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Integrating Risk Mapping and Condition Reporting for Cultural Heritage at Risk: Synergies between ProteCHt2save WebGIS and ChemiNova in Extreme Climate Events

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Cultural heritage is increasingly exposed to the growing intensity and frequency of extreme climate events, highlighting the need for integrated methodologies that combine large-scale risk assessment with real-time diagnostic tools [1]. In this context, the Horizon Europe project ChemiNova [2] develops an advanced framework for cultural heritage inspection and condition reporting, while the methodology implemented in the Interreg Central Europe projects ProteCHt2save and STRENCH provides a structured approach to risk assessment and preparedness through the WebGIS-based platform “Risk Mapping Tool for Cultural for Cultural Heritage Protection” [3].

This study illustrates the synergy between these two complementary approaches. The Risk Mapping Tool supports the identification of hazard, vulnerability, and exposure assessment at territorial scale, enabling the prioritization of cultural assets at risk. In parallel, ChemiNova focuses on in-depth analysis through multi-scale monitoring (artefacts, buildings, monuments) and the development of standardized condition reports [4], integrating non-invasive diagnostic techniques and artificial intelligence for automatic detection and damage classification.

The integration of these methodologies is demonstrated through two complementary pilot contexts characterised by high climate vulnerability. The first case concerns the catastrophic DANA (Isolated High-Altitude Depression) event in the Valencia region occurred on October 29 2024, where extreme rainfall induced flooding, sediment deposition, and material degradation. In this context, the Risk Mapping Tool provides a spatial understanding of exposure and vulnerability, supporting the identification of priority intervention areas. Concurrently, ChemiNova tools enable detailed post-event condition assessment, including evaluation of material decay, moisture distribution, and structural stability, supporting evidence-based decision-making during emergency and recovery phases.

The second case study focuses on the *Palchetto della Musica* in Palermo, a coastal monument located in a Mediterranean area highly exposed to extreme weather conditions. Here, the

combination of climate-related hazard mapping and condition reporting allows the identification of specific vulnerabilities linked to heavy rainfall, marine aerosol, and pollution. Advanced documentation techniques, including 3D models in which data obtained from hyperspectral imaging and surface analysis are mapped in layers, contribute to defining a consistent damage taxonomy and to generating datasets for AI-based classification tools developed within ChemiNova.

The results highlight how the synergy between large-scale risk assessment (Risk Mapping Tool) and site-specific analytical investigation represents a crucial step towards a dynamic and resilient management of cultural heritage. This integrated approach supports the transition from static preparedness models to adaptive, data-driven strategies capable of responding effectively to the rapid onset and increasing severity of climate-induced hazards. Ultimately, the combined use of ProteCHt2save-STRENCH and ChemiNova methodologies demonstrates a scalable framework for strengthening heritage resilience across Europe, fostering coordination between strategic planning and operational intervention.

[1] European Commission Directorate-General for Education, Youth, Sport and Culture. Strengthening Cultural Heritage Resilience for Climate Change: Where the European Green Deal Meets Cultural Heritage; Publications Office of the European Union: Luxembourg, 2022; Available online: https://data.europa.eu/doi/10.2766/44688;

[2] https://cheminova.eu/

[3] www.protecht2save-wgt.eu

[4] EN17135:2020, "Conservation of cultural heritage – General terms for describing the alterations of objects"

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