Earth Observation for Disaster Risk Management: From Images to Decisions

Queensland Earth Observation Hub Workshop; Transforming Queensland's Disaster Resilience from Space

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EO 101

Earth observation (EO) = *measuring the Earth's surface and atmosphere from:*

– Satellites
– Aircraft & drones
– Ground / in-situ sensors

Repeated in time → to support decisions.

Why EO matters for disasters:

✓ See large areas consistently

✓ Track change over time

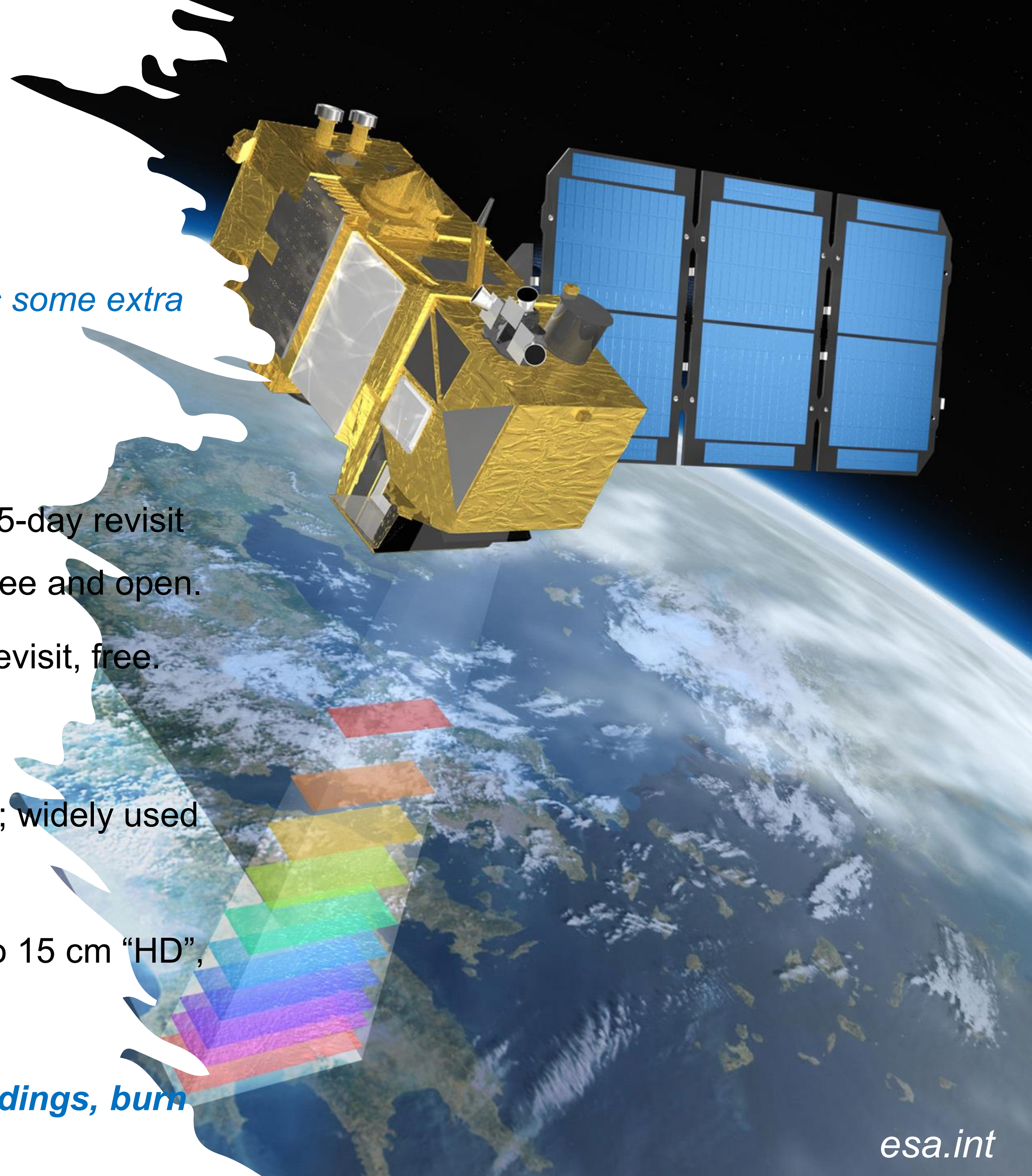
✓ Combine with models + local data → better decisions

