

Disaster risk management for built heritage: what it takes

Xavier Romão

Faculty of Engineering of the
University of Porto, Portugal
ICOMOS-ICORP

20th European Heritage Heads Forum
Zagreb, 7-9 October 2026



A brief glossary

- **Hazard** - A physical event, natural or human-made, with a given intensity that can cause negative impacts I want to avoid.
(*Climate change can amplify the intensity of certain hazards*).
- **Vulnerability** – Features of an asset **exposed to a hazard** that represent how susceptible the asset is to the negative impacts of the hazard.
- **Disaster risk** – Expected negative impacts (effects of the hazard combined with vulnerability).
- **Damage** - Physical change (i.e. tangible) of an asset that has value (i.e. that is important) and that may or may not generate losses. Damage can be repairable or not (it includes destruction).
- **Loss** - Negative impact of the damage measured in economic or non-economic terms.
- **Disaster risk management** – (*realistically*) the art of finding solutions to minimize negative impacts on what we value, while working with limited knowledge, data, and resources. (*It includes climate change adaptation*).



The starting point

Why is **disaster risk management** important for **cultural heritage**?



Because we want to **preserve cultural heritage** and **minimize negative impacts** (damage and loss) resulting from **natural or human-induced hazards**



But why do we **want to do that**?



Because **cultural heritage** has **value(s)** to us



But **what** are those **values** and **how** do we **define** them?



The starting point

I want to **preserve/protect cultural heritage from disasters**, but to what extent natural and human-induced **hazards threaten cultural heritage**?



How much cultural heritage have we been **losing to disasters**?



> 640 heritage assets · 29 countries · 5 years - one event per country, 2021–2026 (none found for Finland, Iceland, Latvia)

Country	Date of event	Event	Impacted site(s)	Nº of sites
Austria	15 Sep 2024	Storm Boris & floods	Cistercian Abbey of Heiligenkreuz	1
Belgium	14-16 Jul 2021	Western European floods	AWaP recorded 100 damaged classified properties, most in Verviers, where 60% of classified heritage was affected	100
Bulgaria	2 Sep 2022	Karlovo / Stryama valley floods	Narodno chitalishte 'Probuzhdane', Karavelovo; village cultural centre (kulturen dom); bridges at Bogdan	2
Croatia	4 Jun 2024	Storm	Church of St. John Capistran, Ilok	1
Cyprus	23-26 Jul 2025	Limassol District wildfire	Chapel of Agios Ioannis Rossos, Vouni; Chapel of Agios Silouanos, Souni; ruins of Agios Shiallouni church, Souni; 'two churches' site, Souni; watermill at Kapsalia, Kisousa	7
Czechia	24 Jun 2021	South Moravia tornado & hailstorm	Church of St Bartholomew, Hrusky; Church of St Jacob the Elder and T. G. Masaryk monument, Moravska Nova Ves; Valtice Chateau (Lednice-Valtice Cultural Landscape WHS) Valtice town hall, Valtice; cemetery at the Chapel of St Roch, Mikulcice	5
Denmark	16 Apr 2024	Fire	Borsen (Old Stock Exchange) building, Copenhagen	1
Estonia	15 Feb 2021	Fire	Narva-Jõesuu Saint Vladimir Orthodox Church	1
France	24-25 Sep 2025	Fire	Chateau de Medavy	1
Germany	14-15 Jul 2021	Western European floods	Historic buildings of Traben-Trarbach; Ahrweiler Art Museum; Sinzig Castle	3
Greece	5-7 Sep 2023	Storm Daniel & Thessaly floods	Sarakina bridge, Trikala/Meteora; Gkika bridge; Palaioskala archaeological site, Lake Karla	3
Hungary	3 Jul 2026	Fire	Church "Saint Elijah", Pusztafentős (Posta)	1
Ireland	24 Jan 2025	Storm Éowyn	Elphin Windmill, Elphin	>1
Italy	May and Jul 2023	Emilia-Romagna floods	155 churches, 21 museums, 91 historic buildings, 12 archaeological areas, 5 historic parks and gardens, 21 archives and 13 libraries	318
Lithuania	9 Sep 2022	Fire	Apytalaukis Manor (Apytalaukio dvaras), Apytalaukis	1
Luxembourg	14-15 Jul 2021	Western European floods	Grund quarter, Luxembourg City; historic town of Echternach	2
Malta	19-21 Jan 2026	Storm Harry	the Haġar Qim and Mnajdra Archaeological Park, Qrendi; Fort St Elmo, Valletta; Fort St Angelo, Birgu	4
Norway	7 Jun 2025	Fire	Historic town of Lærdalsøyri	1
Poland	14-16 Sep 2024	Storm Boris & Kladzko Valley floods	Bridge of St John Nepomuk & historic market square, Ladek-Zdroj; Franciscan monastery & church of Our Lady of the Rosary, Klodzko; baroque chapel of St Onufry, Stronie Slaskie; parish church of the Assumption, church of St Wojciech, town hall, former Jesuit college & Most Zelazny, Klodzko	9
Portugal	22 Jan - 15 Feb 2026	Storm sequence Ingrid, Joseph, Kristin, Leonardo, Marta, Nils, Oriana	> 120 monuments and museums, including 4 WHS: Convento de Cristo (Tomar), Mosteiro da Batalha, Mosteiro de Alcobaça, Palácio Nacional de Mafra.	>120
Romania	25 Jul 2025	Fire	Casa Lupuț, Cizer	1
Slovakia	9 Oct 2023	Eastern Slovakia earthquake	27 national cultural monuments, predominantly churches, plus two manor houses and one military-history monument	27
Slovenia	3-8 Aug 2023	Slovenian floods & landslide	Rudarska hisa, Idrija - national monument, part of the WHS; Katzenstein Castle, Begunje; Church of St Sebastian, Moste pri Komendi; Skofja Loka unit of the Ljubljana Historical Archive; Stara zelezarna, Ravne na Koroskem; Vrbovec Castle, Nazarje	6
Spain	23-28 Jan 2021	Granada earthquake swarm	18 monuments including several parts of the Alhambra and Generalife WHS	18
Sweden	30 Nov 2024	Fire	Glasbruket building, Skansen	1
Switzerland	23 Dec 2024	Fire	Badhütte, Rorschach	1
The Netherlands	14-16 Jul 2021	Western European floods	Church of St Nicholas and Barbara, Valkenburg	1
Ukraine	25 Mar 2024	Fire	Church of Archangel Michael, Smozhe	1
United Kingdom	24 Jan 2025	Storm Éowyn	Falkland Palace, Culross Palace, Hill of Tarvit, Kellie Castle and Newhailes	5

