ARCH

Good practices in building cultural heritage resilience

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Advancing Resilience of historic areas against Climate-related and other Hazards

Deliverable D7.2, Work package 7

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01 Introduction

This report has been prepared for the European Commission-funded research project ARCH: Advancing Resilience of historic areas against Climate-related and other Hazards. The ARCH project aims to enhance the resilience of areas of cultural heritage to climate change-related and other hazards. To this end, tools and methodologies will be developed with the pilot cities of Bratislava (Slovakia), Camerino (Italy), Hamburg (Germany), and Valencia (Spain), in a co-creative approach with local policy makers, practitioners, and community members. The results will be combined into a collaborative disaster risk management platform for guided resilience building, along with a range of models and methods to support decision-making at appropriate stages of the disaster risk, climate adaptation and cultural heritage management cycles.

This report is meant to serve as an inventory of good practices in building cultural heritage resilience. It contains an overview and classification of 40 cultural heritage resilience initiatives, providing information on their location, biogeographical region and lead(s). 32 of them are featured as snapshots and eight of them as case studies (containing in-depth information on aspects such as main outcomes, factors of success and lessons learned). Additionally and reflecting upon the term "replicability", the report proposes a set of criteria to evaluate their transferability potential to other urban contexts. The main objective of this report is to provide people working in city administrations in European cities and regions (especially in the areas of climate adaptation, disaster risk reduction and cultural heritage management) with a source of guidance and inspiration for building the resilience of cultural heritage sites.


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02 Key concepts and terms

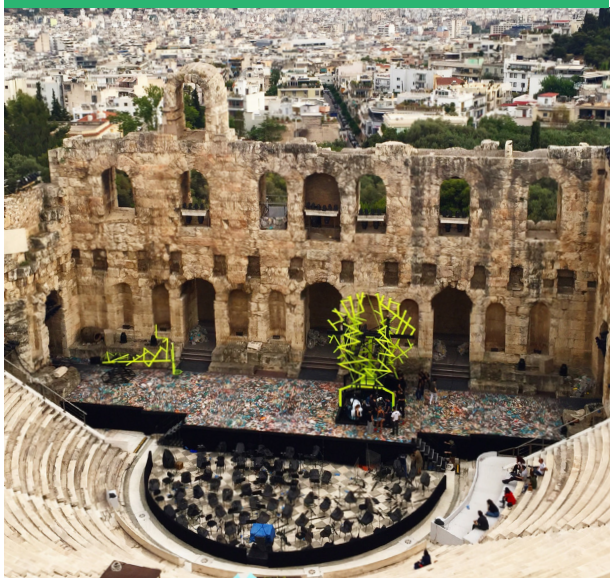
This section outlines the concepts and terms that are essential to understand the rationale behind this report and support the identification and classification of initiatives (e.g. the concept of cultural heritage and its various dimensions, the concept of risk, an overview of the hazards (and stressors) most relevant to cultural heritage sites, and the practice of disaster risk management).

2.1 The dimensions of cultural heritage

The concept of cultural heritage has varied considerably over time, with the contemporary definition including both tangible and intangible dimensions [1] [2] [3].

Tangible heritage

is described by UNESCO [8] as "physical artefacts produced, maintained and transmitted inter-generationally in a society. It includes artistic creations, built heritage and other physical or tangible products of human creativity, which are carriers of cultural significance within society and are considered to be worthy of preservation in the future".



Intangible heritage

is defined as "practices, representations, expressions, knowledge, skills – as well as the instruments, objects, artefacts and cultural spaces associated therewith – that communities, groups and, in some cases, individuals recognize as part of their cultural heritage. This intangible cultural heritage, transmitted from generation to generation, is constantly recreated by communities and groups in response to their environment, their interaction with nature and their history, and provides them with a sense of identity and continuity, thus promoting respect for cultural diversity and human creativity [8].

Images: Veronica Rebollo

The ARCH project adopts the classification also proposed by UNESCO [8], later revised by the ICOMOS Climate Change and Cultural Heritage Working Group in 2019 [4], where cultural heritage elements are categorised into six main groups:

- Moveable heritage;
- Archaeological resources;
- Buildings and structures;
- Cultural landscapes;
- Associated and traditional communities,
- Intangible heritage

Building on the category proposed above, as well as on other key publications [10] [5] [6] [7] these different categories and the examples of heritage types and elements therein, are visualised in Table 1 on the following page.

