Multiscale satellite analysis of the 2025 Sumatra Floods:

A report on Sentinel Asia Training and Multi-party collaboration

Image credits: BRIN Task Force

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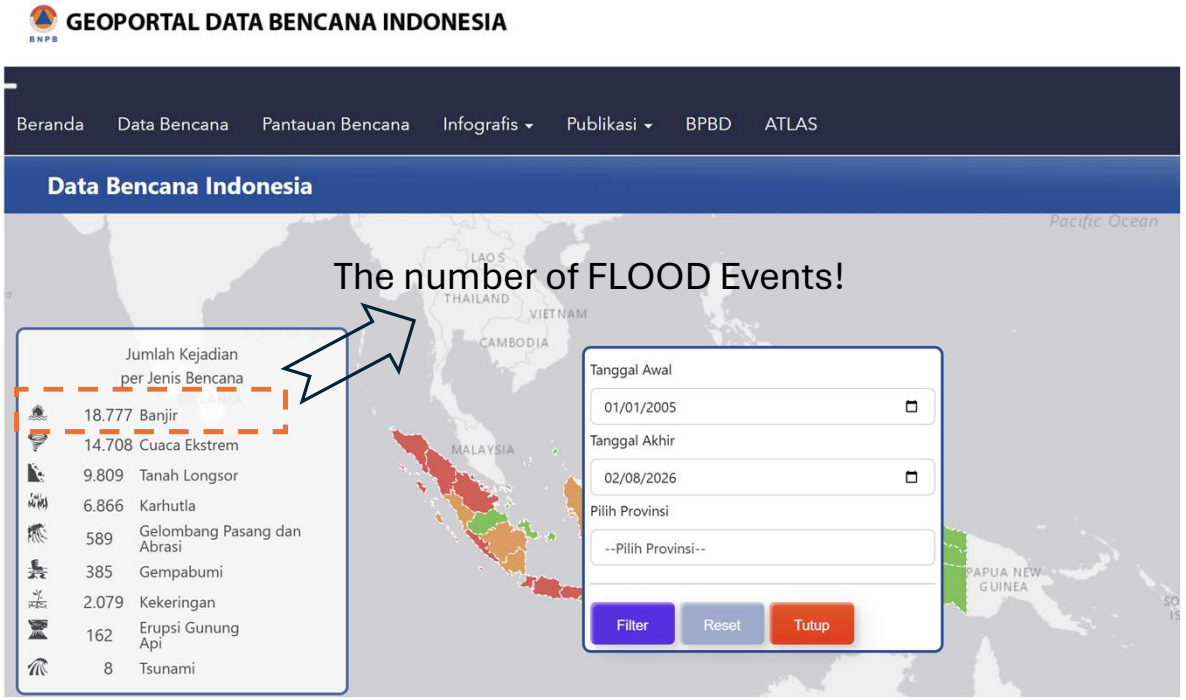
National Contact Point for Disaster Management, Secretariat
Indonesian Space Agency, BRIN

Outline

- Flood as Indonesia’s most frequent disaster
- 2025 Sumatra floods and landslides: situation overview
- Operational support: Sentinel Asia, International Charter activations, others partner for Sumatra
- Key products and examples
- Sentinel Asia SAR training in Jakarta (capacity building)
- Lessons learned and future plan

Image credits: Planet

Flood is Indonesia's most frequent event since the last two decades



Source: National Disaster Management Authority; https://gis.bnpb.go.id/ (accessed on 8 Feb 2026)

2025 Sumatra Floods and Landslides

Severe flash floods and landslides struck Sumatra in late November 2025, affecting Aceh, North Sumatra, and West Sumatra. Rescue operations faced significant challenges as damaged roads challenges as damaged roads and disrupted communications limited access to impacted communities across multiple areas.

>1,000

Lives Lost

Reported deaths by 27 January 2026 (BNPB)

>100

Missing Persons

Still unaccounted for as of late January 2026

Key Drivers of the Disaster

Tropical Cyclone Senyar

BMKG reported a tropical disturbance in the Malacca Malacca Strait evolved into Tropical Cyclone Senyar on Senyar on 26 November 2025, warning of very heavy to heavy to extreme rainfall and related hazards.

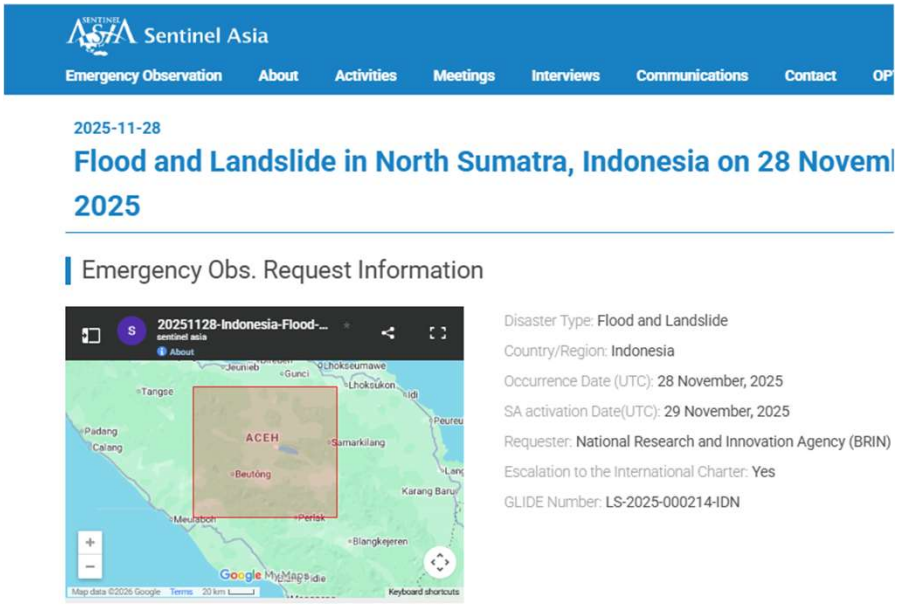
Intense Monsoon Rains

Intense monsoon rains, intensified by the cyclone, leading to river overflow and widespread flooding.

