, the Istituto Nazionale di Geofisica e Vulcanologia / National Institute of Geophysics and Volcanology (INGV) operates a distributed observation infrastructure comprising ionosondes, GNSS scintillation receivers, and optical instruments deployed from polar to equatorial regions. By exploiting these multi-instrument observations, near real-time data is transformed into operational workflows and thematic products supporting the detection and assessment of ionospheric disturbances.

The INGV Space Weather Monitoring Room represents a successful use-case of bridging scientific research with operational decision support for DRM. It enables

continuous situational awareness, validation of ongoing anomalies, and timely dissemination of relevant information, directly supporting the preparedness and early warning phases of DRM. Furthermore, this infrastructure shares models and best practices within international service frameworks, including the PECASUS consortium for ICAO and the ESA Space Weather Service Network, significantly reducing risks associated with GNSS degradation and communication failures.

This presentation will showcase the state of the art in multi-instrument data integration, demonstrating how connecting research-grade observation infrastructures with permanent operational services enhances the reliability of nowcasting and forecasting products. Ultimately, this approach identifies current capabilities and future user needs, strengthening global preparedness and resilience against emerging space weather disasters.

Poster board #31

CALHYPSO: High resolution DSMs from single RGB images

Riccardo Contu ⁽¹⁾, Andrea Nascetti ⁽¹⁾

⁽¹⁾ CALHYPSO

CALHYPSO — The third dimension, from a single image.

The world is three-dimensional. Almost all the data we use to understand it is flat.

Height is what decides which buildings flood and which stay dry, which structures collapse in an earthquake, how much carbon a forest stores, and how many people live on a given city block. Yet it remains one of the most expensive and unevenly distributed data layers on the planet. LiDAR campaigns cost a fortune and cover a fraction of the Earth. Stereo satellite acquisitions require tasking matched image pairs. Both leave out precisely the places where the information matters most: fast-growing cities, informal settlements, disaster zones, and regions no one has ever surveyed.

CALHYPSO removes that constraint. We generate Digital Surface Models and normalised DSMs — the height above ground of every building, tree and structure — from a single monocular RGB satellite image. No stereo pairs. No LiDAR. No fieldwork. Because one image is enough, we work on archive imagery as well as new captures, which means we can reconstruct heights not only anywhere, but also backwards in time.

What that unlocks: per-building heights and storey counts to sharpen catastrophe and exposure models, where height is among the strongest drivers of flood, earthquake and wind loss; rapid post-event damage assessment through volumetric before-and-after comparison; population and settlement estimates derived from built-up volume; mapping of informal settlements and displacement sites.

Poster board #32

Digitalizing Community Disaster Risk Management Plans to Strengthen Early Warning and Community Resilience in Armenia

Lilit Minasyan ^(1,2)

⁽¹⁾ Climate Change and Disaster Risk Management Specialist, Armenia

⁽²⁾ University of Lisbon, Portugal

Climate-related physical risks are becoming increasingly important for financial stability, investment planning and risk-informed decision-making. Yet climate information often remains difficult to use in practice because relevant datasets are technically complex, fragmented across institutions and insufficiently localized for operational decisions.

This work presents a settlement-level climate and physical hazard assessment and interactive mapping platform developed in Armenia within an assignment commissioned by the Asian Development Bank (ADB) for the Central Bank of Armenia. Its objective is to transform climate, Earth observation and geospatial information into an operational decision-support tool for assessing physical risks affecting territories, assets and economic activities.

The methodology integrates GIS, remote sensing, national and international geospatial datasets, climate observations and projections, and spatial modelling. Multiple climate-related and physical hazards are assessed at settlement level and complemented by indicators describing vulnerability and water accessibility. The resulting framework enables users to move from separate thematic datasets toward an integrated understanding of local risk conditions.

A key output is an interactive GIS-based climate hazard atlas. Users can select a settlement, explore current and projected hazard information, compare thematic layers and access localized risk information through a user-oriented interface. The

platform is designed not only for visualization, but also for practical climate-risk screening and evidence-based decision-making in the financial sector.

The work demonstrates how Earth observation, GIS and climate modelling can bridge the gap between technical hazard information and operational decision-making, while providing a scalable approach for broader applications in territorial planning, disaster risk management and climate adaptation.

Poster board #33

ORSS: Integrating Copernicus EGMS and Open Data for Preliminary Screening and Prioritization of School Sites

Nicholas Rasetta ⁽¹⁾

⁽¹⁾ Ministero dell'Istruzione (MUR), Italy

ORSS (Osservatorio sul Rischio Strutturale Scolastico) is an experimental web-based platform exploring how Earth Observation data can support the preliminary prioritization of further technical investigations on school sites.

