

S1. Detailed End-user Needs Identified

Based on the feedback of all user categories, a qualitative and quantitative analysis has been conducted, leading to the end-user needs and requirements. These needs have been used as the driving force to design the Xenios architecture and its components. We split user needs into three categories, namely, key needs (KN), functional requirements (FR), and non-functional requirements (NFR). The key needs are linked to the necessary basic components that the Xenios platform must include (Table S1). Functional requirements capture the functionality that these components must have (Table S2). Non-functional requirements gather all user needs not directly related to the platform's or mobile app's functionality, but rather other aspects that must be considered for the design of the architecture, such as security issues (Table S3).

Table S1. Key end-user needs identified for the Xenios system.

ID	Description
KN1	Alerts on events related to natural hazards
KN2	Evacuation guidelines and necessary procedures in case of emergency
KN3	Emergency reporting capability from visitors to the center (panic button)
KN4	Tourism related information available to visitors regarding the areas of interest (information and local area)

Table S2. Functional end-user requirements identified for the Xenios system.

ID	Description
FR1	Real-time monitoring of the number of visitors and their distribution on the site
FR2	Natural hazards risk mapping and monitoring
FR3	Fire behavior simulation capabilities for prevention planning
FR4	Identification of precursor phenomena that occasionally increase the risk (e.g., increased number of visitors at high-risk locations)
FR5	Emergency calls (via the mobile app or the cellular network directly) from visitors to the site manager with identification of location and caller ID
FR6	Deployment of a common high-availability database for collecting and homogenizing the information provided by the different risk prediction services
FR7	Graded access to system and its information (e.g., Gold, Silver, Bronze and Open access level), depending on the user's role
FR8	Relevant information (e.g., descriptive text, photographs, 3D models) on points of interest (PoIs) within the site as well as the surrounding areas
FR9	Route suggestions and tailormade multilingual tour
FR10	Automatic display of touristic information when the visitor reaches a PoI
FR11	News/announcements for the specific site
FR12	Updates on events taking place in the site or nearby
FR13	Offers from tourism-related businesses in the area
FR14	Promotion of local businesses in the surrounding area

Table S3. Non-functional end-user requirements identified for the Xenios system.

ID	Description
NFR1	Clear privacy policy and personal data processing, only after consent from the visitor
NFR2	No processing of special categories of personal data
NFR3	Information transparency and access availability of stored data to subjects (visitors)
NFR4	Satisfaction of the rights of the subjects (visitors)
NFR5	Privacy and security by design
NFR6	Log files of processing activities
NFR7	Application of retention policy

S2. Detailed Description of the Test Sites

Two touristic destinations with diverse characteristics have been selected as pilot areas for developing and testing the Xenios system, namely, the Samaria Gorge National Park in Chania, Crete, and the Archaeological Park of Dion at the base of Mount Olympus in Greece. Samaria Gorge lies in the heart of Lefka Ori (literally, White Mountains) mountain range in Crete, comprising more than 50 summits higher than 2,000 meters above sea level and multiple gorges, most of which end up in the Libyan Sea. The Samaria Gorge is characterized by its geographic isolation, landscape diversity, presence of large-scale climatic and micro-environmental condition, rich flora with high degree of endemism, and significant fauna richness, with the Cretan goat (*Capra aegagrus cretica*, colloquially known as kri-kri) being the most distinctive mammal of the region. The Natural Park has been designated, among others, as a UNESCO Biosphere Reserve, an Important Bird and Biodiversity Area (IBA), and NATURA 2000 network site. Due to its natural beauty and uniqueness, it attracts thousands of visitors every year from across the whole world. It has been as a test site for Xenios due to the challenges it involves in mitigating risks, the most prominent of which are the rough terrain that inhibits evacuation processes (Figure S1a), geomorphology that restricts cellular and internet network connectivity in most of the regions (Figure S1a–b), and fire danger due to the dense pine forest all over the area (Figure S1c).