Main EO data types

1) Optical & infrared imagery *(like Google Earth pictures, plus some extra ‘invisible’ infrared bands)*

- Public:
  - **Sentinel-2** (Copernicus, EU): 10 m – 60 m resolution, ~5-day revisit with 2 satellites, 2–3 days at mid-latitudes; completely free and open.
  - **Landsat 8/9** (USGS/NASA): ~30 m, ~8-day combined revisit, free.
- Commercial:
  - **PlanetScope**: daily, ~3–5 m resolution, global coverage; widely used for rapid flood and damage mapping.
  - **Maxar**: 30 cm native resolution, sometimes enhanced to 15 cm “HD”, used heavily in disaster and defence.

Use in disasters: water extent, landslides, damaged buildings, burn severity.



nasa.gov

2) Radar / Synthetic Aperture Radar (SAR) *(Satellite sends out radio waves and measures the echo, so we can see floods and ground changes through cloud, rain and at night)*

- Public:
  - **Sentinel-1** (Copernicus): C-band SAR; ~10–20 m spatial; global, all-weather; feeds global flood monitoring and Copernicus EMS.
- Commercial:
  - **ICEYE**: SAR constellation (tens of satellites) delivering near-real-time flood and bushfire “insights” – flood depth and extent maps often within ~24 hours of peak.
- Near-future: **NISAR** (NASA–ISRO), dual-frequency SAR to monitor land deformation, ice, etc., revisiting every 12 days – relevant for ground deformation, landslides, infrastructure.