The platform integrates open data on Italian school buildings with ground-motion measurements from the Copernicus European Ground Motion Service (EGMS). School locations are georeferenced and associated with nearby EGMS measurement points. Vertical and East-West ground-motion components, together with spatial variability and temporal indicators where available, are processed to derive a relative preliminary prioritization index.

ORSS does not assess the structural safety of individual buildings and does not replace geological, geotechnical or structural investigations in situ. Its purpose is to provide an early territorial screening and decision-support layer, highlighting locations where available Earth Observation data may suggest that further technical investigation deserves higher priority.

The project was initially developed in the Abruzzo Region and is being progressively extended to additional Italian regions. ORSS is under continuous development: school records are progressively verified, the methodology is being refined, and data sources, geolocation quality, assumptions and limitations are explicitly documented.

The project aims to demonstrate a possible downstream use of Copernicus ground-motion products for preventive screening of distributed public infrastructure, while promoting a transparent and cautious interpretation of satellite-derived indicators. It also provides a framework for discussing the opportunities, limitations and validation requirements of EO-based prioritization approaches in Disaster Risk Reduction.

The platform is publicly accessible at <https://orss.it/>.

Poster board #34

From Earth Observation to Actionable Geohazard Digital Twins: the GEO-DREAM and GET-it Initiatives

Elisa Trasatti ⁽¹⁾, Stefano Corradini ⁽¹⁾, GEO-DREAM and GET-it teams ⁽¹⁾

⁽¹⁾ National Institute of Geophysics and Volcanology (INGV), Osservatorio Nazionale Terremoti, Rome, Italy

Digital Twins can enhance Disaster Risk Management by transforming multi-source and multi-purpose Earth Observation (EO) data, in situ measurements and numerical models into dynamic environments for analysing ongoing events, exploring possible evolutions and supporting informed decisions. This contribution presents two complementary initiatives involving the Istituto Nazionale di Geofisica e Vulcanologia / National Institute of Geophysics and Volcanology (INGV): GEO-DREAM and GET-it.

GEO-DREAM (Geohazard and Environmental Observation for Data-driven Assessment of Monitoring, Research, and Evaluation), a four years (2026–2029) INGV project, investigates the feasibility of an Earth Digital Twin composed of interconnected thematic Digital Twins addressing volcanoes, earthquakes, landslides and space weather. Satellite and ground-based observations, artificial intelligence (AI) and advanced numerical simulations will be integrated into Digital Twin Components able to recognise signals and generate simulation scenarios. These components will be accessible through VISTA, an interactive environment supporting what-if analyses, uncertainty assessment and the evaluation of alternative hazard scenarios.

GET-it (Geohazards Early Digital Twin Component), a two years (2025–2027) ESA project, focuses on the implementation and validation of an operational Digital Twin for volcanoes, earthquakes and landslides. Built around ESA's Geohazards Exploitation Platform, GET-it combines multi-sensor satellite, airborne and ground observations with AI-based processing and physics-based modelling to produce near-real-time

information and what-if scenarios. Its capabilities are being demonstrated through representative use cases covering seismic sequences, volcanic eruptions and unrest, and rainfall- or earthquake-triggered landslides in different geographical and operational contexts.

Together, GEO-DREAM and GET-it illustrate a pathway from research-oriented Digital Twin architectures to pre-operational geohazard services. Their added value for Disaster Risk Management lies not only in faster access to EO-derived products, but also in the capacity to integrate observations and models, quantify uncertainty, test possible scenarios and provide reproducible, accessible information for preparedness, early warning, emergency management and recovery planning.

Poster board #35

Digital Twin Earth Hydrology Next: advanced EO integration for high-resolution operational water cycle monitoring and civil protection

Jaime Gaona ⁽¹⁾, Luca Brocca ⁽¹⁾ and the whole DTE Next project team

⁽¹⁾Institute of Geosciences (CNR-GEO), National Research Council (CNR) of Italy, Perugia, Italy

The Digital Twin Earth (DTE) Hydrology Next initiative—funded by the European Space Agency (ESA) and led by the CNR in collaboration with leading European research institutes—is developing a high-resolution digital replica of the hydrological cycle across Europe, Africa, and a region of Central America to improve the operational monitoring of the water cycle and associated natural hazards. The Digital Twin leverages the increasingly high spatial and temporal resolution of Earth Observation (EO) hubs and platforms—incorporating key hydrological cycle variables such as precipitation, soil moisture, snow, runoff, reservoir levels, groundwater, flooded areas, and irrigation—combined with advanced hydrological and hydraulic models. This initiative harnesses national and international satellite assets, including those from EUMETSAT, ESA, and ASI, to establish a scientifically validated framework for the operational monitoring of the hydrological cycle.