Table 1: Classification of cultural heritage categories, types and examples

Cultural Heritage Categories	Cultural Heritage Types	Examples
Moveable heritage	Works of monumental sculpture and painting	Paintings, sculptures, furniture, wall paints
Archaeological resources	Archaeological finds	Pottery, artefacts, inscriptions
	Archeological materials	Bones, textiles, ceramic
	Archaeological sites	Tombs, caves
	Archeological monuments	Sacred places, temples, burial sites
	Stratigraphic elements	Stratigraphic tests and finds
Buildings and structures	Architecture (historic and monumental buildings)	Castles, theatres, churches, cathedrals
	Groups of separate or connected buildings	Streets, warehouse complexes, harbours
	Historical nuclei	Historic centres of towns and cities
Cultural landscapes[1]	Parks/gardens	Parks, cemeteries, botanical gardens
	Combined works of nature and humankind	Agricultural landscapes, mining landscapes
Associated and traditional communities	Traditional groups, communities and individuals	Indigenous peoples
Intangible heritage	Oral traditions and expressions	Proverbs, poems, tales
	Performing arts	Theatre, music, dances
	Social practices, rituals, festive events	Festivals, religious rituals, ceremonies
	Traditional craftsmanship (knowledge and skills)	Crafts, traditional agricultural techniques, masonry
	Knowledge and practices concerning nature and universe	Traditional ecological wisdom, traditional healing systems

The ARCH project's scope of work is mostly oriented to protecting those heritage assets associated to the wider urban context (including peri-urban metropolitan areas), which are widely represented by tangible, immovable heritage such as historical and monumental buildings and infrastructure that constitute historic centres, as well as cultural landscapes more broadly. Nevertheless, most elements of cultural heritage are frequently intertwined, and historic centres and other cultural heritage types found in cities are strongly associated to intangible elements, e.g. traditional practices. For this reason, a wide range of elements have been considered in the current analysis, although there is a prevalence of those actions, measures and initiatives relevant to tangible cultural assets.

1 The Operational Guidelines for the Implementation of the World Heritage Convention (UNESCO, 2008) includes in this category **intentionally created landscapes** (e.g. parks, cemeteries), **organically evolved landscapes** (e.g. relic /or fossil landscape where an evolutionary process came to an end or a continuing landscape which retains an active social role associated with a traditional way of life and which exhibits significant material evidence of its evolution over time) and **associative cultural landscapes** (landscape that has value by association by powerful religious, artistic, or cultural association of the natural element)

2.2 Risks to cultural heritage

Understanding how cultural heritage assets are threatened requires a basic introduction to the concept of risk and its constituent elements: hazard, vulnerability and exposure. Hazards that may affect cultural heritage are of different origins – e.g. environmental, anthropogenic or biological– and most of them are mutually dependent. The impacts on cultural heritage are often a result of concatenating hazards and are aggravated by non-climatic and climatic drivers. The current section aims to review some of these concepts and the relation between them.

The IPCC [8] defines **hazard** as "*the potential occurrence of a natural or human induced physical event or trend, or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, and environmental resources*". According to the UN [9] each hazard is further characterised by its location, intensity or magnitude, frequency, and probability. The events and trends addressed in the IPCC definition may have consequences of different magnitude, depending on the system or community's exposure to a hazard, and that system or community's underlying vulnerability (comprised of its sensitivity and its capacity to deal with the consequences, i.e. adaptive capacity). These key terms can be defined as follows:

- **Exposure**: "*The presence of people, livelihoods, species or ecosystems, environmental services and resources, infrastructure, or economic, social, or cultural assets in places that could be adversely affected*" [14]

- **Vulnerability**: "*The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt*" [14][2]

- **Adaptive capacity**: "*The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences*" [14]

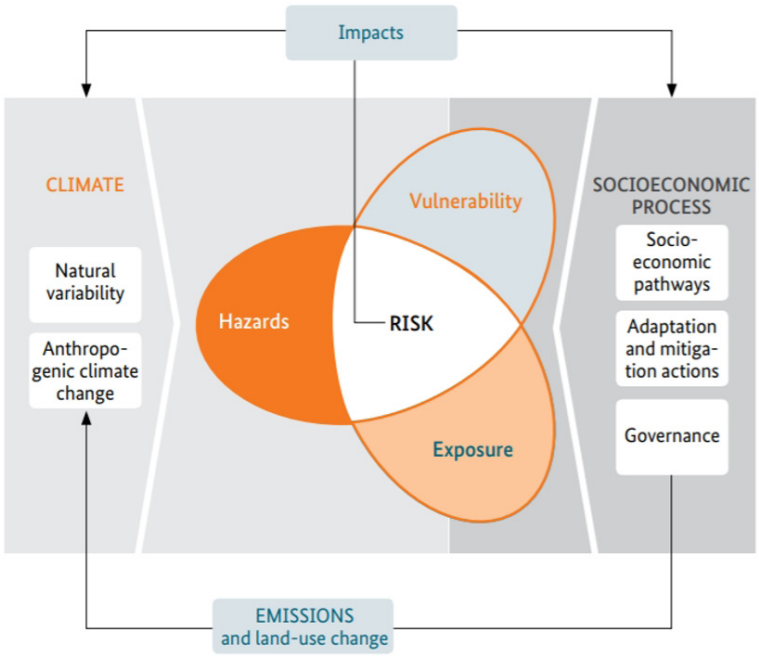
When these factors (occurrence of an event, exposure and vulnerability) interact they may result in a **hazardous physical event or disaster** (in this last case, especially when the adaptive capacity of a community is low and its sensitivity high). This report adopts the UNISDR [10] definition of **disaster**: "a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources".

