Mapping Tsunami Disaster Impact of Indonesia by Satellite Remote Sensing

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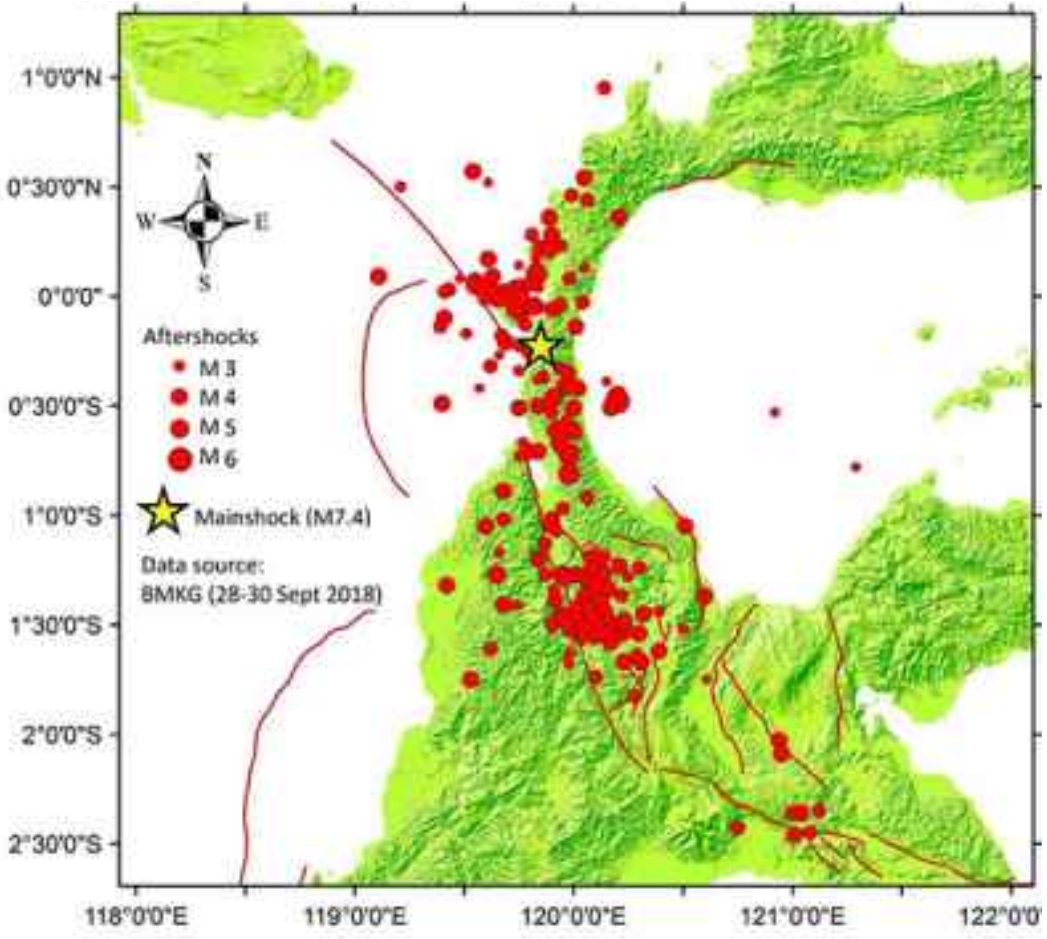
LAPAN

KEMENTERIAN KELAUTAN DAN PERIKANAN

The 28 September Earthquake Tsunami of Sulawesi, Indonesia
M7.5, 10:02:45 (UTC), 18:04:44 (Local time)



