# Development of an early warning and incident response system for the protection of visitors from natural hazards in important outdoor sites in Greece

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## Abstract

As tourism is a critical sector driving economic growth in Greece, maximum attention should be given to tourist comfort, support, high-quality services and safety. Safety in touristic destinations is of outmost importance since tourists' preferences change frequently in response to emerging threats. Natural hazards are a significant risk and, as such, they need to be considered in the effort for safe tourism. Furthermore, it is challenging to raise awareness for the protection against hazards to tourists that are not familiar with them.

In this direction, services and systems monitoring and predicting extreme natural phenomena and disasters in sites of special tourist and cultural interest that are vulnerable to natural hazards, can lead to more effective risk management and incident response. Such a system is currently under development in Greece within the context of the XENIOS project, providing early warning and risk communication services via web-based and mobile phone applications—specifically designed to meet end users' needs.

User needs have been carefully gathered—via questionnaires targeting both operational users (including safety managers, incident commanders, first responders, and field personnel)—and analyzed, in order to define the necessary services and their respective specifications, as well as the architecture of the proposed platform. This procedure identified the specificities of such touristic areas, the IT infrastructures and safety systems used, the operational needs and concepts of operation, the training needs, and end user willingness for service/system acquisition. The European Union General Data Protection Regulation (GDPR) and personal data management are major considerations in the XENIOS system, which adheres to the "privacy by design" principles.

Based on the operational and technical needs derived from the aforementioned study, a Business Process Model (BPM) has been developed that describes the way each system component is used while fulfilling those needs, respecting legal, ethical, and societal constraints. The BPM led to the use cases and the interconnected and interrelated components, also defining the methods, processes, interfaces, and flow of information between them. The high-level architecture and the services offered have been designed accordingly.

More specifically, the XENIOS system consists of the following early warning components: **Fire Forecast System** (FFS), **Meteorological Risks** (MRS), **Fire Danger Forecast** (FDF), and the **Flood Danger Forecast System** (FDFS). Interfacing with the tourists is achieved via the dedicated **XENIOS Mobile Application** (XMA), which provides visitors with useful information regarding points of interest and tours, in different languages, whereas in the case of an emergency it will act as the visitor's safe exit navigator, taking advantage of the incorporated emergency plans addressed to visitors.

XENIOS provides its own ticketing system but can also interoperate with existing ones for keeping count of visitors in the monitored areas. Moreover, it interoperates with UAVs using the **UAV Support Request** (USR) system and receives visitors' dispersion data along with live video footage from the

area requested by its operators. XENIOS is enhanced with **emergency plans** (customized for each monitored area), it is accompanied by a **VOIP subsystem,** and it provides a fully functional operation center for crisis management, featuring call center capabilities, supporting visitors of the touristic attraction areas.

The above sophisticated and state-of-the-art subsystems are orchestrated by the **XENIOS Core (XC)**, which utilizes other core components such as the **Forecaster**, the **Alerter** and the **Reporter** for managing requests and data handling in and out of the system, whereas the **Web Services Provider and Communication Middleware** (WSP) provide data feed from XENIOS to other legacy systems. The system's architecture follows a modular design, allowing other early warning or information components to be easily incorporated and feed information into the system as pluggable components.

All the research and development actions described above will be tested in two different touristic areas, the Samaria Gorge National Park and the Archaeological Park of Dion at the base of Mount Olympus in Greece. These tests will focus and address the fire and flood hazards, respectively, in close cooperation with the managing entities of each site. The pilot operations will provide the necessary feedback and evaluation, leading to a modular solution that will operate at all levels of risk management from local to regional, exchanging information and updating with status reports and real-time information.

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