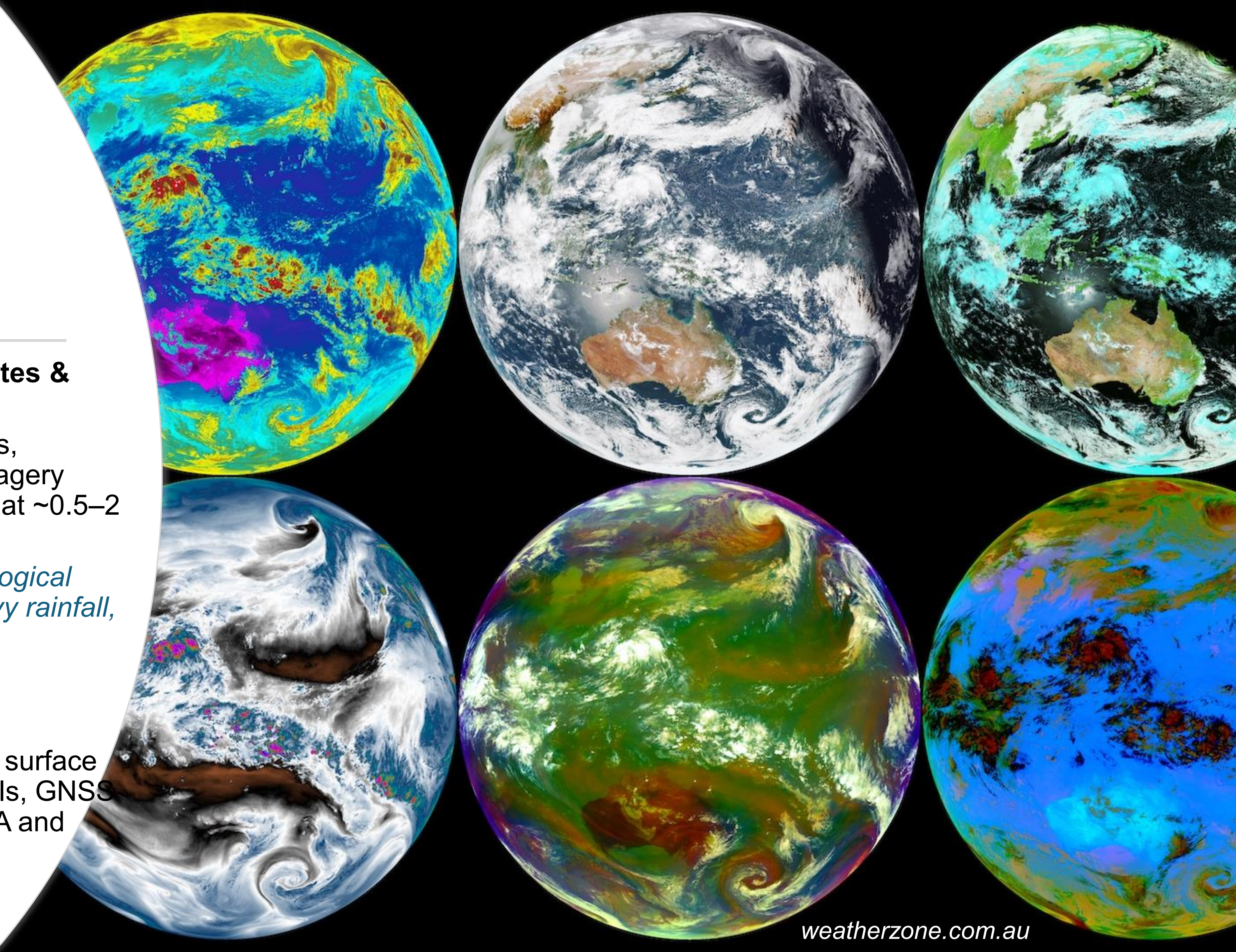
3) Geostationary weather satellites & radar

GOES-R series over the Americas, Himawari-9 over Asia–Pacific: imagery every ~10 minutes (sometimes 5) at ~0.5–2 km resolution.

These feed national meteorological agencies for storm tracking, heavy rainfall, and nowcasting.

4) Other EO "families"

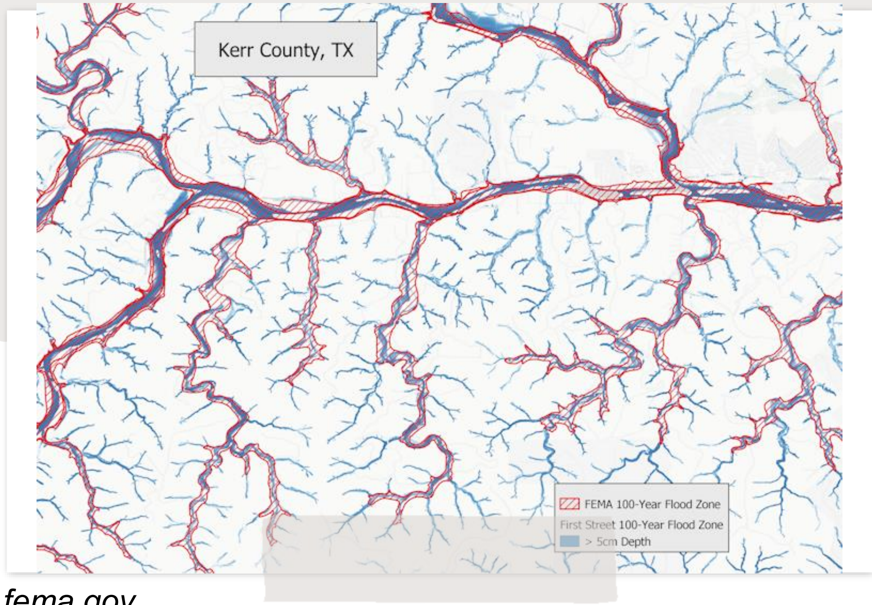
Soil moisture (SMAP/SMOS), sea surface temperature, altimetry & river levels, GNSS-based sensors; part of NASA, ESA and other agencies' fleets.