The starting point

I want to **preserve/protect cultural heritage from disasters**, but to what extent natural and human-induced **hazards threaten cultural heritage**?



How much cultural heritage have we been **losing to disasters**?



But if I want to get the **full picture of disaster damage and loss to cultural heritage**, where are those data?



The starting point

What is the current status of **disaster damage and loss data collection** for cultural heritage?



- Currently, there is no **systematic collection** of cultural heritage **damage and loss data** caused by disasters
- **Disaster data** is **scattered** among various agencies without any **coordination**
- There are no **standardized methods/tools** for disaster **data collection**



Are these data **important**?



The starting point

»»» Uses of disaster damage and loss data

Compensation

- To develop fair and efficient:
 - International aid mechanisms
 - Insurance market

Accounting

- To keep track of losses, recovery costs and monitor evolution trends
- To balance prevention budgets and loss compensation

Post-event forensics

- To identify new risk scenarios and learn from the past
- To assess and improve
 - prevention measures
 - prevention policy

Risk modelling

- Validation of risk assessment models based on real data from past events
- Development of new risk assessment models

What it takes

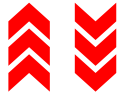
What should a **disaster risk management system** include to support **Prevention, Preparedness and Recovery**?

Baseline Data

- Hazard identification
- Inventories (immovable and movable heritage)
- Architecture, structure and current condition
- Values
- Damage & loss
- Support for emergency response

Methods & Tools

- Vulnerability assessment for single hazards and for cascading and compounding hazards
- Large-scale vulnerability assessment for prioritization
- Assessment of non-economic values and impacts
- Emergency response planning and training
- Integration of technological developments



Active Governance

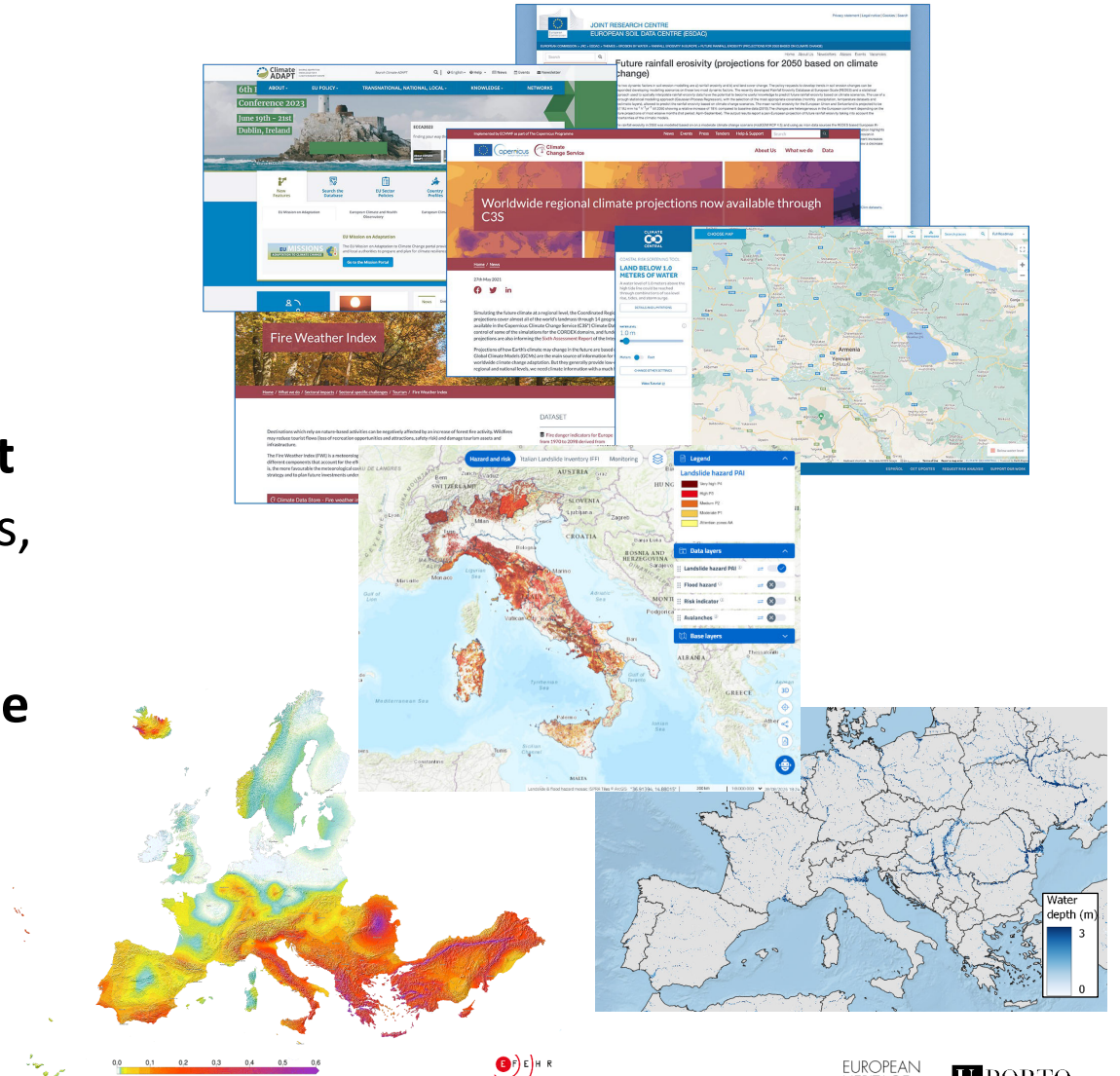
- Mandate and coordination
- Sustained financing
- Definition of standards

