

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 Tapete²,
Paolo Gamba³, and Silvia Liberata Ullo¹

(1) University of Sannio, Engineering Department, Benevento, Italy, (2) Italian Space Agency (ASI), Rome, Italy,
(3) University of Pavia, Engineering Department, Pavia, Italy

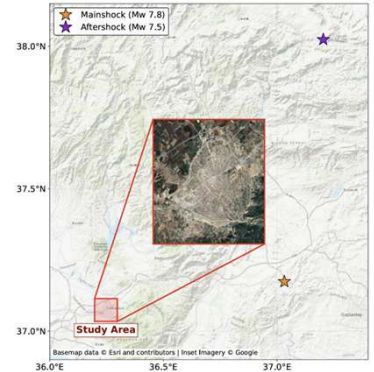


PROJECT MOTIVATION

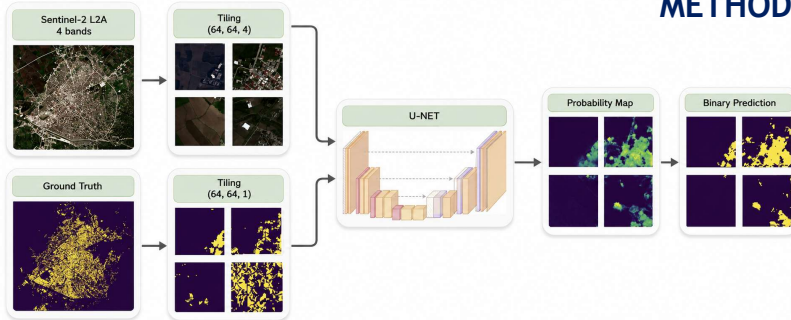
- Urban expansion increases territorial exposure**
Rapid and often unplanned urban growth can increase vulnerability, especially in hazard-prone regions.
- Hazard-prone urban environment**
Osmaniye is located close to the East Anatolian Fault system, in a region exposed to significant seismic risk.
- 2023 earthquake sequence**
The February 2023 Turkey earthquakes caused widespread damage across southern Turkey and represented a major disruption in the urban trajectory.



This study analyses Osmaniye's urban evolution from 2015 to 2025 and investigates the impact of the 2023 Turkey earthquake.



METHODOLOGY



1. Dataset preparation

Low-cloud Sentinel-2 L2A images from Google Earth Engine (Blue, Green, Red and NIR, 10 m) are paired with WSF 2015/2019 masks and tiled into aligned 64x64 image-label patches.

2. Model training

We train U-Net to distinguish built-up from non-built-up pixels in Sentinel-2 images, using WSF masks as reference labels.

3. Multi-temporal analysis

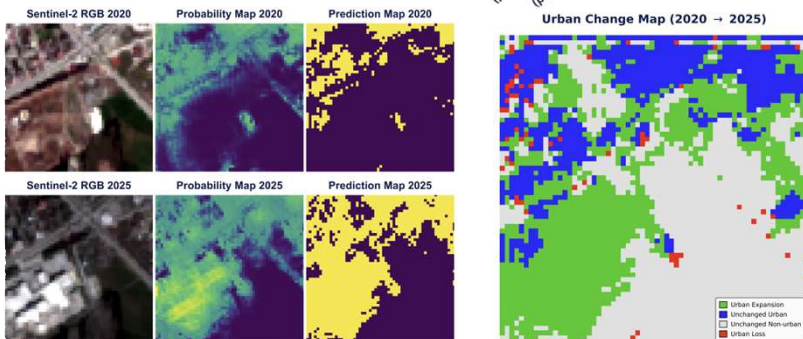
Applying the model across 2015-2025 produces binary built-up maps for comparing urban extent and identifying expansion and post-earthquake changes.

ANALYSIS AND RESULTS

Accuracy	Precision	Recall	F1-score	IoU
0.8727	0.5754	0.5820	0.5787	0.4071

- Balanced detection performance**
Comparable precision and recall indicate a balance between detecting built-up areas and limiting false detections.
- Moderate spatial overlap**
IoU reflects the difficulty of built-up mapping at 10 m resolution, especially in mixed urban/peri-urban pixels.

Urbanization Trend in Osmaniye (2015-2025)



CONCLUSIONS AND FUTURE WORK



Long-term urban monitoring

Sentinel-2 time series and U-Net segmentation support long-term built-up monitoring and reconstruct Osmaniye's urban evolution from 2015 to 2025.



Urban growth and recovery

Results show long-term urban growth, a decrease after the 2023 earthquake and a rebound in 2025 consistent with recovery and reconstruction processes.



Spatial patterns and limitations

Change maps highlight expansion, persistence and localized urban loss. Mixed pixels and spectral ambiguity remain challenging at 10 m resolution.



Future work

Integrate SAR data, higher-resolution reference data and additional earthquake-affected cities.

REFERENCES

- Russo, L. et al. (2025). A Deep Learning framework for building damage assessment using VHR SAR and geospatial data: demonstration on the 2023 Türkiye Earthquake. IEEE JSTARS.
- Memar, B. et al. (2024). A U-Net Architecture for Building Segmentation Through Very High Resolution Cosmo-Skymed Imagery. IGARSS 2024, 4653-4657.
- Dong, L. & Shan, J. (2013). A comprehensive review of earthquake-induced building damage detection with remote sensing techniques. ISPRS J. Photogramm. Remote Sens. 84, 85-99.

Read our full paper
Pigna et al. (2026)



ACKNOWLEDGMENTS

The authors would like to acknowledge the Italian Space Agency (ASI) for funding support provided through the PhD scholarship of Pietro Di Stasio under the contract N. 2024-24- HH.0 CUP: F83C24000890005, and for the Traineeship of Antonino Pigna.