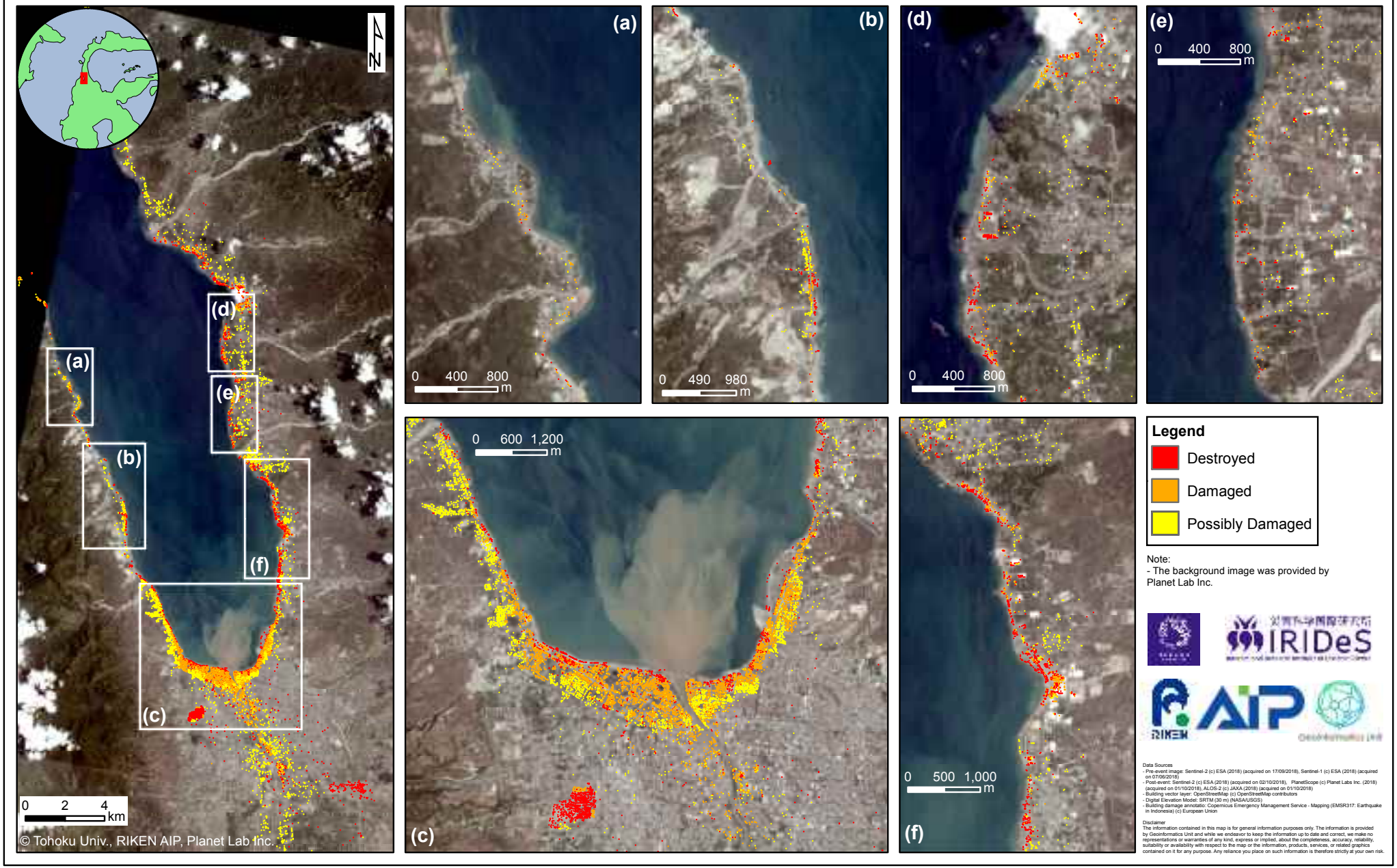
BMKG

Digital Globe

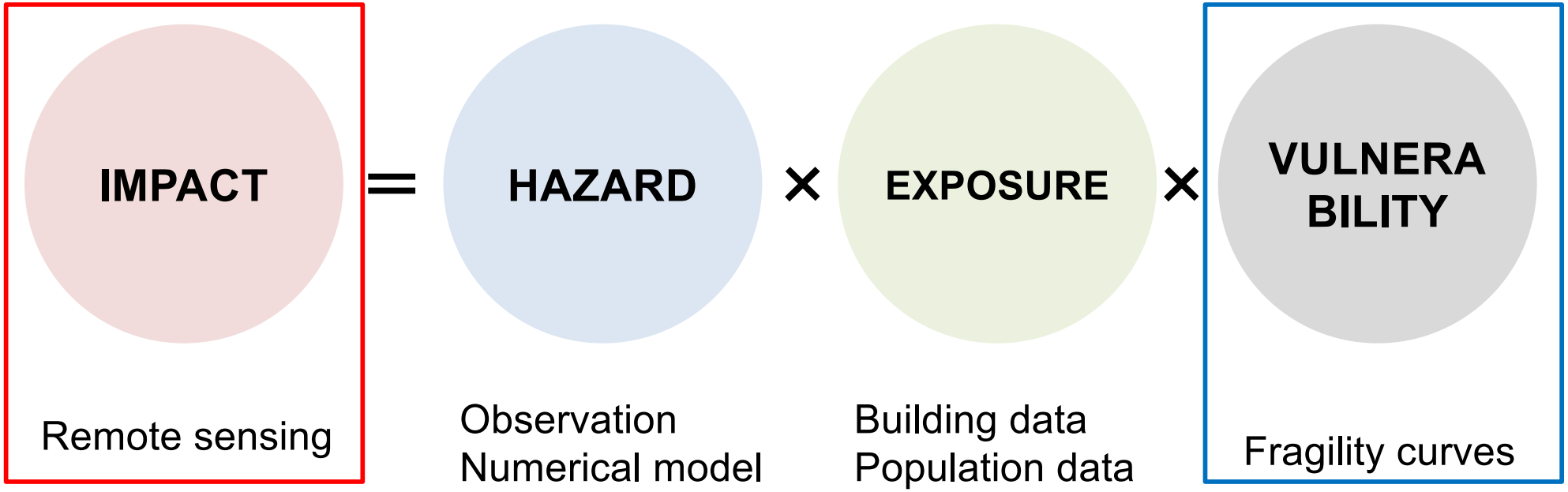
Objectives

- Developing satellite remote sensing methods and mapping technology based on emergency earth observation for identifying impacts and vulnerabilities as emergency response efforts in future major disasters.
- Understanding building vulnerability of Palu, as a form of “Tsunami Fragility Curve”.