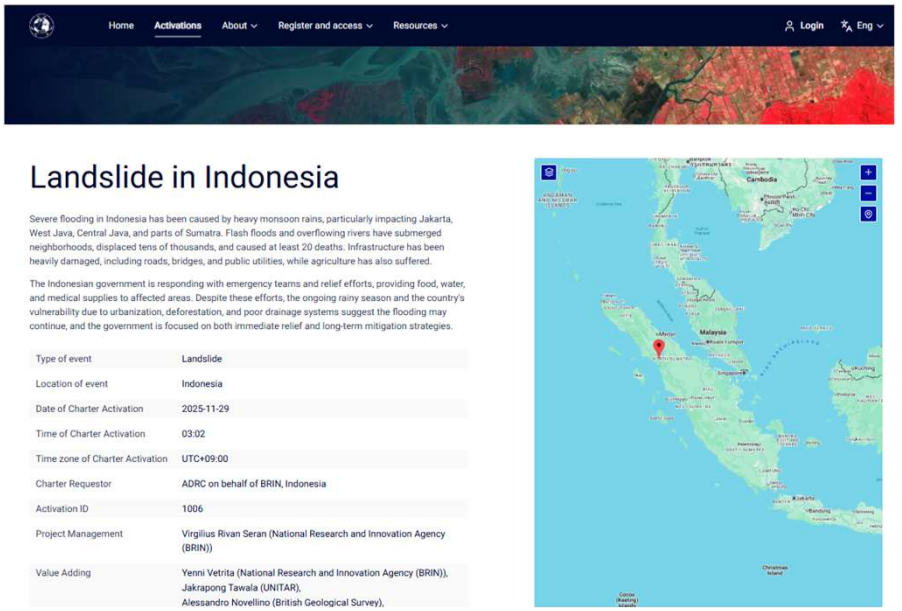
Climate Change Amplification

Environmental degradation worsening impacts.

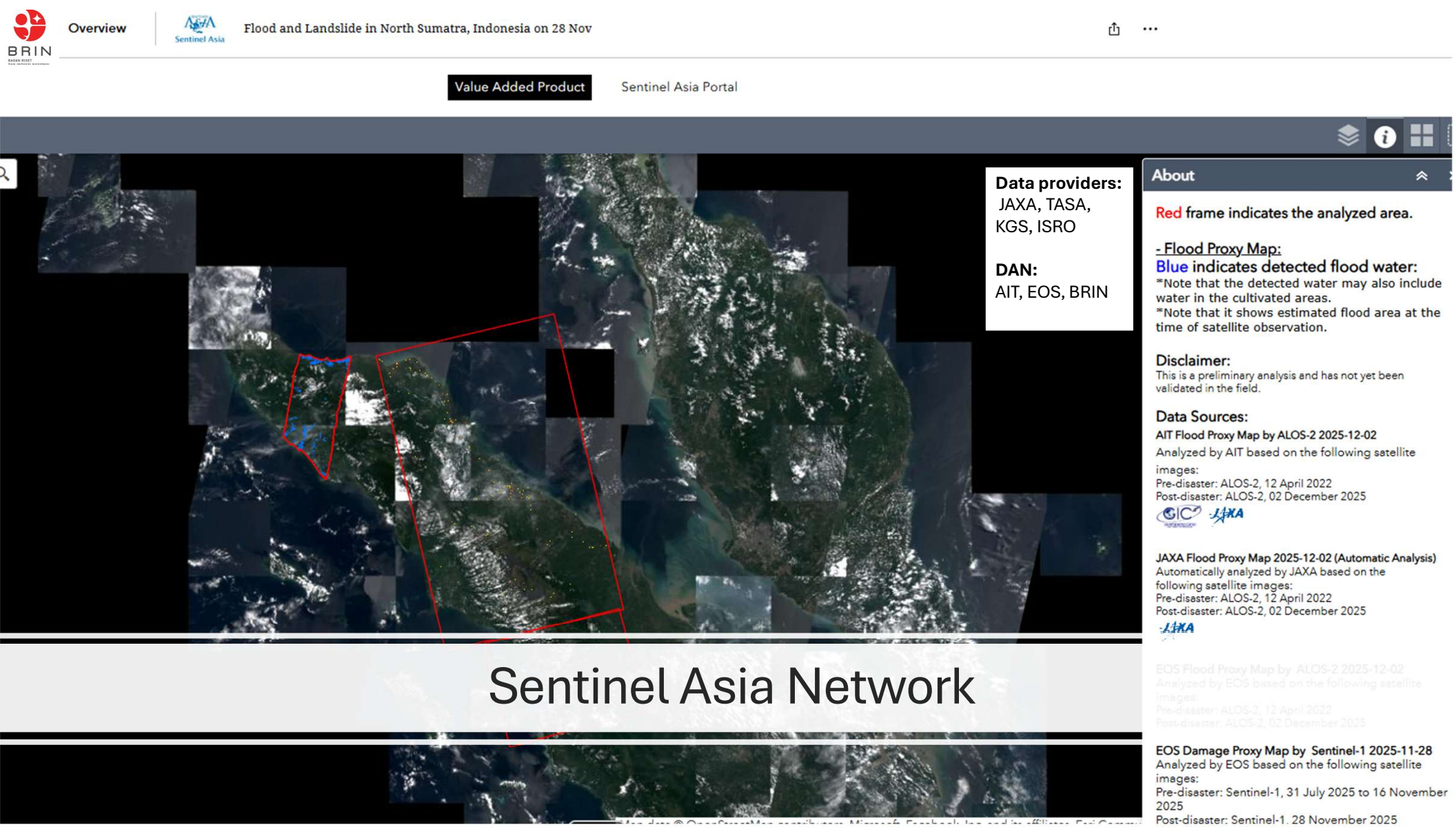
Emergency activations through Sentinel Asia and the International Charter



https://sentinel-asia.org/EO/2025/article20251128ID.html



https://disasterscharter.org/activations/landslide-in-indonesia-activation-1006-



Sentinel Asia Network

International Disaster Charter

- **Data providers**

US-Gov, CNES, ESA, and many more

- **Value adders**

BRIN, BNPB,
UGM, UNITAR/UNOSAT, British Geological Survey, ICube SERTIT, BGC Engineering