Hazards may be single, sequential or combined in their origin and effects. They entail risks, which could manifest as impacts on cultural heritage: e.g. deterioration, collapse, weathering of materials, etc. Here, **risk** is understood as "*the potential for consequences where something of value is at stake and where the outcome is uncertain, recognising the diversity of values. Risk is often represented as probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. Risk results from the interaction of vulnerability, exposure, and hazard*" [14] and the

2 Note that some commentators go further to emphasise the social dimensions of vulnerability, and specifically power structures that contribute to it, defining vulnerability as 'the structural conditions, including physical, social, cultural, economic and political systems that render people and communities susceptible to the impacts of hazards, and which make it possible for a hazard to become a disaster' See: Gorman-Murray, A., & Dominey-Howes, D. (2016). 'The greatest loss was a loss of our history': natural disasters, marginalised identities and sites of memory. Social & Cultural Geography, 17(8), 1120-1139.

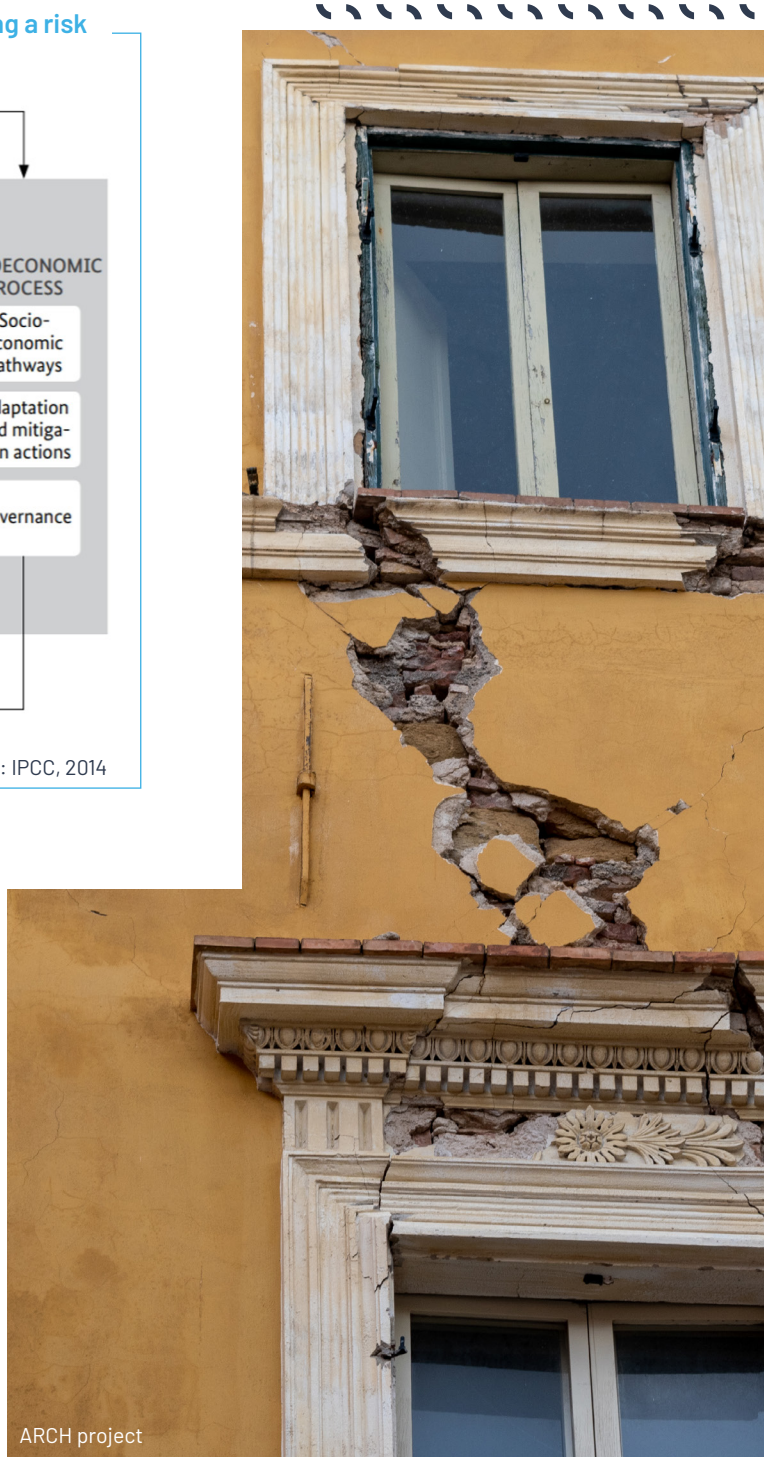
impact, as the consequence or effects of a risk when it becomes tangible (see Fig 1 below). An initial impact can trigger other phenomena that may lead to consequences of significant magnitude (e.g. physical, social or economic disruption), known as "cascading effects" [11].