Disaster risk management cycle: where EO plugs in

- Before: risk assessment, planning, mitigation.
- During: situational awareness, prioritization.
- After: damage assessment, learning, resilience building.

Before; risk and preparedness



fema.gov

- **Floodplain & coastal hazard mapping**

- In the US, **FEMA flood maps** combine base imagery and DEMs plus hydrologic/hydraulic modelling to map 100-year and other flood zones.

These guides zoning, building codes, insurance requirements.

- European flood and risk systems, the **European Flood Awareness System (EFAS)** provides pan-European hydrological forecasts using consistent data (including EO-derived forcing and hydrological models).

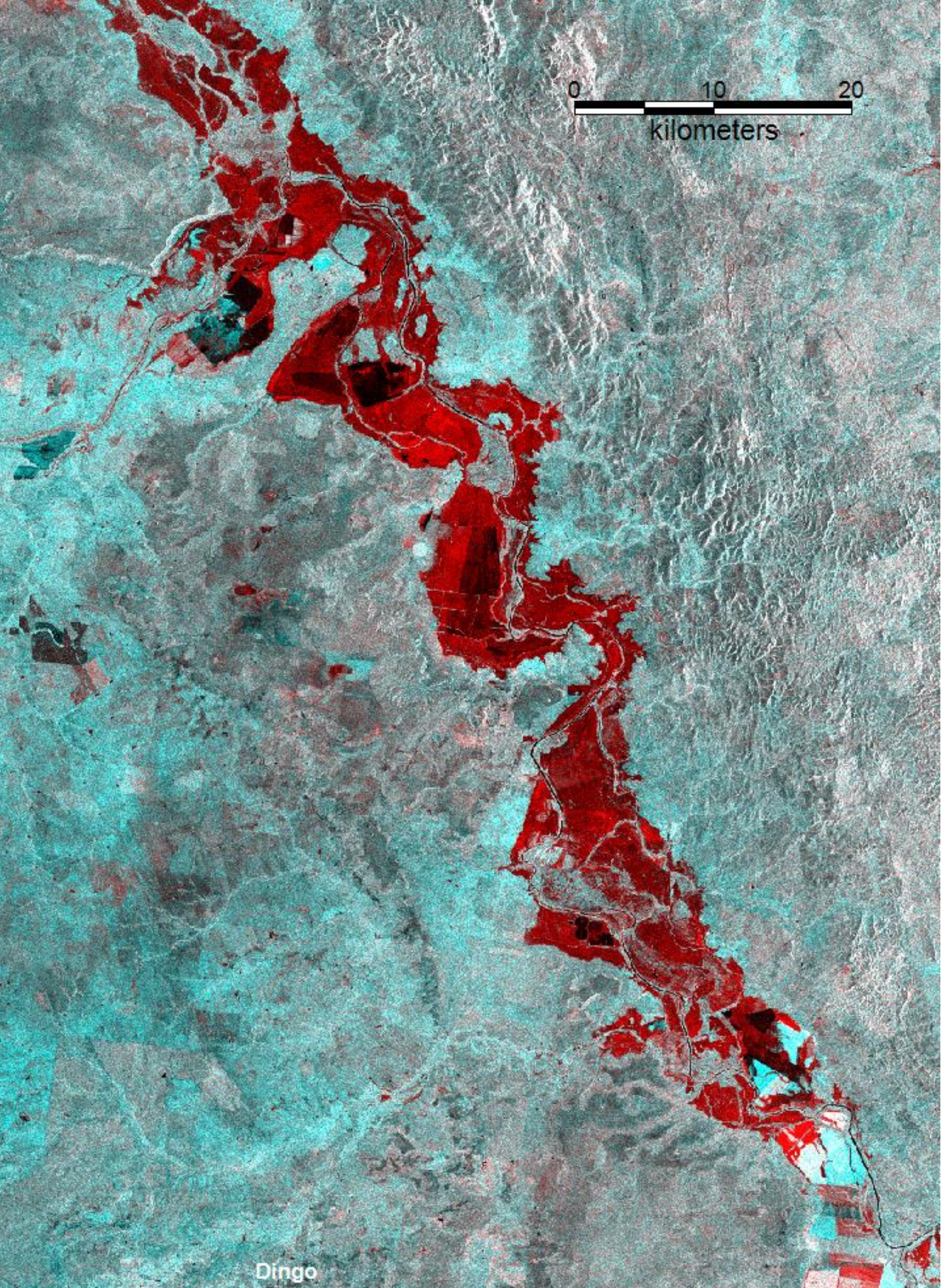
EO is used to characterize catchments, soil moisture, snow, land cover, etc., which feed into model calibration and risk assessments.