Baseline Data

Hazard identification



- Identify **relevant categories of hazards** in your region, based on available national-level or European-level hazard maps
- Check that available hazard maps have **sufficient spatial resolution** to distinguish individual assets, and **licensing** that permits operational use
- Check if existing hazard maps account for **climate change effects**

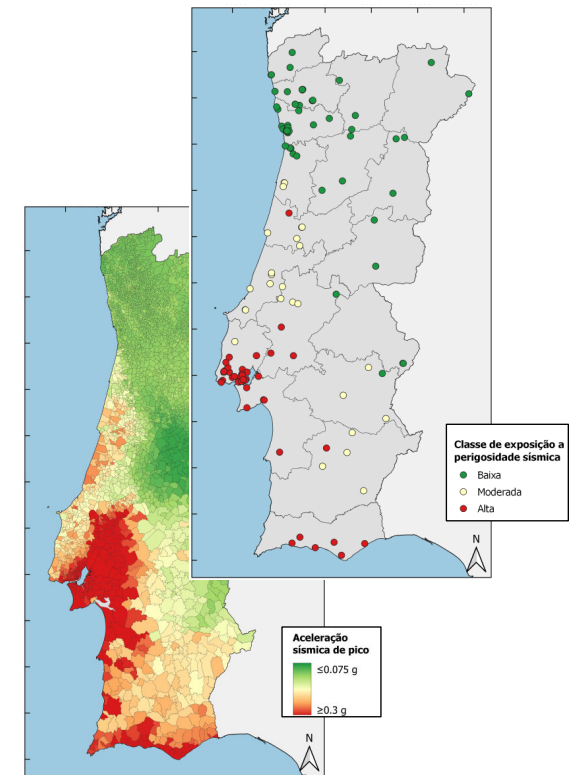
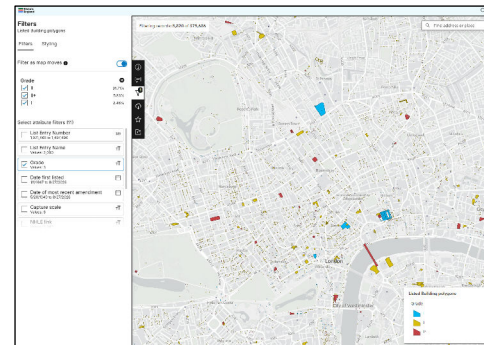
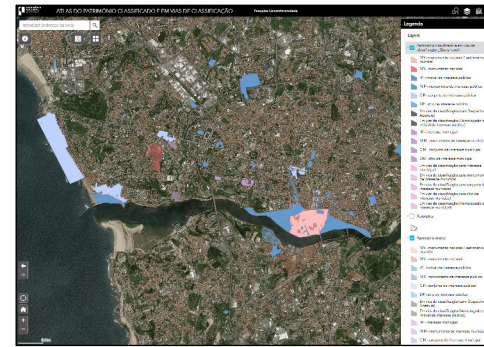


Baseline Data

Inventories (immovable and movable heritage)



- Define a **minimum (European) data profile for risk purposes**: geometry (footprint), construction period, structural type and materials, use and occupancy, protection status, presence of movable collections
- Publish the data as **machine-readable geospatial services** others can use, with an access policy for sensitive fields
- Combine this with hazard maps to get **hazard exposure maps specifically for cultural heritage**