Fig 1: Schematic representation of main factors influencing a risk



Source: IPCC, 2014

Also relevant are drivers of deterioration (also called **stressors**) as a different category to hazards, referring to those factors that aggravate the impacts of a potential event. More concretely, the IPCC [12] define stressors as "*events and trends, often not climate-related, that have an important effect on the system exposed and can increase vulnerability to (climate-related) risk*". This concept is used here to include those elements hindering the implementation of cultural heritage conservation or management measures, or accelerating the deterioration of the assets, such as neglect, lack of political or social support, lack of resources, or ineffective funding mechanisms, just to name a few.



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2.3 Most common threats to cultural heritage

The challenges that society faces in order to successfully adapt to and resist future disasters are widely documented [13]. They come in different forms and shapes, either as natural hazards (some of which are increasingly frequent and aggressive as a consequence of climate change) or as anthropogenic –or human-induced- hazards such as those resulting from the industrial development, urban growth and overexploitation of natural resources. The combined effect of all of them frequently leads to economic and socio-political issues, augmenting inequality and triggering civic unrest in different manners (i.e. armed conflicts, terrorism).

Cultural heritage assets, as an intrinsic element of human civilisation, face particular and serious risks in this regard, including their social, cultural, historic and artistic values; the safety of their occupants and users and those whose livelihoods depend on tourism [14]. Moreover, a heritage site or object can also be negatively affected by inappropriate emergency response and post-disaster actions, ill-conceived restoration and recovery phases, or technical and economic constraints, among others [20]. This is a major concern; partly because of the significant role that heritage plays in contributing to social identity, social cohesion and sustainable development [15].

Understanding and classifying such hazards and their consequences has been a core activity in the topical areas of disaster risk management (hereafter DRM) and more recently, climate change adaptation (CCA). Climatic hazards may have received closer attention due to the momentum the topic of climate change has been gaining in the last decades, with typologies developed by The Intergovernmental Panel on Climate Change [16], C40[3] and The Covenant of Mayors [17], mostly targeting urban areas. The manual *Managing disaster risks for World Heritage* [21] and the more recent report *Safeguarding Cultural Heritage from Natural and man-made disasters* [20] depict the most common hazards affecting cultural heritage.

As mentioned in section 2.2 above, some of these hazards – whether climatic or non-climatic – interact with each other, giving place to complex impact chains, where new hazards emerge based on the vulnerability and exposure of the cultural heritage assets affected. Building on previous typologies, as well as on research conducted within the H2020 project RESIN, the ARCH project team proposes a schematic categorisation of the main hazards affecting cultural heritage in Europe and the main interconnections between them (Fig 2).

