



NebulOuS

A Multi-Scale Urban Heat Island Digital Twin for Monitoring, Simulation and Mitigation Using Satellite Earth Observation

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Motivation

Auditing Urban Heat Islands (UHI) using satellite data — particularly leveraging ESA Copernicus Land Monitoring Service products — enables objective, scalable, and repeatable assessment of UHI vulnerability. By integrating these open datasets into monitoring and simulation frameworks, cities can transition from reactive heat response to proactive, data-driven climate resilience planning.

1. Multi-source urban monitoring

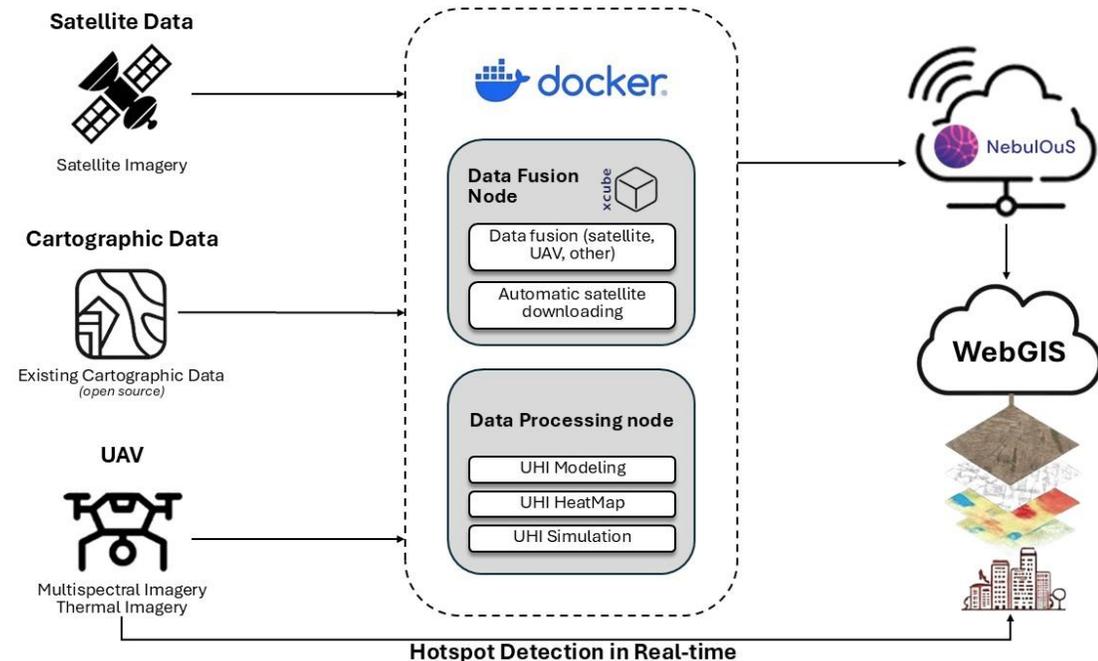
Free and commercial thermographic satellite data and UAV-based thermal sensing, open access data (public IoT environmental data)

2. AI-driven modelling

Cloud-narrative environment where all data are feed into AI models for real-time hotspot detection and UHI pattern analysis

3. Actionable decision support

WebGIS interface providing visualisation, early warnings and planning insights



- A **UHI Digital Twin platform** integrating multi-source satellite and environmental data is developed.
- A **UHI index** is proposed, combining LST, albedo, sky view factor, air quality, altitude, NDVI and NDWI.
- A **coarse-to-fine framework** enables city-wide screening using free satellite data and refinement with very high resolution satellite thermography.
- **Scenario-based simulation** allows quantitative assessment of mitigation strategies before urban intervention.
- The **methodology is validated in Athens**, demonstrating transferability across heterogeneous urban morphologies.



