

PANTHEON: Building Disaster-Resilient Communities through Smart City Digital Twins

As climate change intensifies natural hazards and cities become increasingly dependent on complex digital infrastructure, the need for smarter, faster, and more inclusive disaster management has never been greater. The EU-funded PANTHEON project responds to this challenge by rethinking how communities prepare for, respond to, and recover from crises.

At the heart of PANTHEON lies the development of a Community-based Digital Ecosystem for Disaster Resilience, powered by Smart City Digital Twin (SCDT) technology and advanced data intelligence. Rather than focusing solely on emergency response, the project addresses the full disaster cycle with an emphasis on people, infrastructure, and decision-makers working together.

PANTHEON's approach aims to advance existing risk assessment methods, mitigate vulnerabilities, and build strong foundations for community disaster resilience. To do so, the project integrates real-world data, simulations, and participatory tools into a single digital environment that supports planning, training, evaluation, and situational awareness.

From data to decisions: How the PANTHEON Platform works

The PANTHEON platform combines Smart City IoT infrastructure, earth observation data, drone-based sensing, in-situ measurements, and community-generated data, processed through AI and Big Data technologies. This enables authorities and first responders to gain near real-time insights into unfolding events, including remote or hazardous areas where information is traditionally scarce.

A key innovation is the Smart City Digital Twin, a dynamic virtual representation of the urban environment that allows users to simulate threats, test response strategies, and evaluate human and system behaviour under stress. Complementing this is a synthetic training environment, enriched with historical weather and environmental data, enabling realistic exercises and skill development for disaster response personnel.

The platform also includes an early detection and situational awareness environment, designed to alert authorities to imminent incidents and support timely, evidence-based decision-making.

A Community-Centred Model of resilience

Unlike purely technical systems, PANTHEON is grounded in a Community Disaster-Resilient Communities Model. This model assembles and assesses resilience indicators at both national and local levels, taking into account cultural differences, vulnerable groups, diverse hazard types, and the five key resilience domains: social, economic, institutional, physical, and natural.

Decentralised and participatory governance is a cornerstone of the project. PANTHEON promotes co-operative learning between researchers, authorities, and local communities, while enhancing the collection of targeted, multi-variable risk data. The result is a flexible framework and set of tools that can be adapted and adopted by communities with different risk profiles and capacities.

Testing the vision: Pilots in Athens and Vienna

The practical value of the PANTHEON platform was demonstrated through large-scale pilots in Athens, Greece, and Vienna, Austria, where first responder organisations used the Digital Twin in realistic tabletop and staff exercises.

In Athens, the platform supported disaster risk management scenarios involving a major earthquake and a fast-moving wildfire, focusing on emergency planning, early warning, and cross-organizational coordination, with the Hellenic Police playing a central operational role.

In Vienna, Johanniter Austria led planning and training scenarios addressing extreme urban heatwaves and a cyber-physical attack on communications infrastructure, showcasing the system's ability to support medical response planning, force deployment, and tactical-level decision-making for emerging hybrid threats.

Across both pilots, the Smart City Digital Twin proved to be a valuable decision-support and training tool, enhancing situational awareness, improving planning efficiency, and generating actionable feedback for further development.

A new standard for Disaster Risk Management

By integrating technology, data, and community engagement into a single operational ecosystem, PANTHEON demonstrates how Smart City Digital Twins can move beyond experimentation to real-world impact. The project offers a scalable, adaptable approach to disaster risk management — one that strengthens preparedness, supports responders under pressure, and ultimately helps communities become safer and more resilient in an increasingly uncertain world.

This project has received funding from the European Union's Horizon Europe programme under Grant Agreement N°101074008.