Remote Sensing Approach for Mapping Damage



Disaster Impact
Consequences of the interaction among hazards and exposure



remote sensing

MDPI

Article

Multi-Source Data Fusion Based on Ensemble Learning for Rapid Building Damage Mapping during the 2018 Sulawesi Earthquake and Tsunami in Palu, Indonesia

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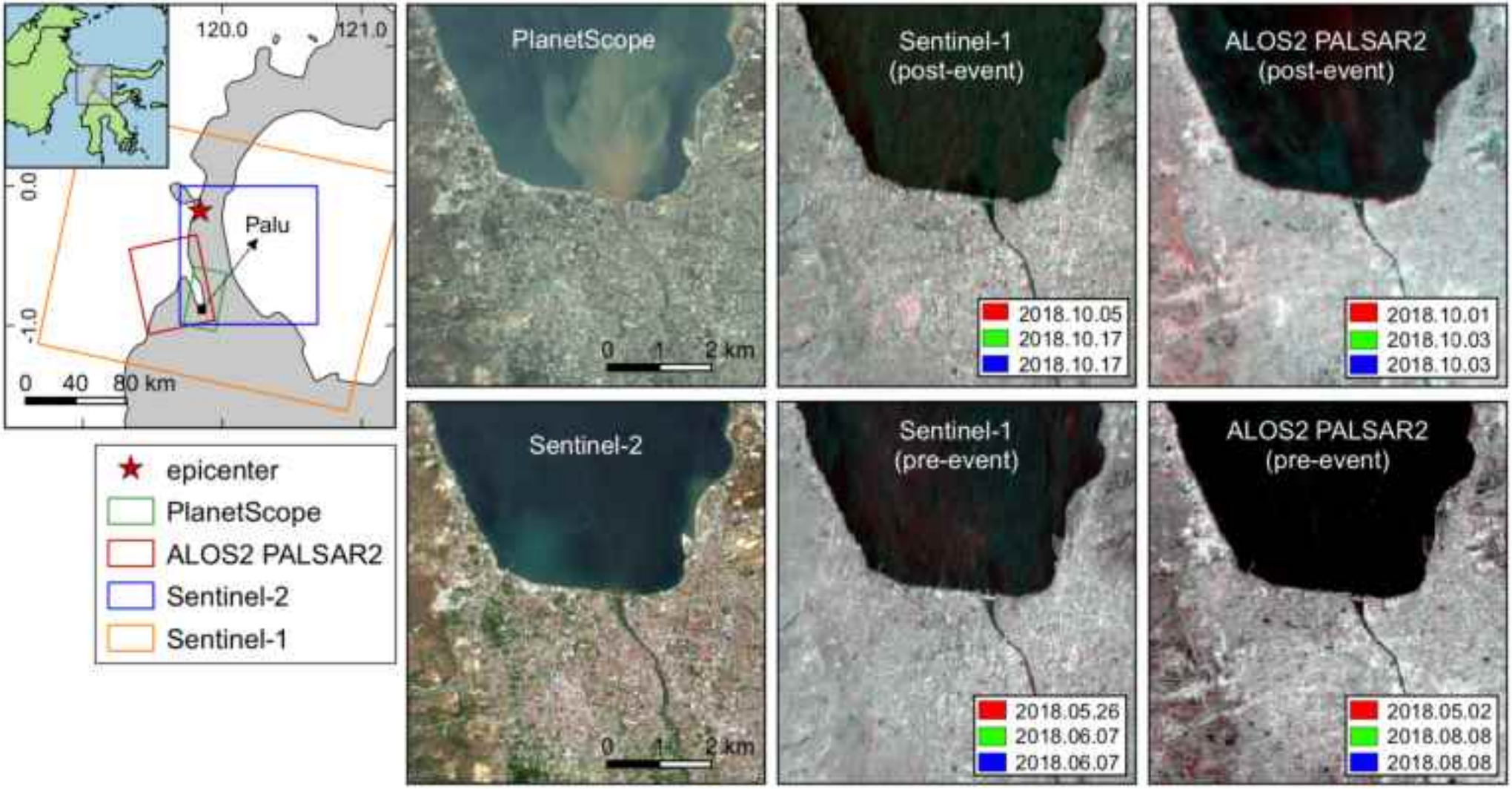
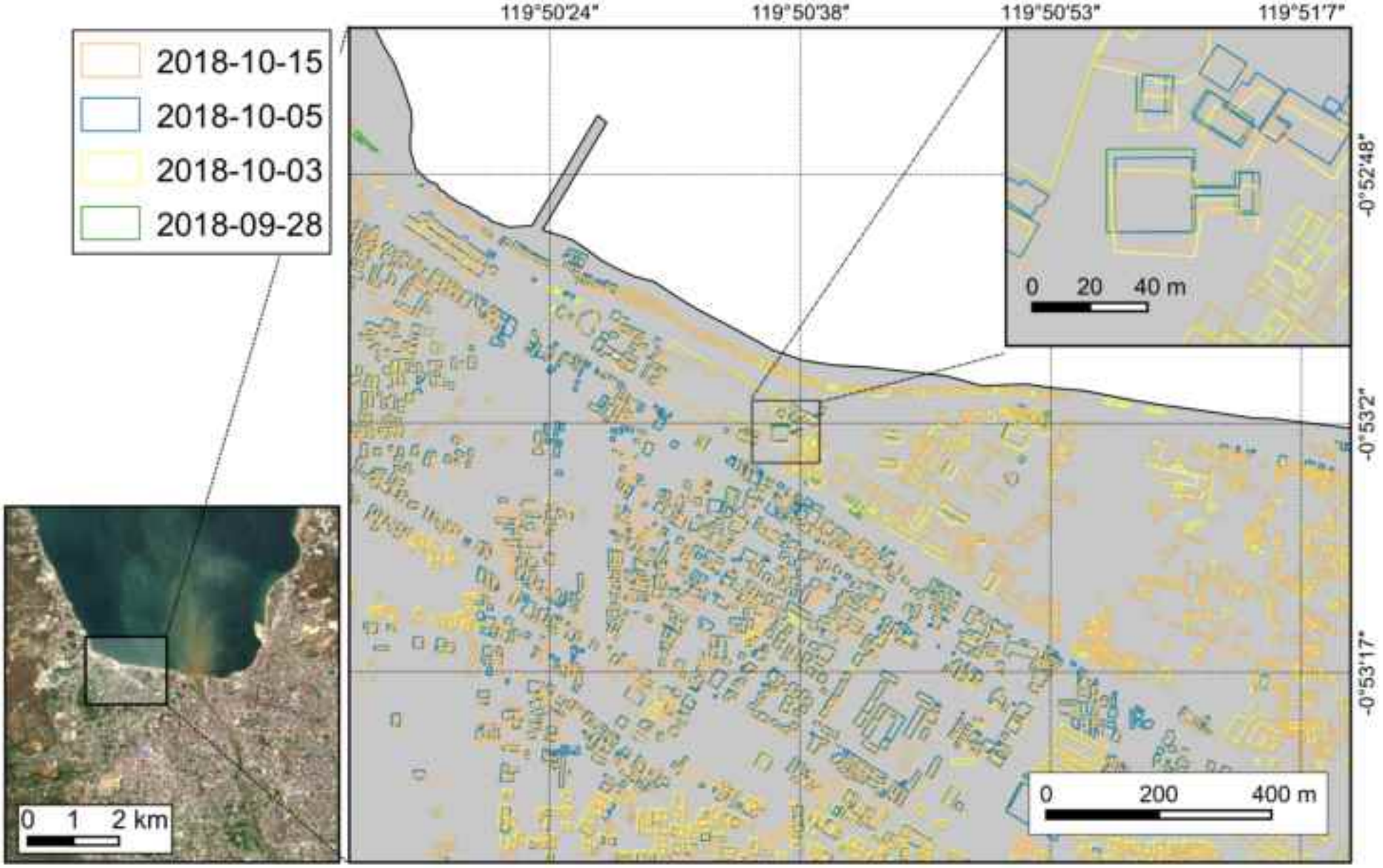
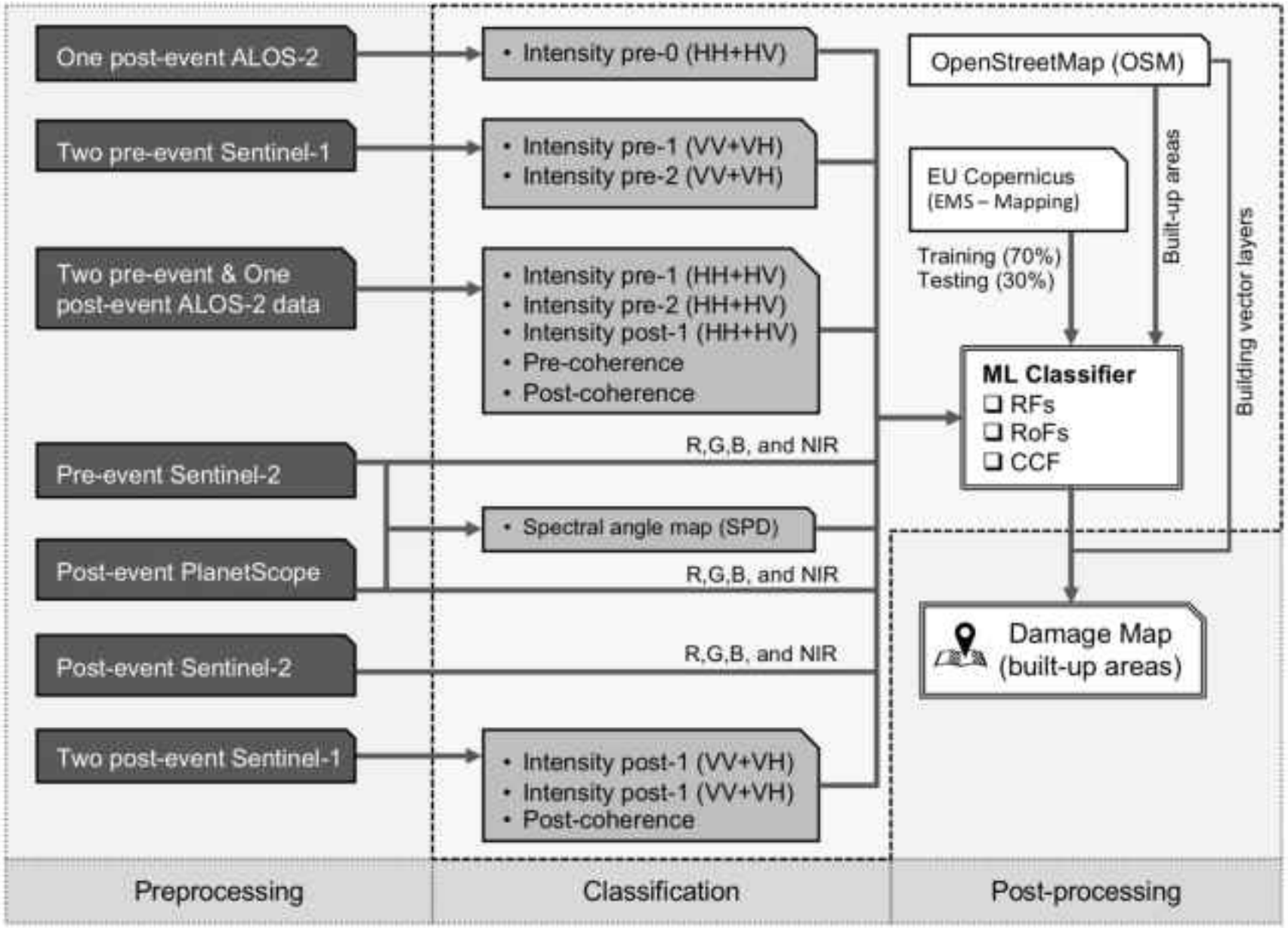
Dataset