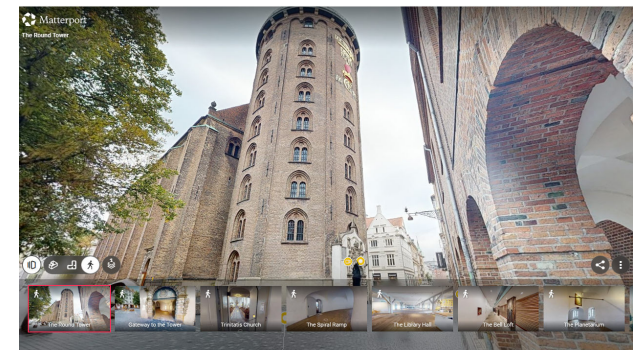
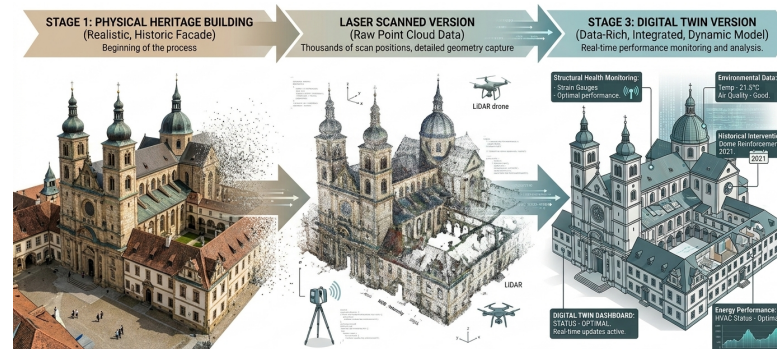
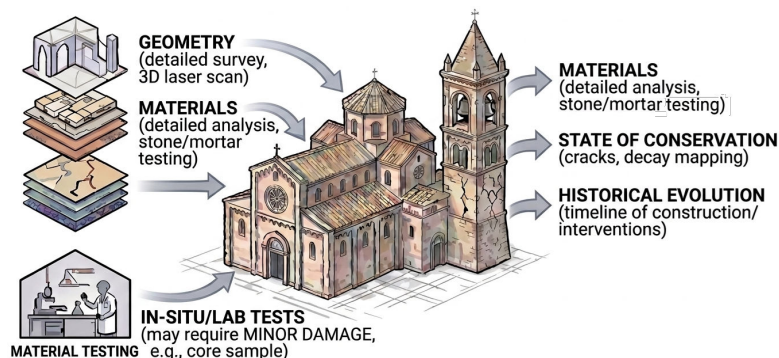
Baseline Data

Architecture, structure and current condition



Collect data for site-specific analysis of **vulnerability, emergency response planning and recovery:**

- **Architectural data:** architectural drawings, plans with geometrical data, 3D surveys
- **Engineering data:** type of materials, their properties and type of construction technology
- **History/evolution of the construction** and interventions carried out over time
- **Current level of conservation** (construction and systems/infrastructures)



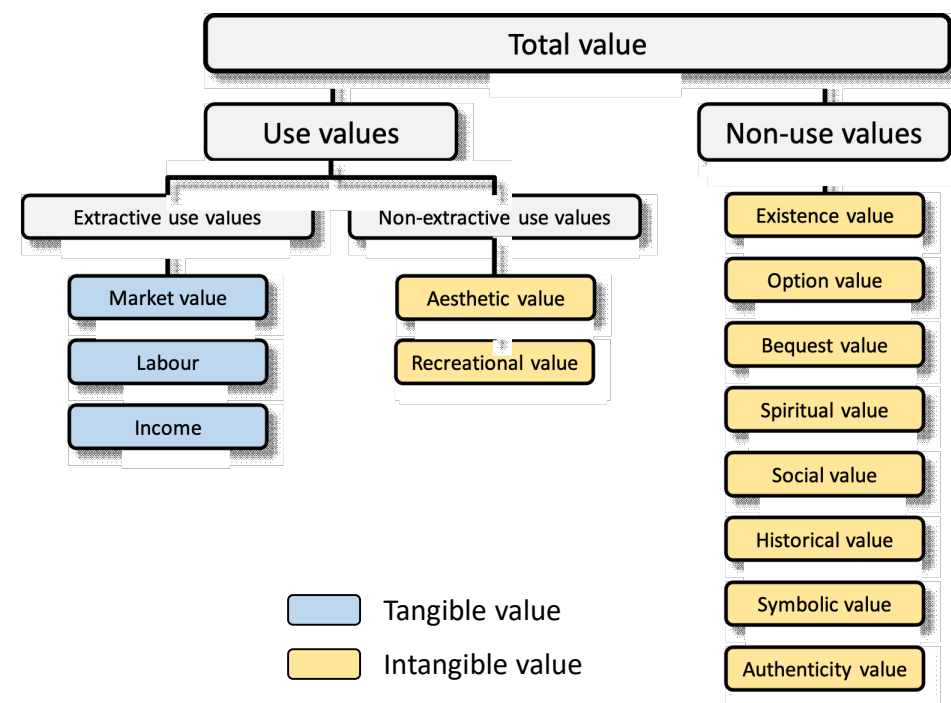
Baseline Data

Values



The ideal **risk metric** represents **loss of value(s)**:

- Include a **classification of values in heritage inventories** using **qualitative** approaches that can represent relative differences between heritage assets
- Translate the value baseline into **well-being dimensions** (quality of life, societal cohesion, health, etc) and connect it to the emerging **cultural heritage satellite account**: allow value (and loss of value) to be estimated using economic metrics such as Gross Value Added (see ESPON's HERITAGE (2018–2019), HERIWELL (2020–2022) and HERMES (2024–2025) studies)