- **Satellite images retrieved through Charter**

Sentinel 1, Sentinel 2, Worldview, Pleiades, etc

Products

Landslides density in Northern-Central Sumatra

09 December 2025

Indonesia, Sibolga - Impact map

11 December 2025

Indonesia, Kasai - Impact map

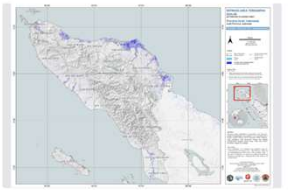
11 December 2025

Indonesia, Pandan - Impact map

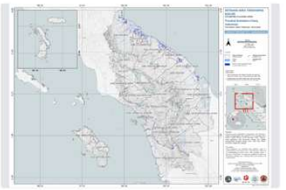
12 December 2025

Indonesia, Lubuk Ampolu - Impact map

Accumulated satellite-detected water extents



Estimated flooded Area, Province Aceh,



Estimated flooded Area, Province North

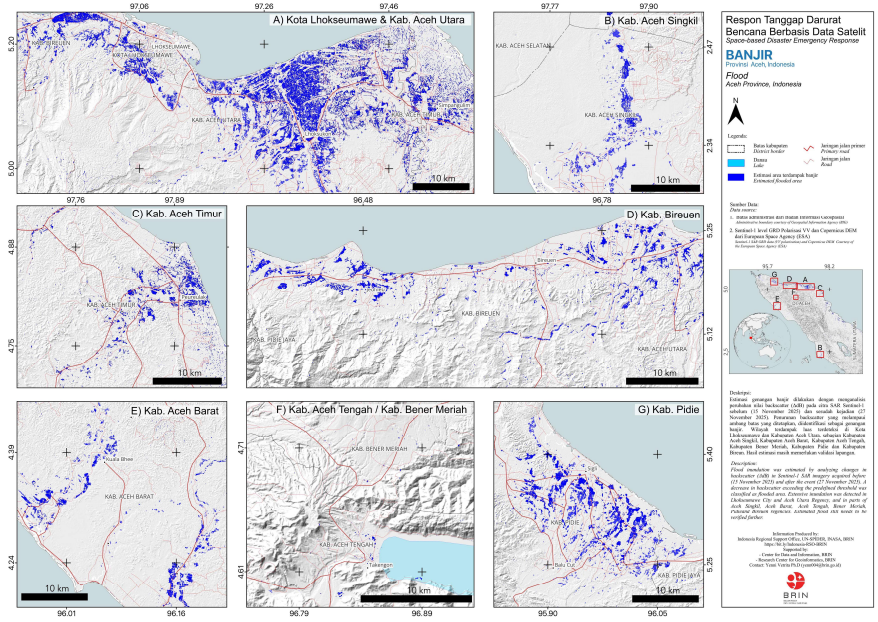
Other data or images retrieved through BRIN'spartner

- Planet, BlackSky
- UAV from the Fly for the Humanity

Key products and examples

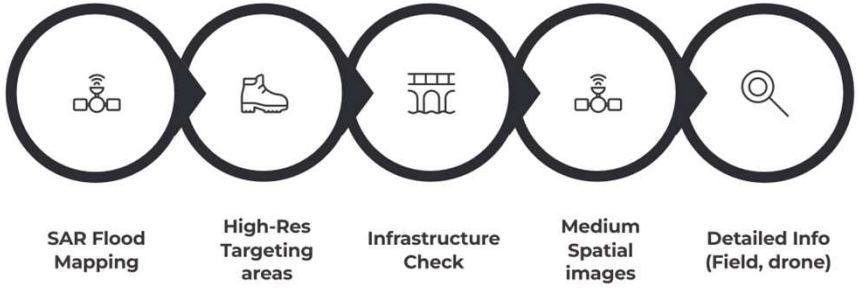
BRIN
BADAN RISET
DAN INOVASI NASIONAL

Initial flood-affected areas delivered to BNPB through Sentinel-1 quick mapping



Multi-Source Satellite Data Workflow for Flood and Landslide Impact Assessment

This integrated remote sensing approach combines satellite imagery across multiple spatial resolutions and temporal scales with ground-based data collection to rapidly assess disaster impacts across Indonesia's affected provinces.



SAR Flood Mapping

Sentinel-1 synthetic aperture radar data processed through Google Earth Engine enables large-scale flood extent mapping via backscatter change analysis across provincial boundaries, unaffected by cloud cover.

Targeted High-Resolution Analysis

Commercial very-high-resolution optical sensors deployed for specific areas with high victim counts, providing detailed structural damage assessment and infrastructure impact quantification.

Temporal change detection

Medium-to-high spatial resolution optical imagery cross-referenced with BNPB field reports to identify surface area changes over the affected areas.