Implementation

Data acquisition

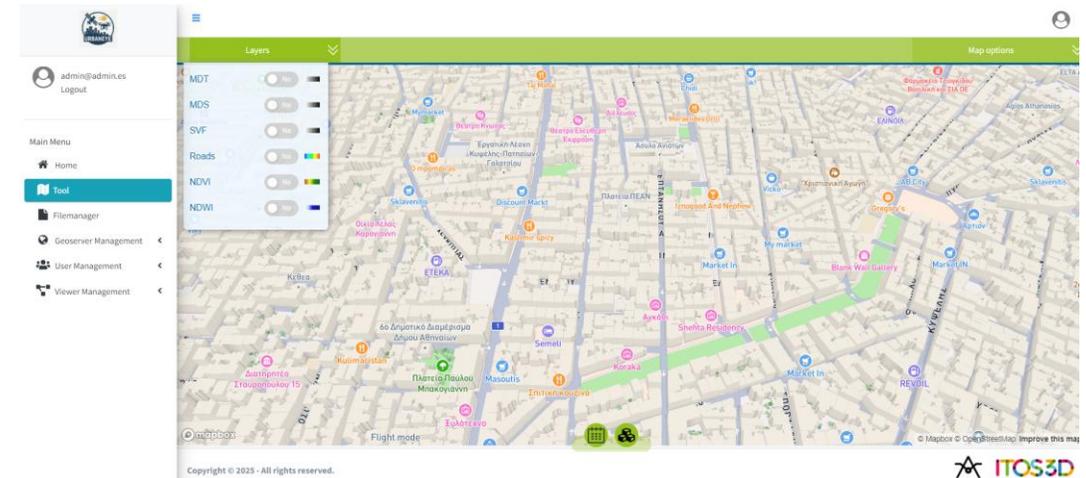
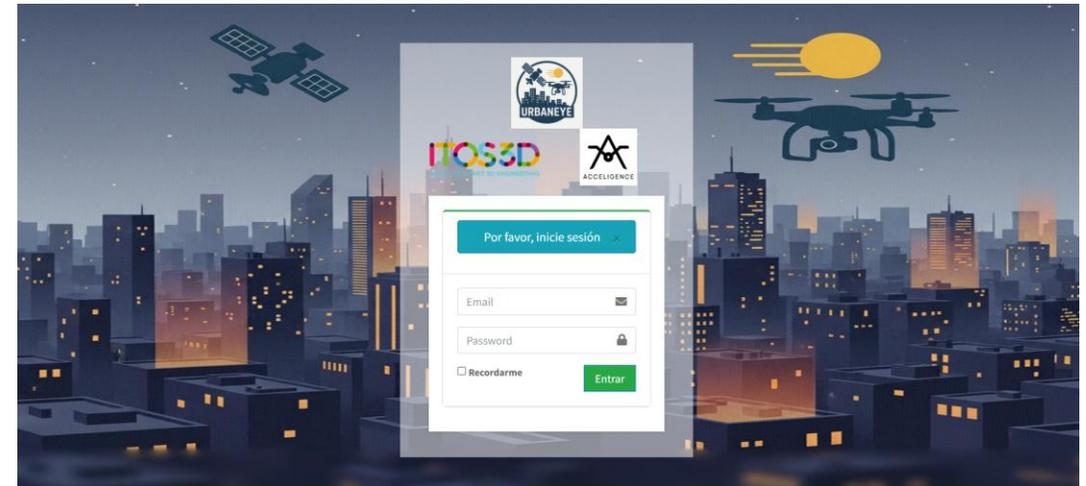
- Satellite EO data, CLMS Bio-Geophysical Variables
- UAV with thermal, RGB, multispectral sensors
- Pollution and air quality data
- Open morphological parameters (building height, street geometry, terrain/ surface models)

Processing layer

- Cloud-native orchestration
- Data fusion engine
- AI/ML hotspot and UHI models

Visualisation

- WebGIS platform
- Dynamic layers and map-based analytics



Live demo



A composite image showing a login form on the left and a promotional slide on the right. The login form is a white box with a purple header "Please log in." containing a close button. Below the header are two input fields: the first contains "admin@admin.es" with an email icon, and the second contains masked characters "....." with a lock icon. There is a "Remember Me" checkbox and a purple "Log in" button. The promotional slide has a purple background with a circular graphic and the text "NebulOuS" and "Urban-Eye". Below the slide title is the text: "A cloud-native, AI-driven application that will deliver near real-time insight into Urban Heat Island (UHI) effects". At the bottom of the screenshot area are logos for ITOS3D (IMAGE TO SMART 3D ENGINEERING) and ACCELIGENCE.



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