120.0
121.0
0.0
-1.0
Palu
0 40 80 km
epicenter
PlanetScope
ALOS2 PALSAR2
Sentinel-2
Sentinel-1
PlanetScope
0 1 2 km
Sentinel-1
(post-event)
2018.10.05
2018.10.17
2018.10.17
ALOS2 PALSAR2
(post-event)
2018.10.01
2018.10.03
2018.10.03
Sentinel-2
0 1 2 km
Sentinel-1
(pre-event)
2018.05.26
2018.06.07
2018.06.07
ALOS2 PALSAR2
(pre-event)
2018.05.02
2018.08.08
2018.08.08

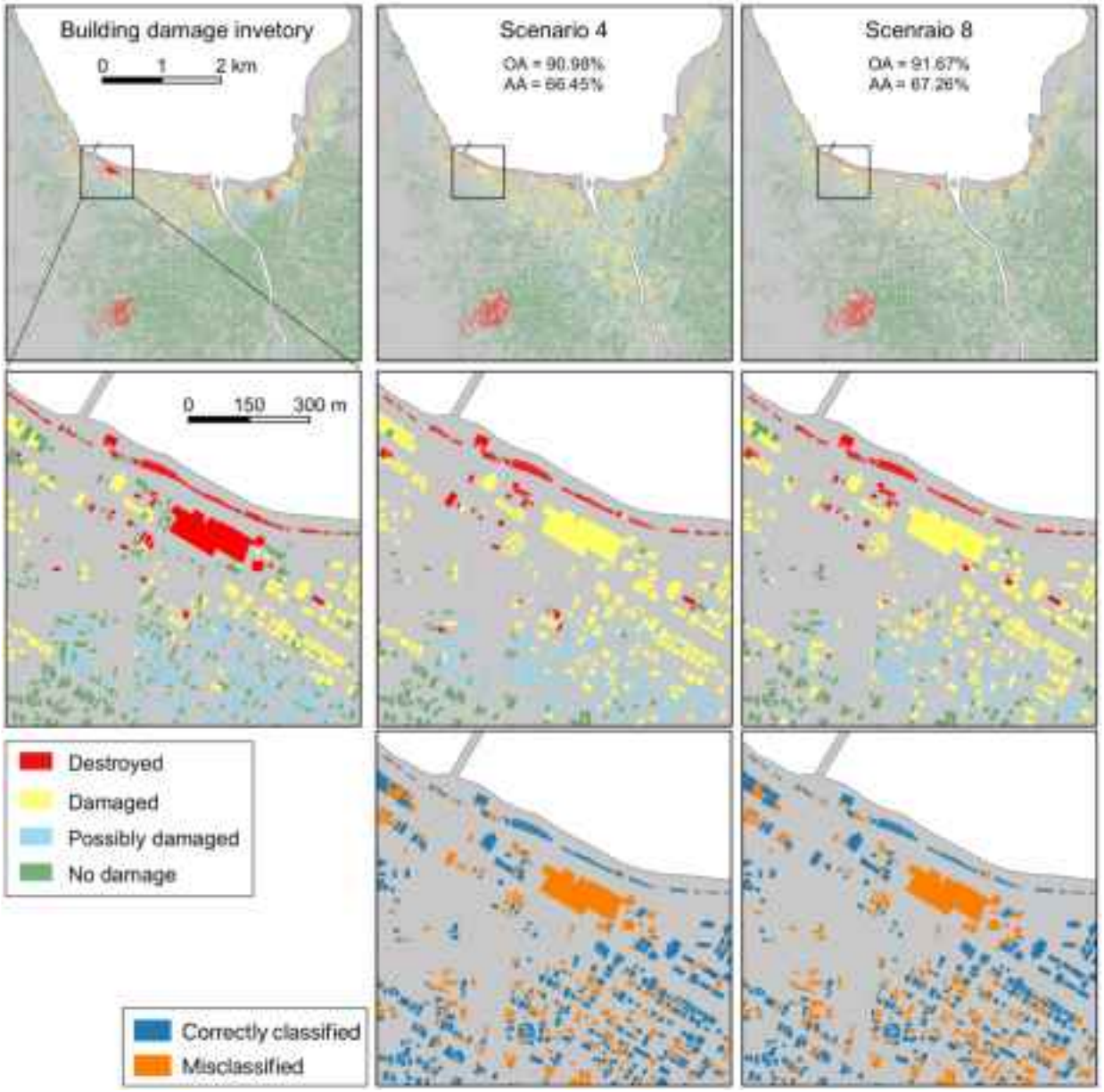
Dataset


2018-10-15
2018-10-05
2018-10-03
2018-09-28
119°50'24"
119°50'38"
119°50'53"
119°51'7"
-0°52'48"
-0°53'2"
-0°53'17"
0 20 40 m
0 200 400 m
0 1 2 km