Landslide Detection

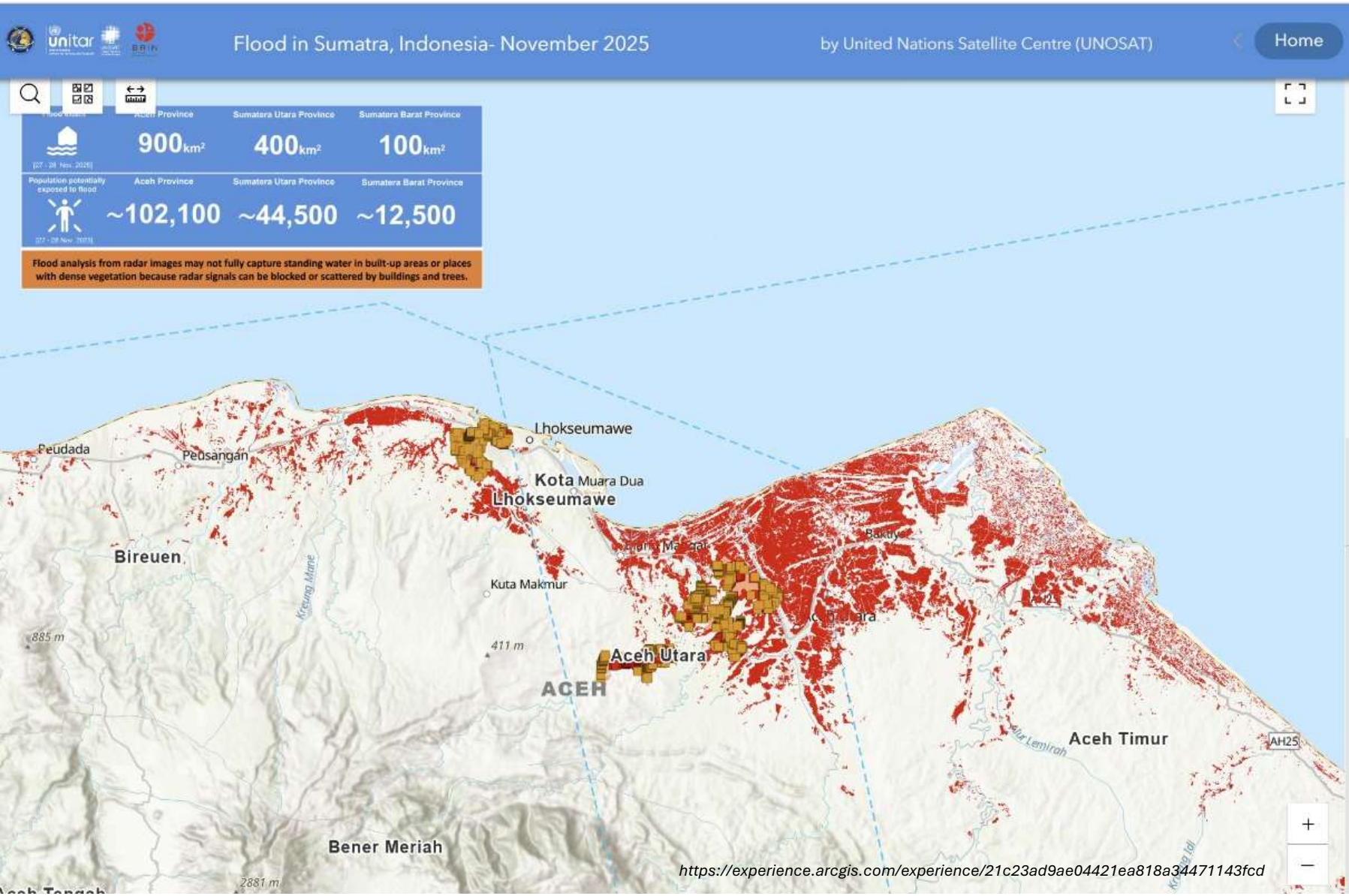
Multi-scale optical data integration from medium-resolution sensors for wider landslide identification combined with high-resolution imagery for precise scar mapping.

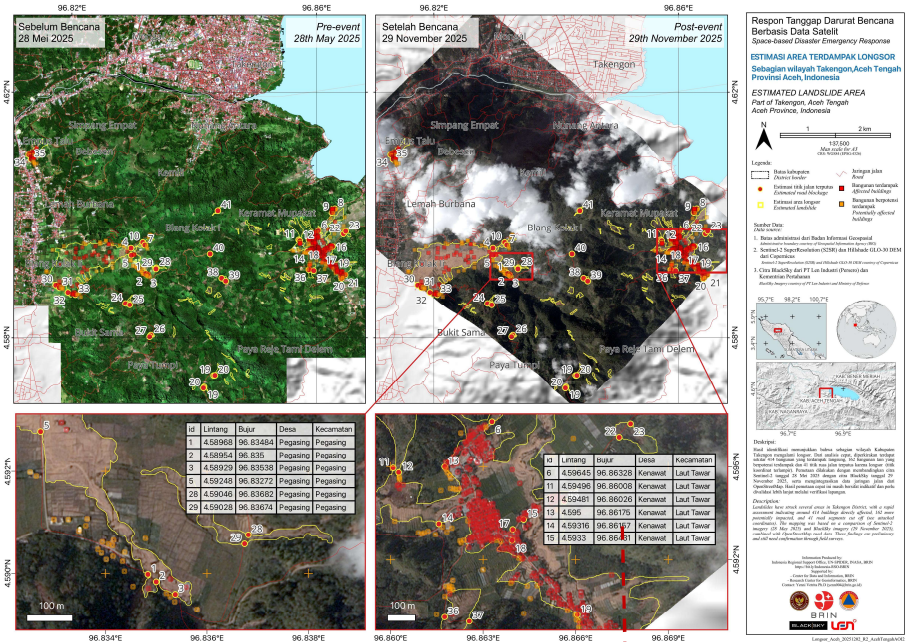
Cloud Gap-Filling Strategy

Community-operated drone surveys deployed in persistent cloud-covered regions, providing sub-meter resolution data to complete the satellite-derived disaster footprint assessment.

Ground Truth Integration

Crowd-sourced observations and stakeholder field reports incorporated throughout the analysis workflow to validate satellite interpretations and guide targeted data collection priorities.