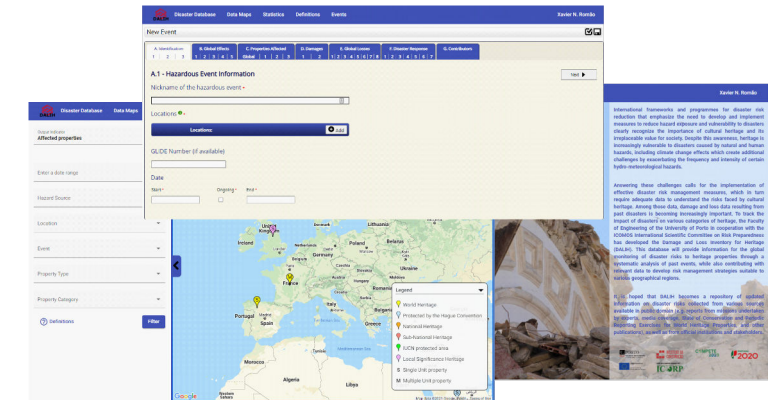


Baseline Data

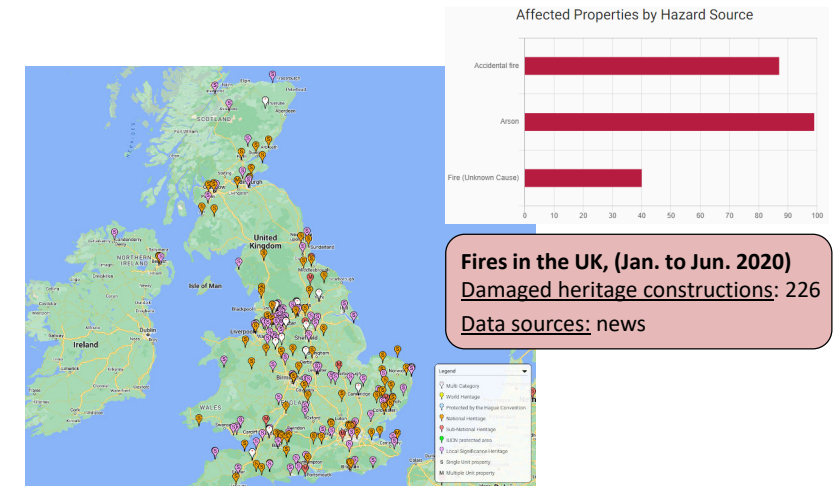
Damage & loss



- Define a **minimum (European) damage and loss data model for cultural heritage**: event and asset identifiers, physical damage state, affected elements, repair and emergency costs, **loss of value**, functional and access disruption, direct and indirect economic consequences
- **Plan post-event data collection**: include a data annex in every emergency response plan and disaster recovery programme
- Recover the substantial **unexploited data from recent past events** before they are lost



DALIH database



Baseline Data

Support for emergency response



- Assess **emergency preparedness** for immovable and movable heritage: available plans, trained staff, storage capacity, specialists, and equipment
- Define hazard-specific **priority lists for movable heritage evacuation** based on heritage values, and feasibility of evacuation



Methods & Tools

Vulnerability assessment for single hazards and for cascading and compounding hazards



The capacity to model **physical vulnerability** for immovable heritage is **more developed for some hazards than others**:

- It's more established for a few single hazards, but very limited for emerging and complex events involving **multi-hazard scenarios, risks driven by climate change or new human-made threats**.
- Further research is needed, supported by **past damage and loss data for validation**.