Through case studies and scenario analyses concerning floods, droughts, storage, and water-use dynamics, the platform provides operational information to resource managers, the agricultural sector, and civil protection agencies. By shifting the focus from localized water resource management to broader water cycle monitoring and

disaster risk reduction, the project demonstrates how high-frequency EO data can support near-real-time decision-making while ensuring accurate long-term monitoring. This work highlights the value of integrating cutting-edge remote sensing with operational monitoring applications to enhance resilience against extreme hydrometeorological events.

Poster board #36

A validation procedure to assess the precision and accuracy of satellite-derived land surface temperature

Anastasiia Khimchenko, Mattia Crespi ⁽¹⁾

⁽¹⁾ Geodesy and Geomatics Division, Department of Civil, Building and Environmental Engineering (DICEA), Sapienza University of Rome, Rome, Italy

Land Surface Temperature (LST) is a fundamental variable for understanding surface-atmosphere interactions, urban climate dynamics, and the Earth's energy balance. As the use of satellite-derived LST products continues to expand, ensuring their reliability has become increasingly important, particularly for recently developed downscaled products that provide enhanced spatial detail. This research presents a comprehensive validation framework designed to evaluate both the accuracy and precision of satellite-derived LST datasets and their high-resolution downscaled counterparts.

The study is organized into two complementary phases. The first phase focuses on validating original-resolution LST products. A ten-year archive (2013–2022) of MODIS and Landsat 8–9 observations was assessed against "GOLD" standard ground measurements collected at seven climatically diverse reference stations in the United States. This analysis was complemented by a cross-satellite comparison conducted across Italy during 2023. Results revealed a clear seasonal dependence of retrieval performance, with higher accuracy and precision during winter than in summer, while both sensors also exhibited sensitivity to land cover and climatic conditions.

The second phase investigates a machine learning downscaling algorithm developed to increase the spatial resolution of satellite LST products. The algorithm enhances Landsat-derived LST from 100 m to 10 m using Sentinel-2 imagery and MODIS-derived LST from 1 km to 100 m using Landsat data. Three successive product versions (2023–2025) for Milan, Florence, and Naples were evaluated through a multi-step validation framework combining comparisons with original satellite products, independent air

temperature observations, and Ordinary Least Squares regression with Huber-weighted outlier detection.

Overall, the downscaled products successfully preserved the spatial and temporal characteristics of the original LST maps, with coefficients of determination generally exceeding 0.90. The proposed validation framework provides a robust basis for assessing downscaled LST products across sensors and resolutions, supporting their application in local climate studies while identifying opportunities for further methodological improvements.

Poster board #37

Matera Space Center Lab

Deborah Katia Pallotti ⁽¹⁾, Federica Muscolo ⁽¹⁾, Daniele Santese ⁽¹⁾

⁽¹⁾ Italian Space Agency, Rome, Italy

The Matera Space Center Lab is a multidisciplinary technological infrastructure designed to support advanced computing, solution development, and cross-sector collaboration. The laboratory was established through an initiative promoted by the Italian Space Agency (ASI) and developed with the support of e-GEOS, using funding provided under the National Complementary Plan (PNC) to the National Recovery and Resilience Plan (PNRR). Accessible physically at the ASI Space Centre in Matera and online, the Lab provides a flexible environment with platform-based resource reservation, high-performance asset sharing, and service integration. This enables the design, testing, and deployment of advanced technologies for a wide spectrum of domains and applications, including solutions tailored for the full disaster management cycle, from prevention to post-event response.

Specifically, the Lab is equipped with a diverse range of assets readily available for booking and utilization. High-performance GPU-based workstations, servers, and specialized software suites—covering orbital analysis, advanced SAR/optical processing, AI pattern recognition, and predictive modeling—empower users to develop tools for challenges such as flood mapping, landslide susceptibility, and wildfire monitoring. Furthermore, the Lab offers a fleet of drones equipped with LiDAR, optical, thermal, infrared payloads and GNSS-Reflectometry (GNSS-R) receivers, alongside dedicated GNSS-R tide-gauge stations. Together, these assets provide ideal capabilities for localized monitoring, sea-level tracking, high-resolution damage

assessment, and emergency spatial analysis. Beyond technical equipment, the Lab offers additional facilities, including a digital scientific library, e-learning platforms, videoconferencing, and meeting rooms.

By integrating these advanced technical tools with collaborative spaces, the Matera Space Center Lab extends its core objective beyond simply providing equipment. It is designed to be a dynamic hub for geospatial innovation and multidisciplinary partnerships among research institutes, industry, and public institutions, accelerating the translation of raw satellite and aerial data into actionable insights for decision-making and sustainable development.