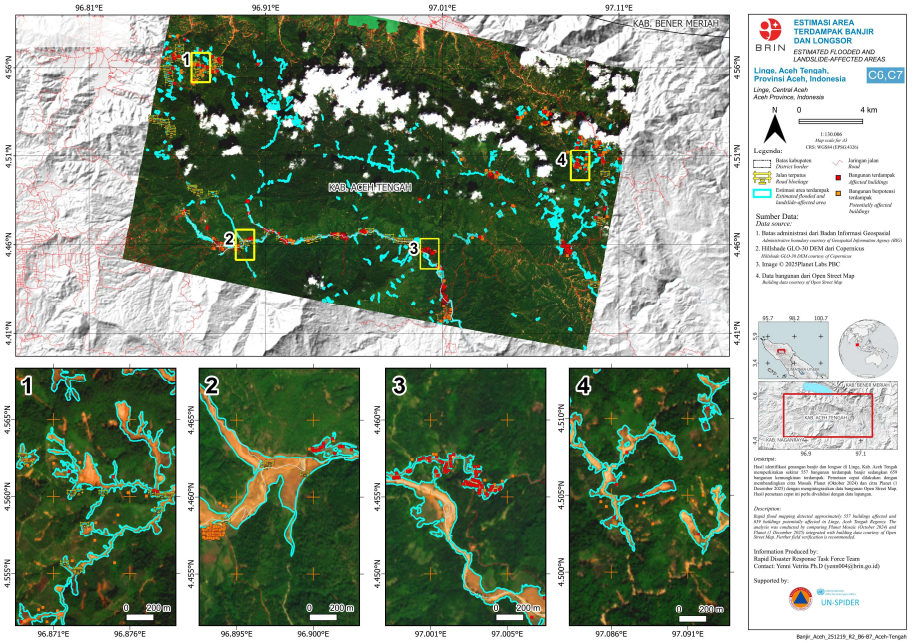

Flood in Sumatra, Indonesia- November 2025
by United Nations Satellite Centre (UNOSAT)
Home
Layers
Share
Aceh Province
Sumatera Utara Province
Sumatera Barat Province
900km²
400km²
100km²
Aceh Province
Sumatera Utara Province
Sumatera Barat Province
~102,100
~44,500
~12,500
Flood analysis from radar images may not fully capture standing water in built-up areas or places with dense vegetation because radar signals can be blocked or scattered by buildings and trees.
Aceh Province
Sumatra Utara Provinc
Sumatera Barat Provin
Building Damage Assessme
Provinsi Aceh
Takengon Aceh
Road Assessment [3 Dec
Broken Road
Building Assessment [3
Affected Buildings
Buildings Likely Affec
Lhokseumawe
Peudada
Peusangan
Kota Muara Dua
Lhokseumawe
Bireuen
Kuta Makmur
Aceh Utara
ACEH
Aceh Timur
Bener Meriah
AH25
885 m
411 m
2881 m
https://experience.arcgis.com/experience/21c23ad9ae04421ea818a34471143fcd



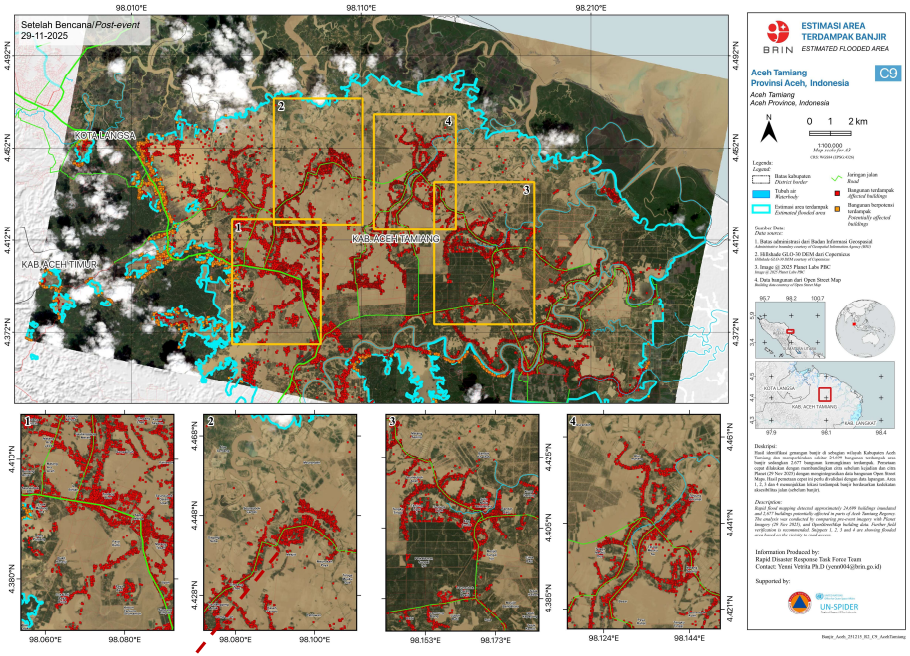
id	Lintang	Bujur	Desa	Kecamatan
1	4.58968	96.83484	Pegasing	Pegasing
2	4.58954	96.835	Pegasing	Pegasing
3	4.58929	96.83538	Pegasing	Pegasing
5	4.59248	96.83272	Pegasing	Pegasing
28	4.59046	96.83682	Pegasing	Pegasing
29	4.59028	96.83674	Pegasing	Pegasing