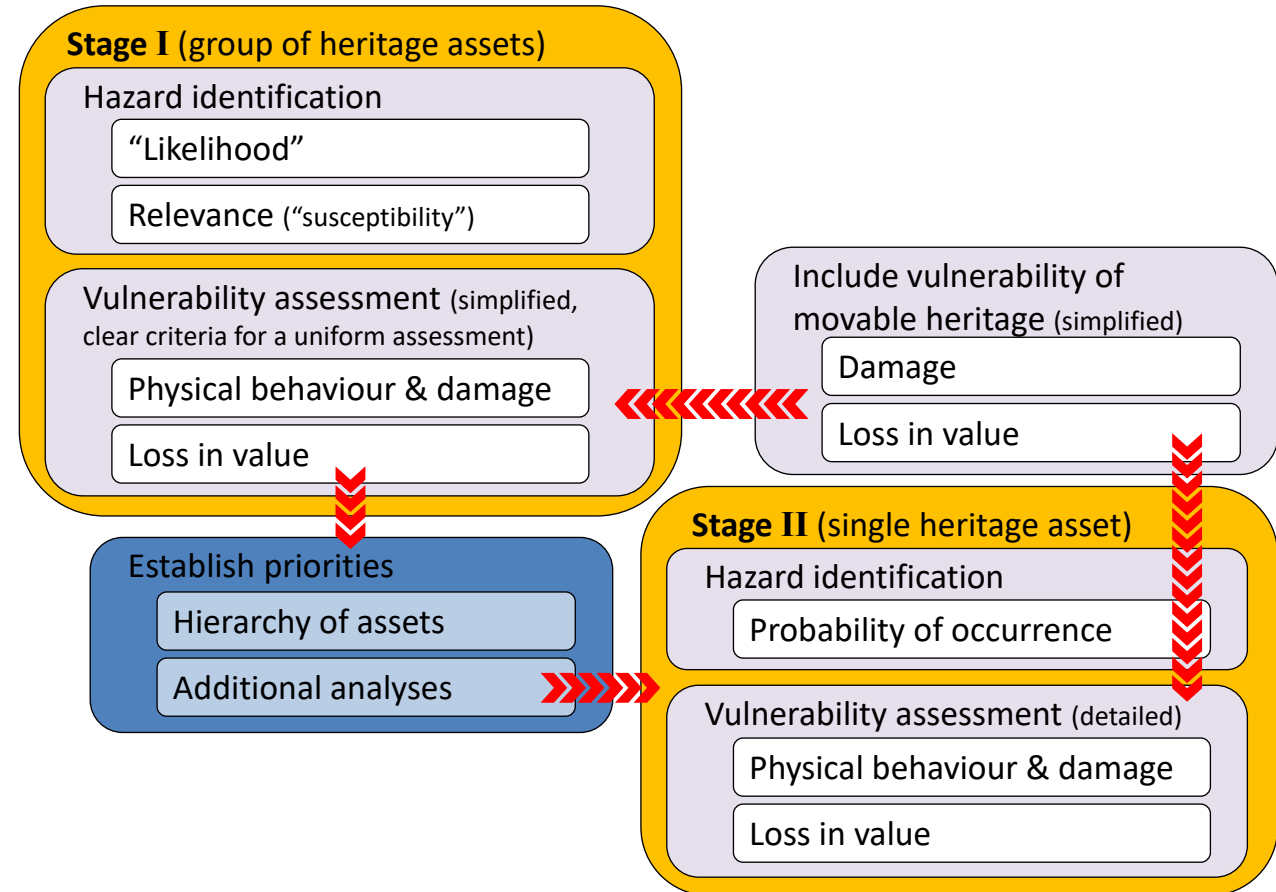
Methods & Tools

Large-scale vulnerability assessment for prioritization



Resources are often insufficient to assess all immovable heritage across all hazards:

- Develop **multi-level assessment** frameworks to **prioritize** assets
- Develop **simplified methods for (multi-hazard) vulnerability assessment** that can provide relevant results based on **limited data**



Methods & Tools

Assessment of non-economic values and impacts



Impacts are usually expressed as **repair costs**, which understate heritage losses:

- Develop methods to capture **loss of intangible values**, significance and authenticity due to physical damage
- Integrate these methods into risk management frameworks to perform **cost-benefit analyses**

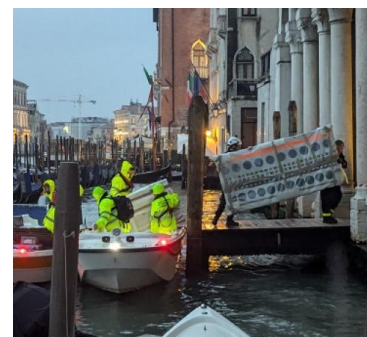


Methods & Tools

Emergency response planning and training



- Develop hazard- and heritage-specific emergency response plans with **civil protection and other emergency services**
- Develop hazard- and construction-specific **post-event damage assessment tools** (based on past damage and loss data, and repair and recovery decisions)
- Develop heritage **first-aid training and materials** for heritage staff and first responders



NAME OF CULTURAL ASSET: Church of the Assumption of the Blessed Virgin Mary, Pokopko

PART OF CULTURAL ASSET: Church of the Assumption of the Blessed Virgin Mary

PHOTOGRAPH: [Image of the church]

Def SCALE: 1:2500 or SCALE 1:1000

CONSERVATION DEPARTMENT/INST: Zagreb Date of record: 5

Number of inventory team - Number of inventory form: 1

Team leader: [Name] [Name] [Name]

Members: [Name] [Name] [Name]

A. DATA CONCERNING INSPECTION BY THE EMERGENCY MANAGEMENT OFFICE/ Usability based on the EMO's stickers: U1 U2 TUU1 TUU2

Urgent interventions and protection measures carried out:

Securing the perimeter: [] Supporting and propping: []

Temporary covering: [] On-site protection: []

Dismantling of architectural ornaments: [] Disposal of architectural or: []

Removal of whole building: [] Removal of whole building: []

Cost of interventions CA: []

MOVABLE CULTURAL ASSETS: [] Damage record: [] Urgent measures: []

D.3. OVER BUILDING: []