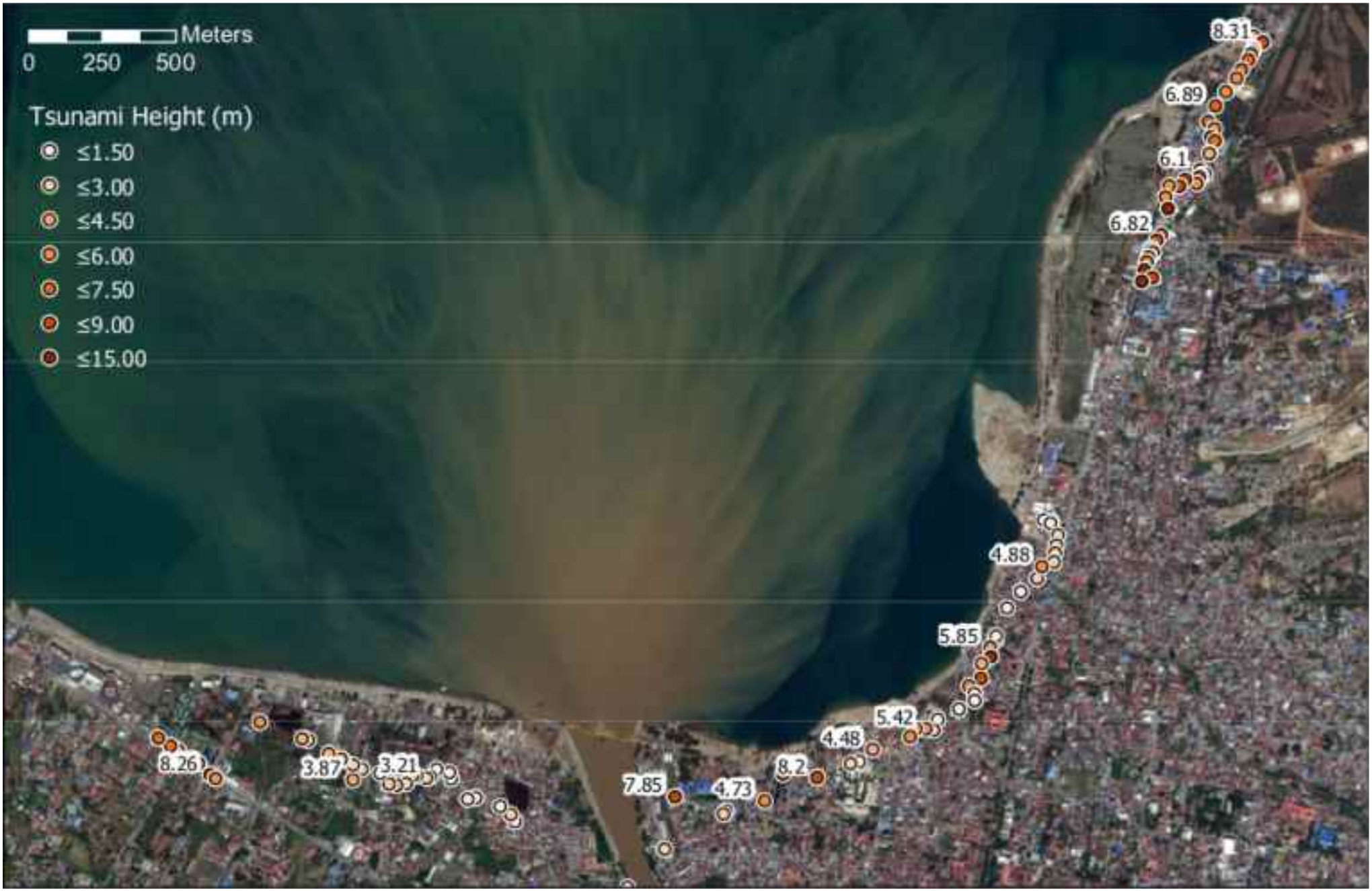
Work Flow


One post-event ALOS-2
Two pre-event Sentinel-1
Two pre-event & One post-event ALOS-2 data
Pre-event Sentinel-2
Post-event PlanetScope
Post-event Sentinel-2
Two post-event Sentinel-1
• Intensity pre-0 (HH+HV)
• Intensity pre-1 (VV+VH)
• Intensity pre-2 (VV+VH)
• Intensity pre-1 (HH+HV)
• Intensity pre-2 (HH+HV)
• Intensity post-1 (HH+HV)
• Pre-coherence
• Post-coherence
R,G,B, and NIR
• Spectral angle map (SPD)
R,G,B, and NIR
R,G,B, and NIR
• Intensity post-1 (VV+VH)
• Intensity post-1 (VV+VH)
• Post-coherence
OpenStreetMap (OSM)
EU Copernicus (EMS – Mapping)
Training (70%)
Testing (30%)
Built-up areas
Building vector layers
ML Classifier
❑ RFs
❑ RoFs
❑ CCF
Damage Map (built-up areas)
Preprocessing
Classification
Post-processing