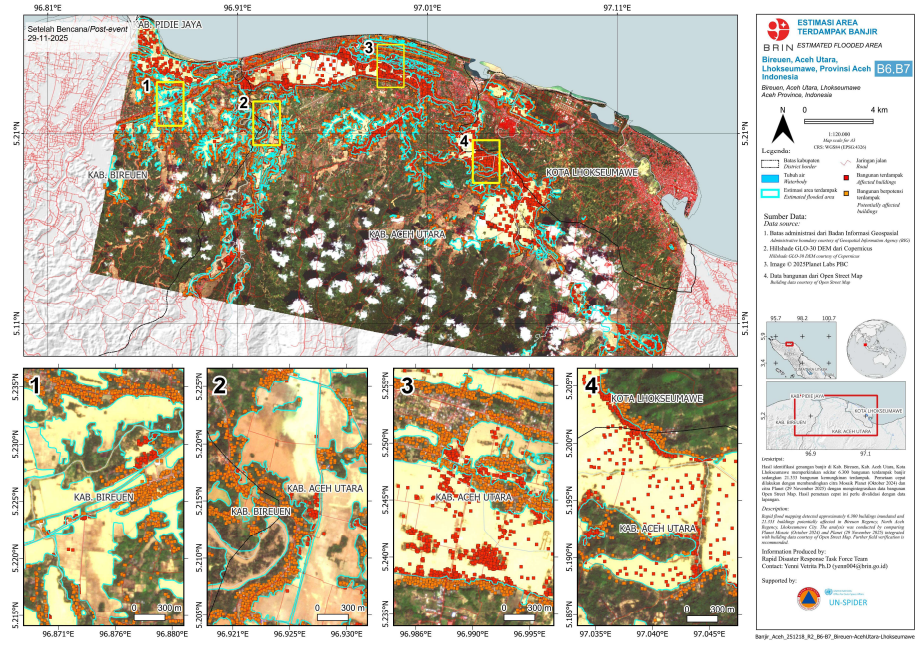
id	Lintang	Bujur	Desa	Kecamatan
6	4.59645	96.86328	Kenawat	Laut Tawar
11	4.59496	96.86008	Kenawat	Laut Tawar
12	4.59481	96.86026	Kenawat	Laut Tawar
13	4.595	96.86175	Kenawat	Laut Tawar
14	4.59316	96.86167	Kenawat	Laut Tawar
15	4.5933	96.86481	Kenawat	Laut Tawar

Coordinates indicating areas requiring specific attention
(e.g., damaged or blocked roads).



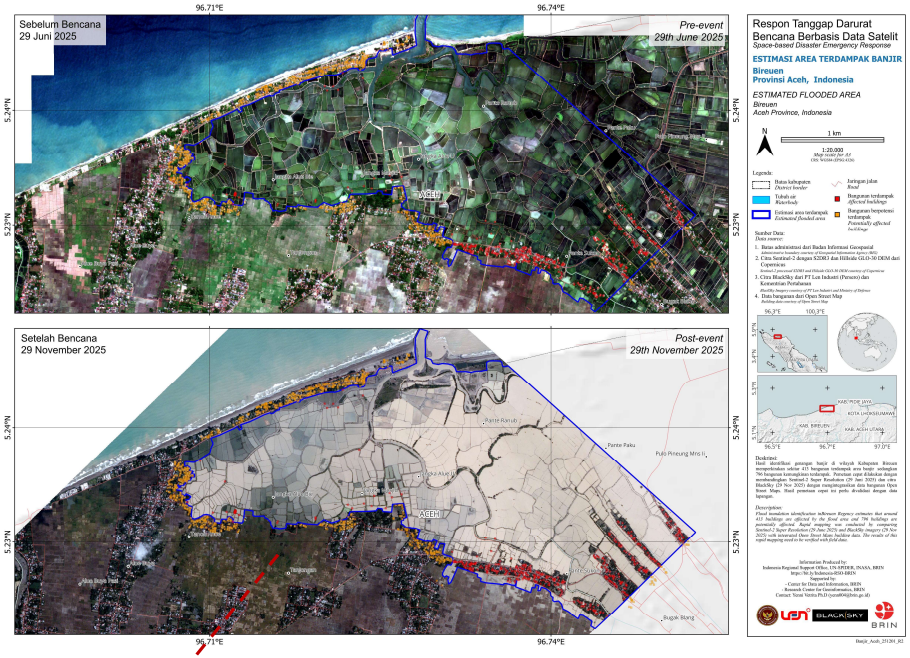
Landslides are likely scattered across multiple locations.



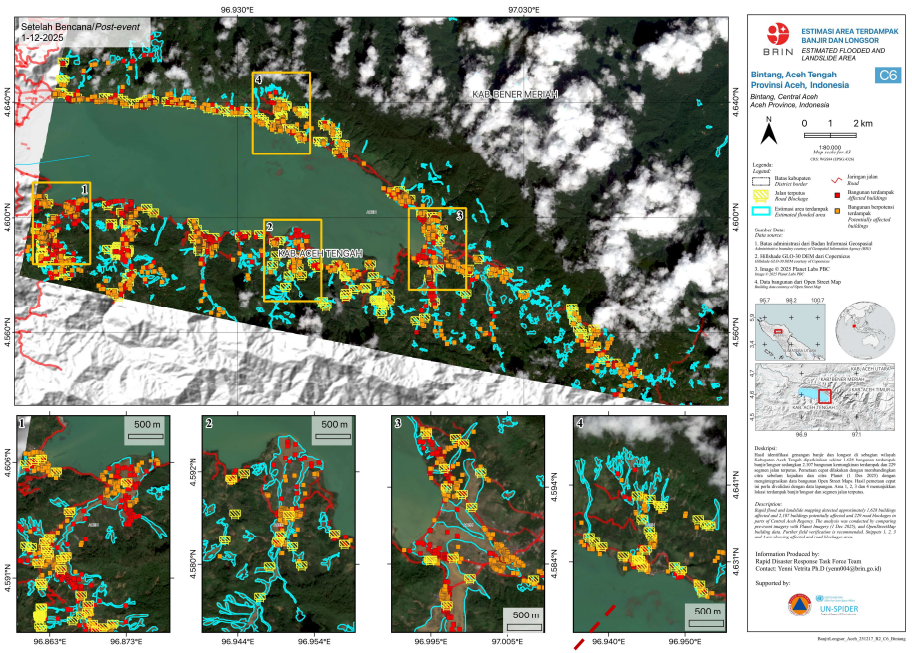


Flooded building

Massive flooding with high sediment loads from river flows damaged buildings and caused loss of life.