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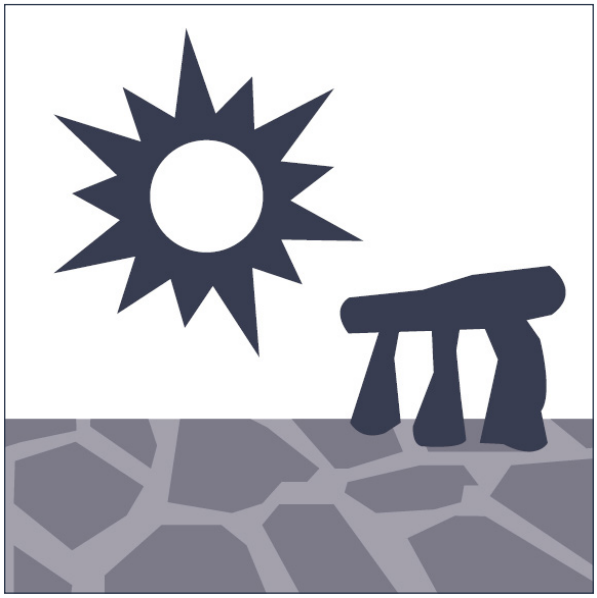
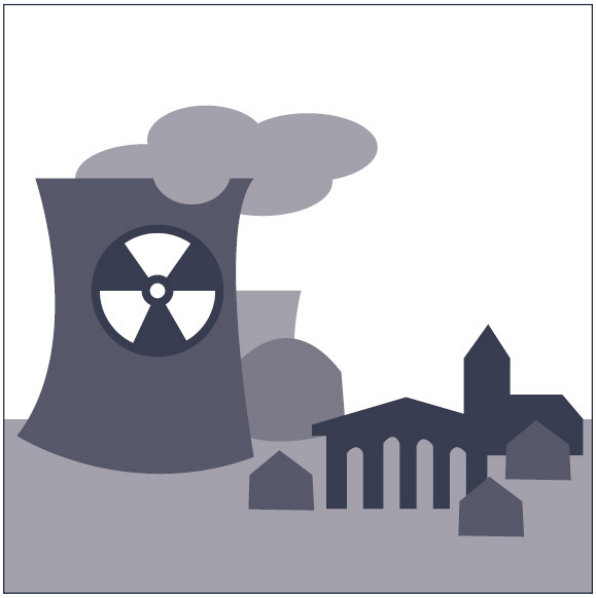
3 C40 developed in 2015, in collaboration with Aarup, a City Climate Hazard Taxonomy, which classifies climate hazards into five key groups: meteorological, climatological, hydrological, geophysical, and biological.
The Taxonomy is available here: www.c40.org/researches/city-climate-hazard-taxonomy