Results

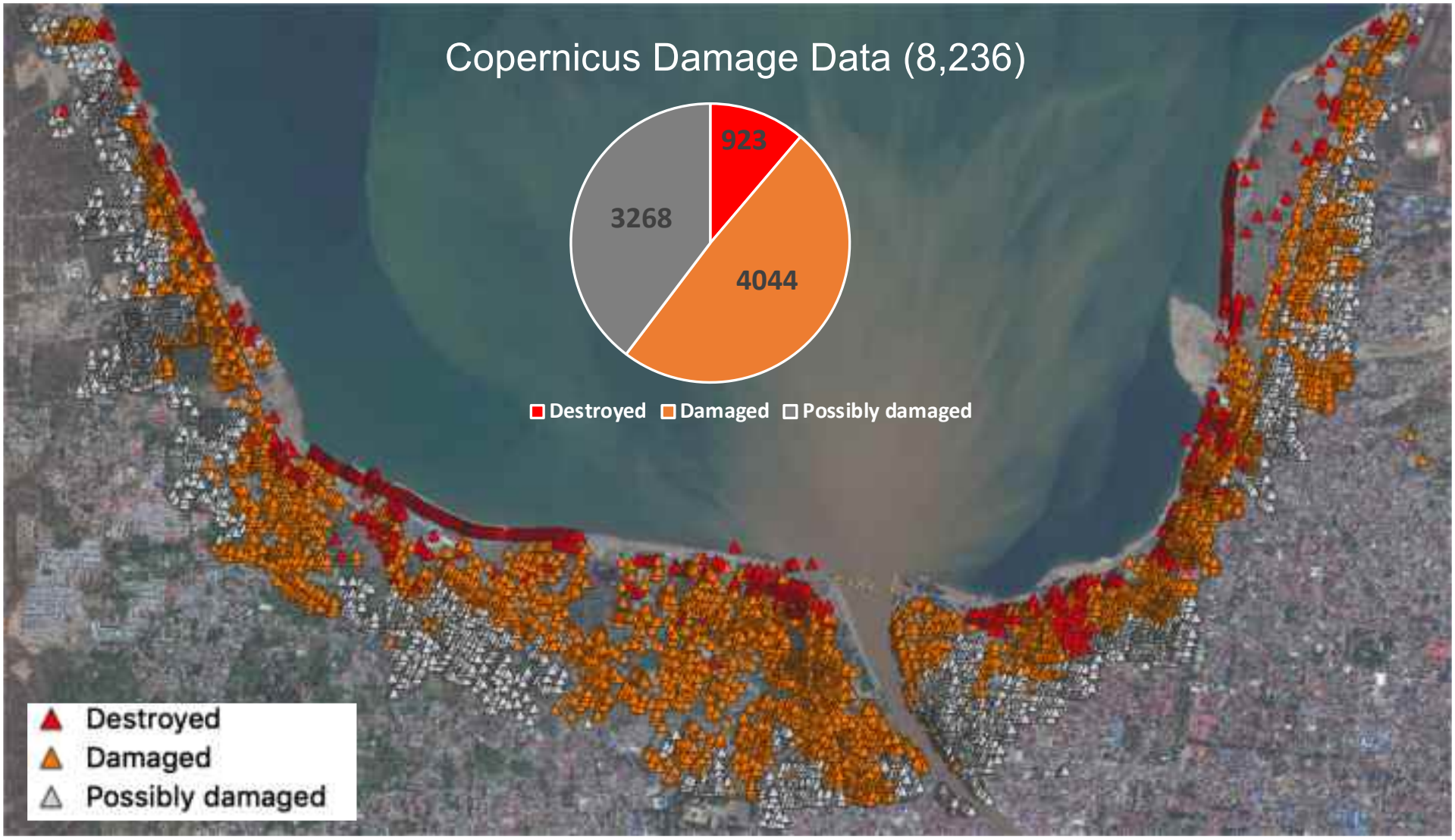

Building damage invetory
0 1 2 km
Scenario 4
OA = 90.98%
AA = 66.45%
Scenraio 8
OA = 91.67%
AA = 67.26%
0 150 300 m
Destroyed
Damaged
Possibly damaged
No damage
Correctly classified
Misclassified