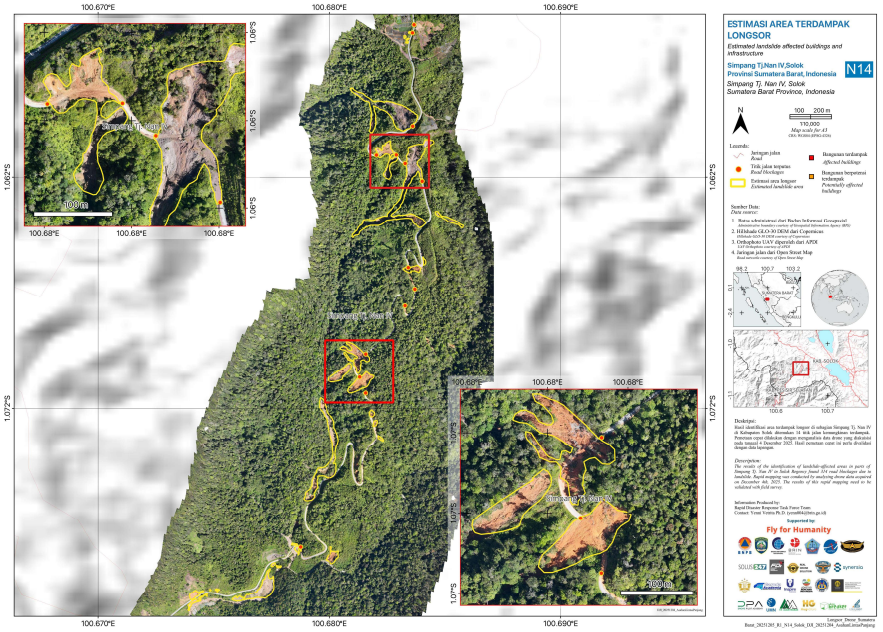


Flooded agricultural areas

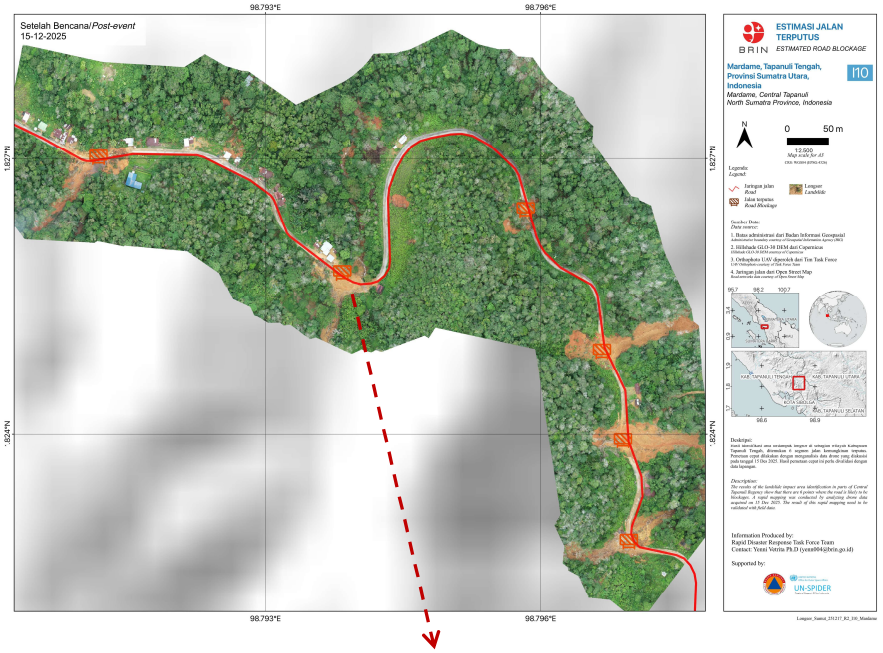


Landslides from nearby hills deposited debris into the lake; Reported through crowdsourced observations.

Unmanned Aerial Vehicle observation



- Due to limited satellite observations and the small, localized but fatal impacts, confirming road disruptions was challenging from satellite imagery alone.



- UAV imagery played a critical role in complementing satellite data and verifying whether roads were damaged or cut off.

Sumatra Flood and Landslide Response: A Multi-Satellite Coordination Success

83	118	>129	37
Impact Grids	**Estimation Maps**	**High-Resolution Imagery**	**Object Analysis**
Regional grids mapping affected areas	Area impact assessments produced	Satellite imagery maps analyzed	Infrastructure impact estimations

BRIN's team played a pivotal role in the national emergency response, coordinating massive data streams from multiple satellite providers and analytical partners.

Data Coordination

- Managed an unprecedented volume of satellite data via Sentinel Asia, International Charter, and direct provider channels, complemented by UAV imagery.
- Integrated, processed, and analyzed multi-source data in near real time to support emergency response operations.
- Key sources included Sentinel satellites, high-resolution commercial imagery, and specialized disaster monitoring systems.
- Applied advanced remote-sensing workflows and distributed outputs through established emergency response channels.

Analytical Partners

- The response leveraged expertise from domestic and international partners:
  - BNPB and all relevant stakeholders, UGM, UNDIP, Fly for Humanity (UAV)
  - British Geological Survey, Rapid Mapping Service SERTIT, UNITAR, BGC Engineering, AIT, EOS, JAXA
- These partnerships enabled rapid mapping, validation, specialized analysis, and cross-verification of satellite-based damage assessments.

Innovation

The team developed a platform to visualize multiscale, multi-source data to meet requests from stakeholders, humanitarian actors, and the public.