EMERGENZA POST-GRAN

SCHEDA PER IL RILIEVO DEL DANNO

1 - Overturning of the façade

2 - Gable mechanisms

3 - Shear in the façade

4 - Damage in the porch

5 - Transversal response of the nave

6 - Shear in longitudinal walls

7 - Longitudinal response of the columns

8 - Damage in the vaults of the main nave

9 - Overturning of the apse

10 - Damage in the vaults of the apse

11 - Shear in the apse

12 - Damage in the vaults of the transept and its roof

13 - Interactions between the nave and its roof

14 - Interactions between the apse and its roof

15 - Roof lantern mechanisms

16 - Overturning of the apse

17 - Shear in the apse

18 - Damage in the vaults of the apse

19 - Interactions between the nave and its roof

20 - Interactions between the apse and its roof

21 - Interactions between the apse and its roof

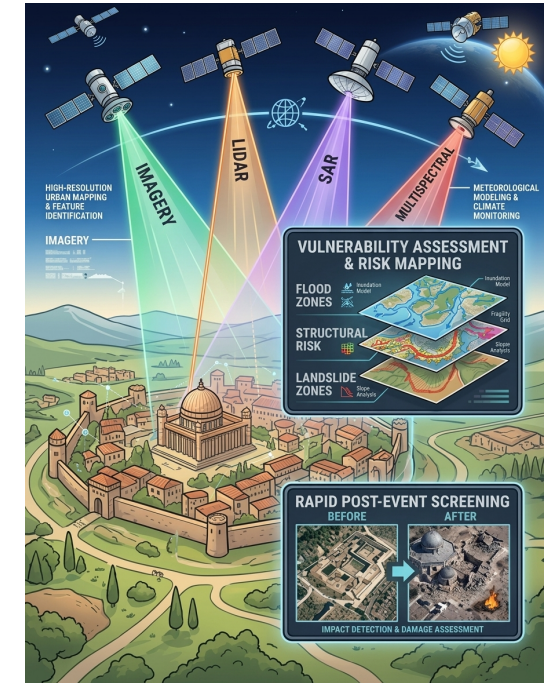
22 - Overturning of the chapels

Methods & Tools

Integration of technological developments



- Connect cultural heritage to national **multi-hazard early warning networks**
- Leverage **satellite multi-source data** to support vulnerability and risk assessment, and rapid post-event screening
- Integrate disaster risk management requirements into **digitization and digitalization efforts**



Active Governance

Mandate and coordination



- **Establish a national body** within the heritage authority with a clear mandate for **cultural heritage and disaster risk management**
- **Designate a data custodian** responsible for **collecting, curating, and sharing** heritage-related disaster risk data, backed by **data-sharing agreements** with civil protection, municipalities, religious authorities and owners
- **Formalize coordination with civil protection** through a designated liaison, and **the inclusion of heritage** in national risk assessments and **heritage scenarios** in national exercises

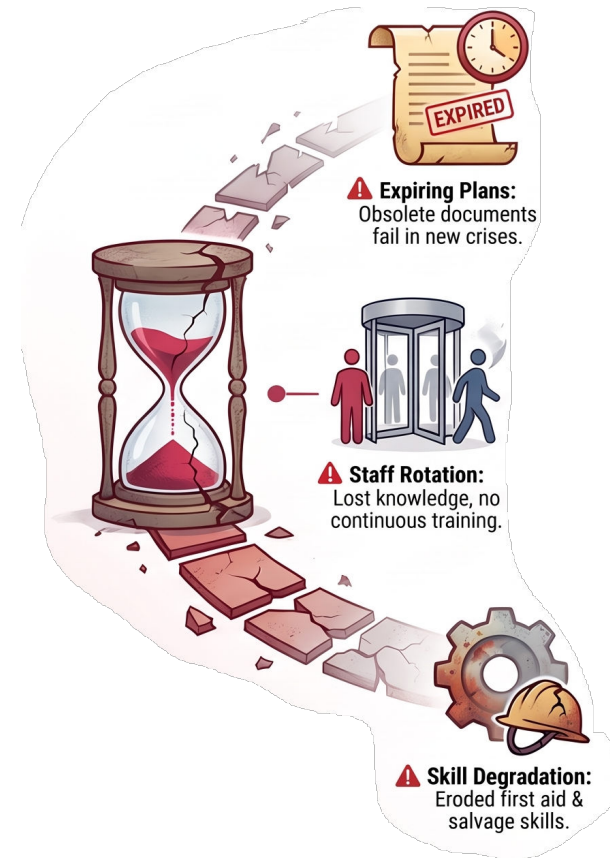


Active Governance

Sustained financing



- **Make money already being spent count twice:** digitization, 3D surveys and restoration/conservation works should also capture what risk assessment needs (structure, materials, condition)
- **Provide sustained funding for emergency preparedness and response:** plans expire, staff rotate, training needs refreshing
- **Commit nationally to the European Partnership for Resilient Cultural Heritage:** it runs on member state contributions, and those contributions set its scale and its agenda