Climate-related hazards



Human-induced hazards

Geological-related hazards

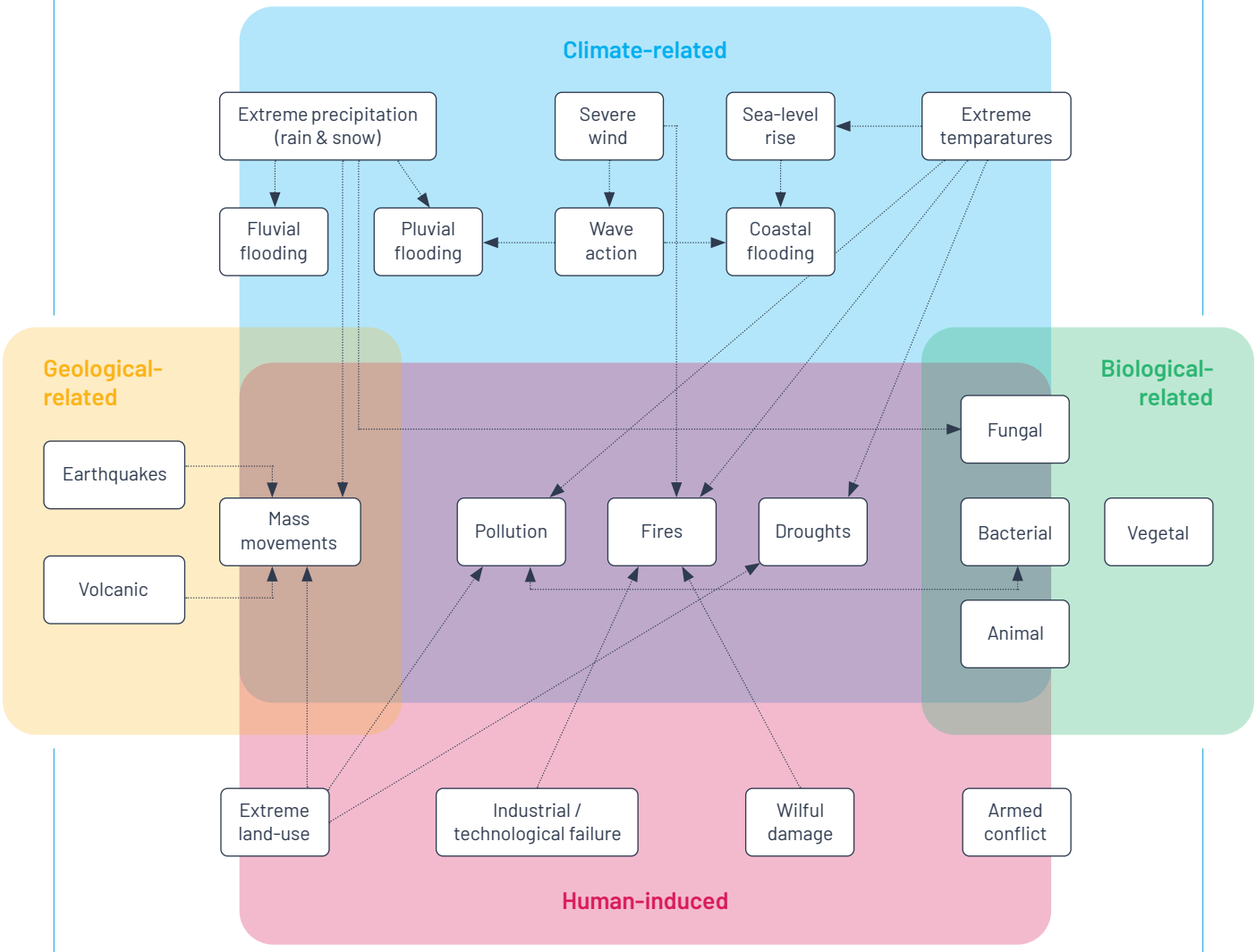
Biological-related hazards

In the current report, hazards have been classified under four main categories: "climate-related", "human-induced", "geological-related", and "biological-related" (even though some of them fall under different categories simultaneously). The graph is a non-exhaustive attempt to depict the complex nature of impact chains, indicating the most evident interactions. Building on previous works [10] [13] [18] [19], the table on the following page (Table 2) shows the most common impacts on cultural heritage assets as well as the main causes and related hazards.

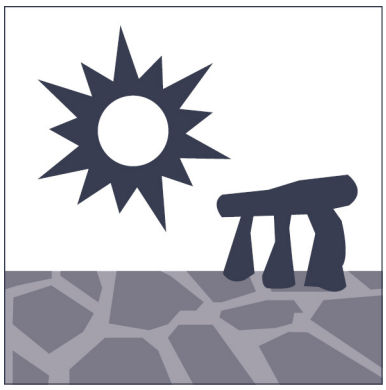
Table 2: Categorisation of damages to/effects on cultural heritage and their causes and related hazards

Damage to Cultural Heritage	Causes	Related hazard(s)
Physical/mechanical erosion and weathering of stone materials	Freeze / thaw cycles	Extreme temperatures
	Rain / hail impact	Extreme precipitation
	Abrasion	Severe wind
	Wave impact	Wave action; Storm surges
	Bio-pitting	Fungal action; Bacterial action
	Root-wedging	Vegetal action
	Tunnelling, carving	Animal action
	Weapons / objects impact	Armed conflicts; Wilful damage
	Landslides, mudslides, rock falls	Mass movement; Extreme precipitation; Extreme land use
Chemical erosion and weathering of stone materials	Wet / dry cycles	Extreme precipitation; Flooding (pluvial, fluvial or coastal)
	Salt intrusion	Flooding (coastal); Severe wind
	Inorganic and organic compounds, gases and particles	Pollution
	Lava flows and ashes	Volcanic activity
Structural damage and collapse	Wind impact	Severe wind
	Faulting, transient shaking	Earthquakes
	Mudflows, landslides, rockfalls	Mass movements; Extreme land use; Extreme precipitation
	Lava flows, lahars	Volcanic activity
	Explosions	Armed conflict; Wilful damage
	Wave impact	Storm-surges
Total or partial burning, blackening, and deformation by heating	Fires	Extreme temperatures (heat); Volcanic activity; Earthquakes; Armed conflict; Wilful damage
	Lightning	Extreme precipitation (thunderstorms)
Subsidence	Soil erosion and instability	Extreme land use; Extreme precipitation
	Faulting, transient shaking	Earthquakes
Isolation and reduced accessibility	Burial and submersion of assets	Sea-level rise; Flooding (fluvial); Volcanic activity
	Mudslides, rockfalls, and landslides	Mass movements
Loss of aesthetic value	Fading/yellowing of painted materials	Extreme temperatures (heat)
	Particulate matter deposition and crusting / soiling of surface masonry materials	Fungal action; Extreme precipitation; Extreme temperatures (heat)
	Foxing of paper materials by fungal action or oxidation	Fungal action; Extreme precipitation; Extreme temperatures (heat)
	Accelerated aging of textile materials	Extreme temperatures (heat); Extreme precipitation
Corrosion of metallic materials	PH precipitation	Pollution; Extreme precipitation
Timber collapse and pulverization	Organic decomposition	Bacterial action; Fungal action
	Tunnelling and boring of pests	Animal action
Abandonment and / or neglect of tangible cultural assets	Desertification	Extreme temperatures
	Exodus, population migration	Armed conflict; Wilful damage
Transformation of cultural landscapes	Proliferation of invasive species	Extreme land-use; Pollution; Extreme temperatures; Extreme precipitation
	Loss of local biodiversity	Extreme land-use; Pollution; Extreme temperatures; Extreme precipitation
	Abandonment of traditional agricultural or industrial practices	Extreme temperatures; Sea-level rise; Flooding (coastal); Extreme land use; Pollution
Loss of traditional knowledge	Displacement or migration of local communities, crop failure and abandonment of traditional agricultural, industrial and artistic practices	Extreme temperatures; Sea-level rise; Coastal floods; Extreme land use; Pollution

Fig 2: Schematic categorisation of main hazards affecting European cultural heritage and the interconnections in between them.