Data and information sharing with BNPB

https://gis.bnpb.go.id/bansorsumatera2025/

Sentinel Asia SAR training inJakarta (capacity building)

Sentinel Asia Training on SAR Data Analysis for Flood Mapping and Damage Assessment

- **Location:** Jakarta, 16–18 June 2025
- **15 Participants:** Indonesian agencies (BRIN, PVMBG, BNPB)
- **Instructors:** AIT, Universitas Diponegoro (UNDIP), and JAXA/Sentinel Asia
- **Support:** JAXA and BRIN
- **Focus:** SAR-based urban flood mapping and damage assessment techniques

Training feedback and Suggestions

Feedback

- The training met participants' capacity-building expectations.
- Learning gains varied due to different SAR skill levels, ranging from SNAP and Google Colab basics to advanced post-disaster analysis.

Future training needs

- InSAR applications for deformation and land subsidence.
- Open-access tools for large-scale processing.
- Longer courses with tiered tracks by skill level, covering programming and AI.
- A dedicated volcanic assessment module for participants without remote-sensing backgrounds.

Lessons learned

Multi-source, multiscale data plus strong inter-agency collaboration improved early-response outputs.

Satellite products became a reliable benchmark when validated with field, UAV, SAR, and optical data.

Rapid mapping worked well, but constraints remain: clouds, small landslide footprints, and complex urban flooding.

Future plan

Deploy automated, AI-enabled processing for faster, repeatable multi-hazard mapping.

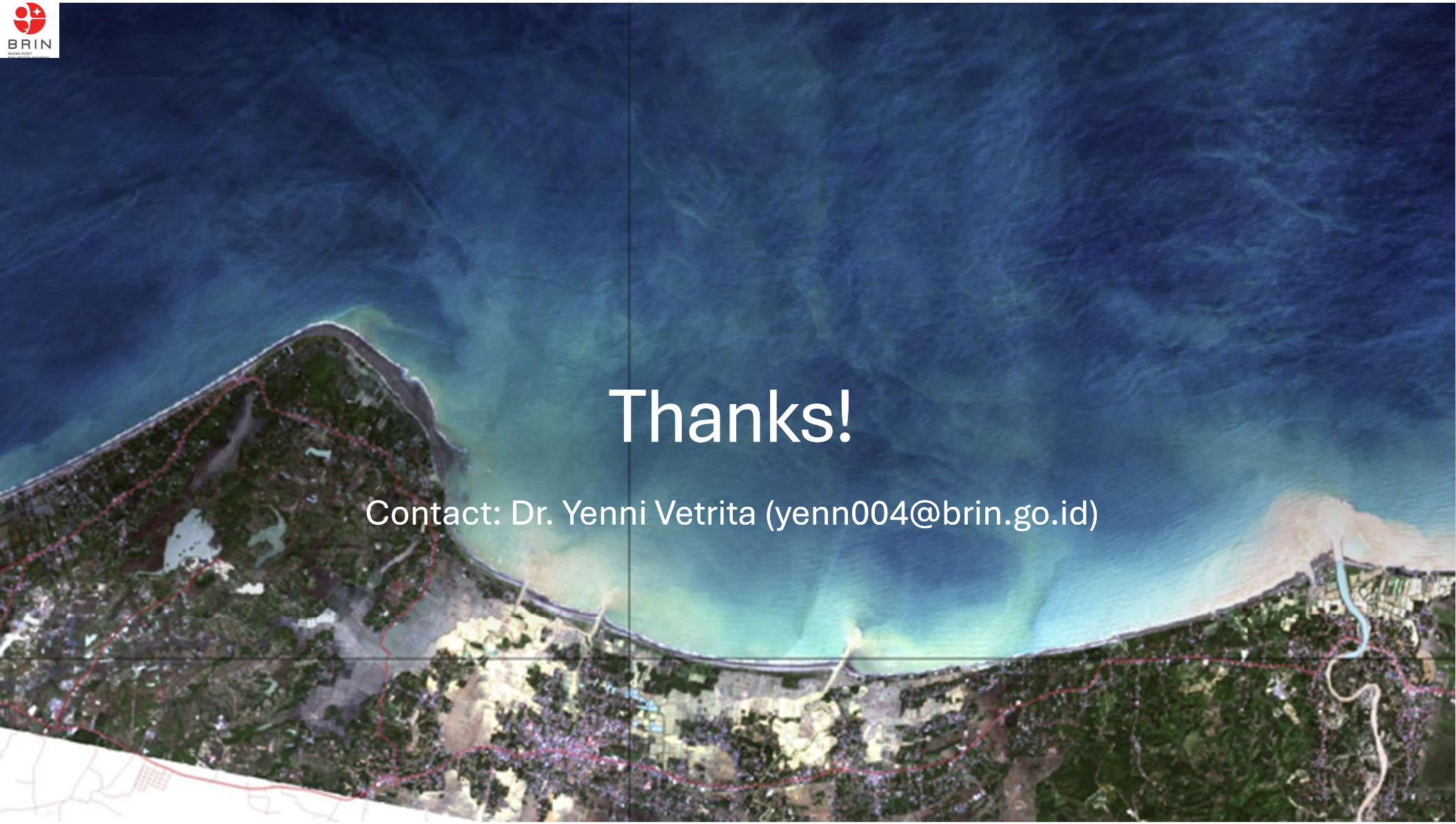
Build an integrated multiscale data stack (field, UAV, SAR, optical, VHR) with standardized QA/QC and version control.

Strengthen collaboration protocols (data sharing, tasking, validation) with Sentinel Asia, the International Charter, and national partners

Our passionate team

Partners


BNPB
DEFEND ID
Defence Industry Indonesia
UNOSAT
SENTINEL ASIA
International Charter Space & Major Disasters
Charte Internationale Espace et Catastrophes Majeures
Fly for Humanity
SEMARANG
planet.
BLACK SKY
JAXA



Thanks!

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