- **Catchment condition & exposure**

Using mid-resolution EO (Sentinel-2, Landsat) you can map:

  - Impervious surfaces, deforestation, wetland loss.
  - Urban expansion into floodplains.

This supports ***"Where do we really allow development?", "Which communities are getting more exposed over time?"***



global-flood.emergency.copernicus.eu

During; response

✓ **Copernicus Emergency Management Service – Rapid Mapping**

Provides flood (and other hazard) maps within **hours to days** after a satellite overpass, using Sentinel-1/2 and other sensors.

✓ **Global Flood Monitoring (GFM) integrated with GloFAS**

Continuous, near-real-time global flood monitoring from Sentinel-1 SAR, fully automated; complements early warning and rapid mapping.

✓ **NASA Disasters Program & Response Coordination System**

NASA's Disasters team uses satellites (e.g. Landsat, Sentinel-2, radar missions) to deliver flood maps, landslide susceptibility, and damage layers to US and international partners during hurricanes and floods.

❖ **Commercial near-real-time services**

- ICEYE Flood Insights: SAR-based flood extent and depth at structure scale, typically delivered within ~24 hours of peak flooding; adopted by insurers and governments.

- PlanetScope and other optical constellations: daily, 3 m imagery supports urban flood mapping where clouds permit.

✓ **Severe weather situational awareness**

GOES-R and similar geostationary satellites deliver imagery every ~10 minutes over the Americas (similar frequency with Himawari in Asia-Pacific), feeding national nowcasting systems for convective storms and heavy rainfall.

abs.net.au

AFTER: recovery and learning

- ✓ **Damage assessment**

Before/after high-resolution imagery (e.g. Maxar, Airbus) is used by US and European agencies, insurers and NGOs to count damaged buildings, washed-out roads, etc.

Used in appeals to international funds, post-disaster needs assessments.

- ✓ **Recovery monitoring**

Sentinel-2 / Landsat time series track vegetation regrowth, reconstruction, and persistent damage or abandonment.

- ✓ **Learning & "building back better"**

Satellite and model data from past events are re-analysed to test: *If we had different levees, zoning or evacuation routes, how would impacts change?*

This supports policy and infrastructure design changes in FEMA, EU, and national agencies.

Gaps and Barriers

1. Discoverability & access

How much people are aware of these capabilities?

2. Timeliness & reliability

- Latency can still be too high for flash floods and short-fuse events.
- Not all areas get the same acquisition priority.

3. Translation to decisions

- Disaster managers want: *"What do I close? Where do I send crews? Who's affected?"*; not a 40-page technical PDF.
- Need integration into existing tools (dashboards, GIS, planning systems) and legal frameworks (e.g. FEMA, EU Civil Protection).

4. Trust & validation

Agencies need clear **accuracy statements**, uncertainty, and independent validation.

The capabilities are there; it's just a matter of translating them "carefully" to the decision!

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Any question is welcome!

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