Measurement of Inundation Extent



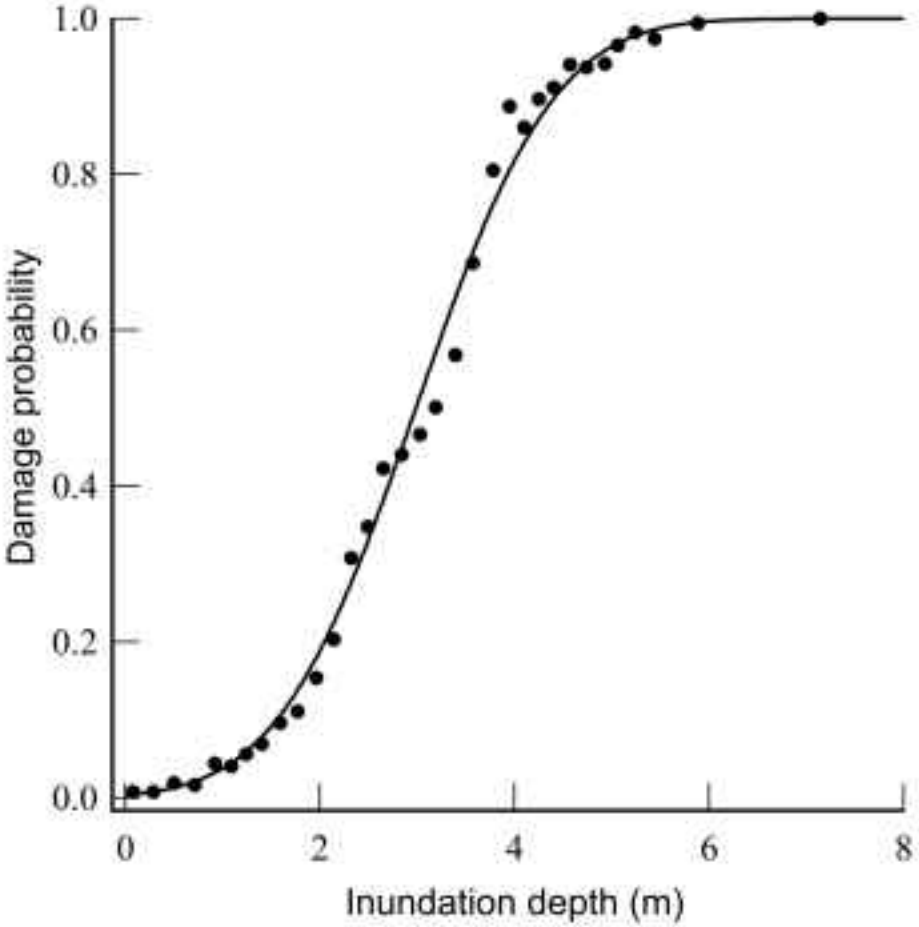
Measurement of Flow Depth

Structural Damage

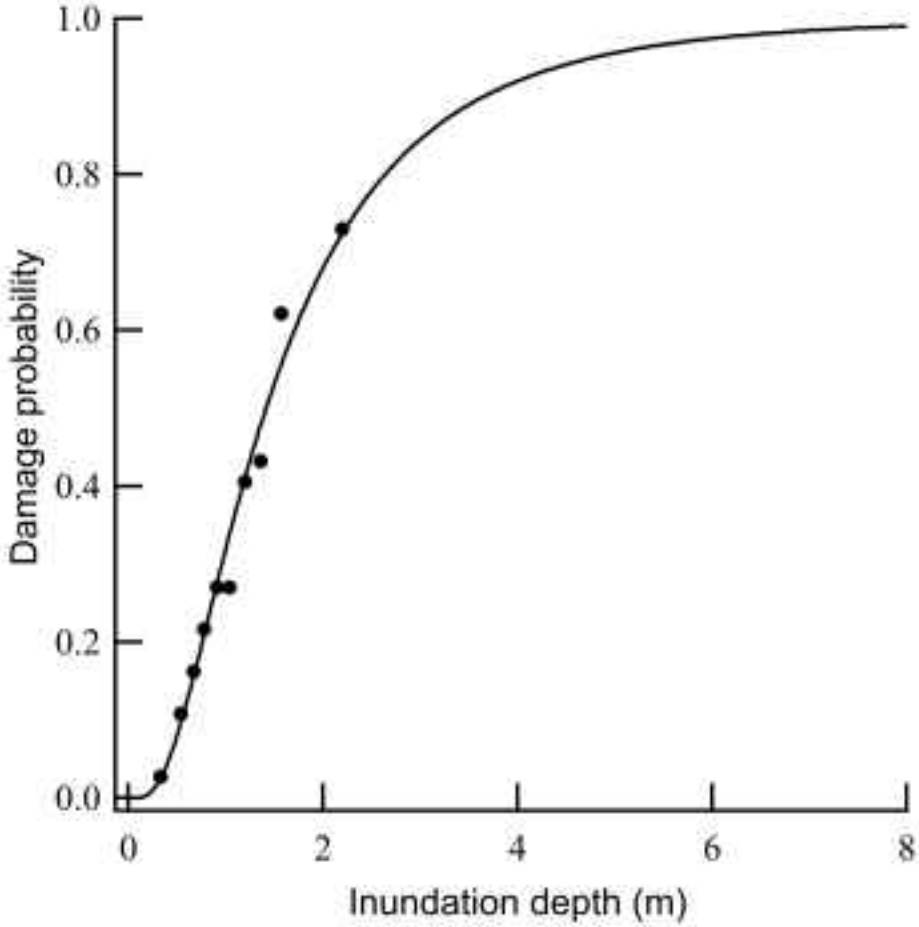


https://emergency.copernicus.eu/mapping/list-of-components/EMSR317

Tsunami Fragility Curve (Preliminary)



Banda Aceh, Sumatra
(Koshimura et al., 2009)



Palu, Sulawesi

Summary

- Ensemble learning classifiers using multi-temporal and multi-sensor data would work for building damage recognition.
- 1-3m flow depths were measured in central Palu coast. The maximum flow depth was 4.6 m at the west. However, the spatial distribution of tsunami flow depths are scattered.
- Major impact was concentrated within about 200 m from the shoreline.
- Relationships between tsunami hydrodynamics and structural damage is determined as a form of tsunami fragility curve.