Active Governance

Definition of standards

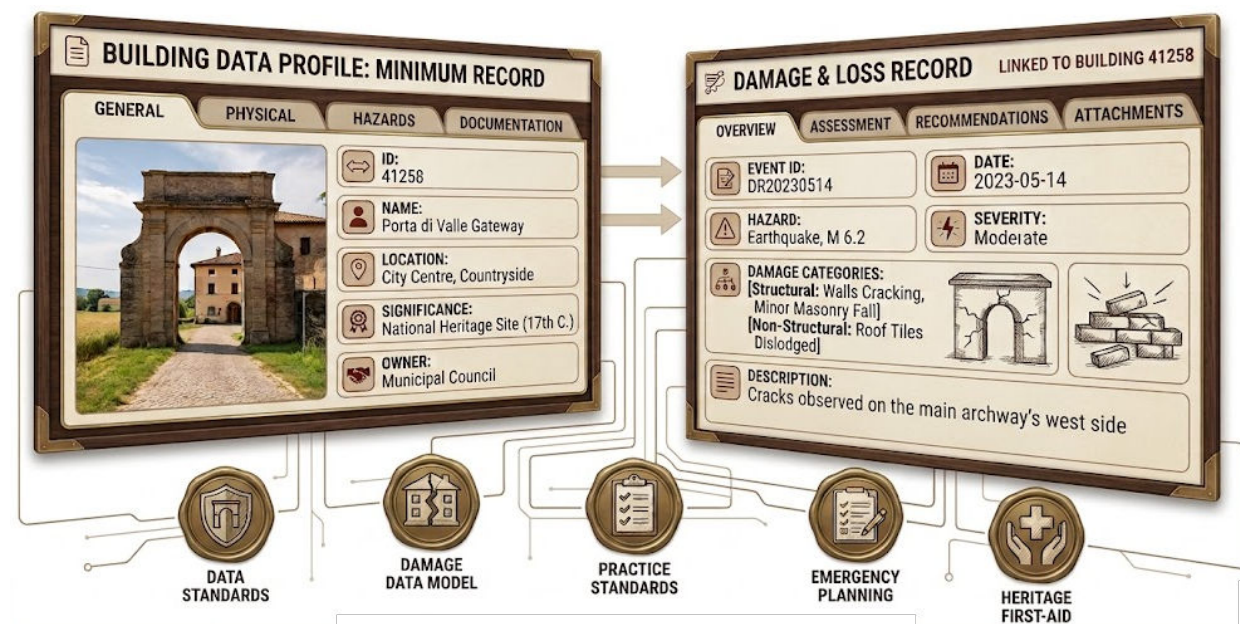


Set data standards:

- Data profile for disaster risk management
- Damage and loss data model for cultural heritage

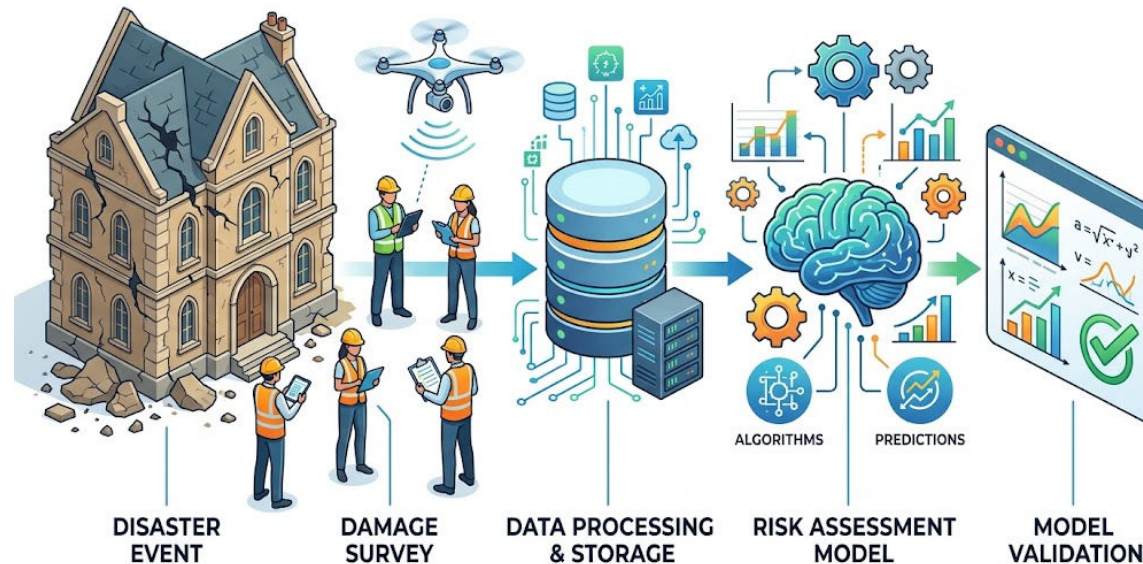
Set practice standards:

- Emergency planning template
- Post-event damage and loss assessment template
- Heritage first-aid training and certification



Final remarks

- Methods and technology are moving forward. What holds them back is data: **no one owns it, and no one is required to collect it**
- **Resilience** starts with knowing **what we lose**
- **Every event we fail to record is a risk model we cannot build, a prevention case we cannot make, and a loss we will repeat**



Final remarks

3 steps to start (urgently):

- **Name the owner:** a body accountable for heritage disaster risk management, and a custodian for its data
- **Agree the minimum:** one European data profile, one damage and loss model
- **Capture the next event** (starting now): a damage and loss annex in every emergency plan and every recovery programme



Mulțumesc Teşekkür ederim
Obrigado Tack Bedankt
Ďakujem Tak Danke Grazie Takk
Děkuji Kiitos **Thank you** Ačiū
Dank u wel Merci **Hvala** Tānan
Grazzi Dziękuję Gracías Paldies
Go raibh maith agat Blagodarya Efcharistó

Final remarks

If you are interested in knowing more about damage and loss data systems



Co-funded by
the European Union

SAVE THE DATE

AHEAD FINAL WORKSHOP

2nd December (Afternoon) & 3rd December (Morning)

Faculty of Engineering, Room B032
University of Porto

📍 Rua Dr. Roberto Frias
Porto, Portugal