The prevalence of the above hazards varies of course depending on geographical variables. The following paragraphs present an overview of the most common hazards in Europe (including the overseas regions) and their consequences on tangible cultural heritage assets, organised under the four main hazard categories identified above: climate-related, geological- related, human-induced and biological-related.



2.3.1 Climate-related hazards

This category encompasses all those hazards deeply influenced by atmospheric variations, whether they are sudden, abrupt or short-term (meteorological) or alternatively prolonged over time (climatic). Such hazards are especially relevant and indeed urgent globally, as their frequency and intensity is being increased by climate change, and the magnitude of consequences is still unpredictable in spite of existing models and future-scenario simulations.

Extreme temperatures, heat waves and droughts

The increase in the global surface temperature is expected to affect the frequency and intensity of heat extremes, heatwaves (and, somewhat conversely, precipitation, as warmer air can hold a bigger quantity of water) – therefore increasing the probability of storm surges or severe rainfall [20].

Prolonged extreme heat can lead to droughts, which refer to the (extreme) scarcity of water, whose origin may be meteorological (caused by rain deficiency), hydrological (caused by low discharge or low ground water level) or linked to lower soil moisture. **Drought** has been a recurrent feature of the European climate in recent times. From 2006 to 2010, on average 15 % of the EU territory and 17 % of the EU population have been affected by meteorological droughts each year [19]. Droughts translate into soil erosion, salt weathering and cracking and collapse of buildings (among them, those of cultural heritage significance), ecological disruptions and lower productivity in agricultural lands.

Abrupt variations in temperature result in changes in freeze-thaw cycles with severe impacts on cultural assets, especially if they are made of stone. Some of the most widely-recognised impacts are the deterioration of facades due to thermal stress, freeze-thaw/frost damage, fading of paintings, yellowing of materials, structural damage in mineral materials (as humidity penetrates and freezes the insides) and biomechanical deterioration [21].

Some other secondary impacts or cascading effects of temperature variations may not be as evident, but equally affect cultural heritage either directly or indirectly, e.g. through the proliferation of invasive

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species and the spread of native and non-native species of insects that could lead to changes in cultural landscapes, or by favouring mould infestation (whose metabolic activity is higher in warmer and more humid conditions) and other biological hazards [22]. Additionally, droughts and increased temperatures are closely linked to **wildfires** and are also associated with desertification, which can force people to migrate (e.g. where a community depends on agricultural land), leading to the abandonment or neglect of a specific area. Climate - induced migration also affects intangible cultural heritage, forcing local communities to abandon their traditional ways of living to secure livelihoods in other areas, while putting their traditions and cultural values at risk [27][23].

Extreme precipitation, storm surges and flooding

Water-related hazards represent a serious multi-level threat with direct and indirect impacts, periodic reappearance and with complicated socio-economic impacts [24]. Heavy (or extreme) **precipitation** (i.e. rain, sleet, hail and snow) can overload structures such as roofing, downpipes, or gutters; cause pollutants to accumulate on and potentially penetrate building fabric to building's surfaces; cause physical changes to internal surfaces and objects (e.g. paintings) due to rising humidity, crystallisation and dissolution of salts from wetting and drying; cause erosion and corrosion of metals; and cause biological attack of organic materials [10]. Additionally, extreme precipitation in the form of hail can also cause erosion when impacting surface materials.

Heavy precipitation poses the risk of one of the most frequent and widespread natural disasters in urban areas: i.e. **pluvial** flooding caused by heavy rainfall (including flash flooding), and **fluvial** flooding, caused by the overflow of bodies of water. Flooding impacts are also influenced by non-climatic factors, such as population density, floodplain development and land use changes [25].

Many flooding events of alarming magnitude have taken place in Europe in the last decades, causing damage worth billions of euros, particularly in 2002 (Czech Republic, Austria, Germany, Slovakia, Poland, Hungary, Romania, Croatia) 2006 (Bulgaria, Romania, Serbia, Macedonia, Germany, Czech Republic, Hungary), 2009 (Austria, Czech Republic, Hungary, Poland, Romania, Slovakia, Turkey) and in 2013 (Germany, Czech Republic, Austria, Switzerland, Slovakia, Belarus, Poland, Hungary) [26][27].