The Archeological Park of Dion is located at the foot of Mount Olympus in Pieria, 10 km south of Katerini. In antiquity, it was the most important sacred city of the Macedonians, where brilliant festivals were held at which sacrifices were offered to Olympian Zeus and the Pierian Muses. The area of the archeological site is generally flat (Figure S2a) and is covered by rich vegetation of deciduous trees. Vaphyras river flows through the site; in fact, it was navigable and connected the city of Dion with the sea in antiquity. The current image of the archeological site corresponds mainly to the Roman period of the city. Over the centuries and probably due to flooding from the outflow of water from Olympus, the antiquities were covered by a relatively thin layer of soil. A significant part of the site has not been excavated yet and the antiquities have not been revealed, with new excavation projects starting continuously. The site hosts thousands of visitors each year, with many organized trips from schools from all over Greece and abroad. Contrary to the Samaria Gorge test site, flooding is the major risk factor in Dion, which apart from visitors' safety causes problems to the site itself (Figure S2b). Every few years, large portions of the site are covered with tons of sediment after a flood, which also damages the infrastructure (as a matter of fact, an internal bridge collapsed during a recent flood and one route of the site is currently blocked). The risk of fire is lower and confined in certain regions of the site, but it still exists and is important to monitor and manage due to the large number of

visitors during the summer months and the organization of the Festival of Olympus in July and August.

The abovementioned test sites were selected to provide the necessary feedback and evaluation for optimally designing the Xenios system. The pilot operations are performed in close collaboration with the sites' management bodies, which are the Samaria National Park Management Body in the case of Samaria Gorge and the Ephorate of Antiquities of Pieria in the case of the Archaeological Site of Dion. This interaction led to the design of a modular solution that operates at all levels of risk management from local to regional, exchanging information and updating with status reports and real-time information.

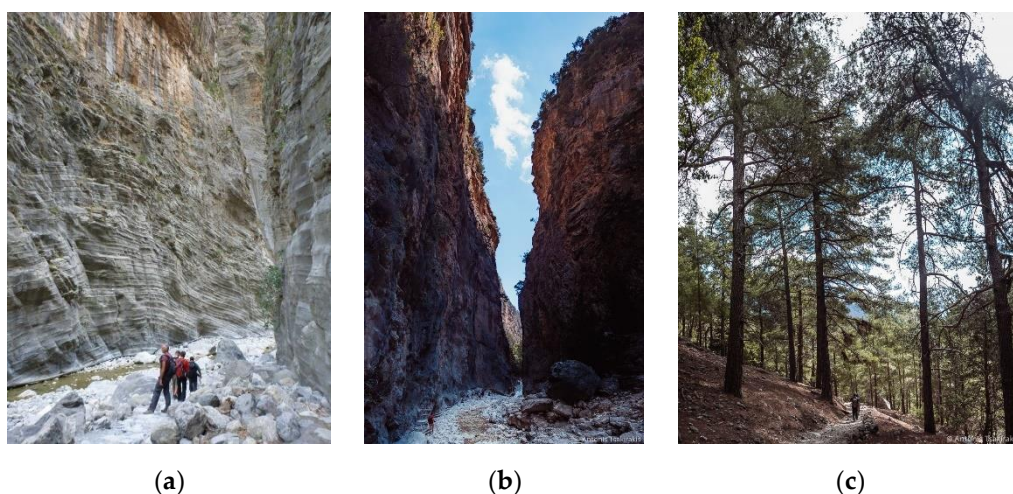


Figure S1. Photographs from the Samaria Gorge National Park test site, highlighting the main challenges in managing the area: (a) rough terrain inhibiting the evacuation process, (b) limited cellular and internet network connectivity, and (c) increased fire danger due to presence of dense pine forest all over the region.



Figure S2. Photographs from the Archaeological Site of Dion test site: (a) aerial of the Hellenistic Theater overlooking Mount Olympus and (b) view of the Isis Temple, constantly flooded due to the Vaphyras river crossing the site. *The monuments of the Archaeological Site of Dion are under the responsibility of the Ephorate of Antiquities of Pieria, Hellenic Ministry of Culture and Sports/ Archaeological Resources Fund. The rights of the depicted monuments belong to the Hellenic Ministry of Culture and Sports (Law 3028/2002).*