Cultural heritage sites can suffer considerably from these events, experiencing failures due to static and

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dynamic loads, impacts from floating objects, chemical erosion, saline intrusion (if located in coastal areas), rot and biological infections [20]. Even though floods are often sudden and short in duration, flood damage entails longer-term complications from a disaster risk management perspective, as they take considerable time and money to be repaired.

Severe wind

The damage caused by wind (e.g. cyclones, hurricanes and storms) poses a serious risk to infrastructure, human lives and property. Whereas cyclones and hurricanes are not so prominent in European countries, the incidence of storms and related meteorological events is increasing in number and intensity as a consequence of the climate change [28]. Wind is frequently accompanied by rain, salt and sand, all of which can have erosive and abrasive effects on the surfaces of built cultural heritage, as well as chemical change due to moisture penetrating porous surfaces [29]. Moreover, wind gusts and changes in flow direction can drive static and dynamic loading of historic and archaeological structures, unchaining rockfalls, structural damage and collapse.

Sea-level rise and wave action

Sea level rise is caused mostly by melting land ice and the expansion of sea water as it warms [30]. Cultural heritage sites located in coastal areas are especially at risk from this phenomenon and the subsequent **coastal flooding**. As stated by Marzeion & Levernmann [31] in a study, 0.7% of global land area would be below mean sea level, affecting about 40 UNESCO World Heritage sites (about 6% of all then-existing World Heritage sites) if the current global mean temperature were to be sustained for the next two millennia (not including the amount of urban areas that would also be affected, along with their historical centres).

Sea level rise can interact with other events as a consequence of climate change, such as **storm surges**, bringing increasing challenges for cultural heritage sites located in coastal areas, and vulnerable to tidal action. This manifests mostly as floods and coastal erosion, which in turn increase the future vulnerability of coastal areas to sea-related hazardous events. As a result, cultural heritage landscapes may be subject to erosion provoked by prolonged contact with water, along with salt intrusion and physical and mechanical impacts resulting from waves [32]. Buildings and objects (particularly those located in low lying areas) may be permanently or temporarily submerged.

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2.3.2 Geological-related hazards

Earthquakes

Earthquakes are among the natural disasters with the most devastating effects in terms of loss of life and structural damage [33]. They are frequently followed by concatenating effects, such as fire, floods, landslides or tsunamis, which can combine to multiply casualties in just one single event. Needless to say, the impacts on cultural heritage places can be equally destructive, and often result in total or partial collapse of structures, causing damage that could be irreversible.

Earthquakes are widespread in the European territory, with Mediterranean countries such as Italy, Greece, Turkey and Spain suffering the most from them [20], though Iceland, France, Albania, Bulgaria and Romania have also experienced major earthquakes.

Mass-movement

Mass movement is a complex hazard with various possible origins that can manifest in different forms. Dry landslides are solid-material mass movements which frequently result from the incidence of other hazards such as earthquakes, volcanic eruptions, mining or infrastructural failures. According to the

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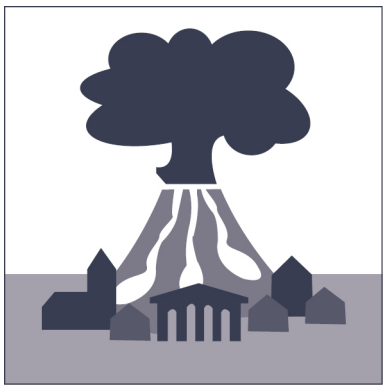


type of materials involved, they would manifest as **rockfalls** – in which rocks or boulders are detached from steep slopes or cliffs – or avalanches – where mineral material of varying size is separated from the underlying substrate, flowing downwards. When mixed with liquid material, they may be referred as wet **landslides**. These are often associated with heavy rainfall or snowmelt, forming **debris flows** (a combination of loose soil, rock, organic matter, air and water which is mobilised as a slurry flowing down a slope) or mudflows (with higher proportion of liquid, and at least 50% of sand, silt and clay-sized particles) flowing at higher speed [20]. Even though classified as geological hazards, extreme weather and climate-related events (e.g. heatwaves, droughts and heavy precipitation) are among the most common triggers of landslides in Europe [19]. Landslides have been known to widely impact cultural heritage from countries such as Italy [34], Bulgaria [35], Austria [36] and Spain [37] leading to damage that may include total or partial collapse, weathering and structural deterioration of materials, chemical change due to humidity, or loss of aesthetic values, among others.

Volcanic eruption

Volcanic eruptions are not a major concern in Europe, with few incidences recorded in the last decades. The most vulnerable areas are located in Southern Europe, mostly in Italy, Greece and overseas territories, such as the Canary Islands and the French Antilles. In spite of the high concentration of World Heritage sites in risk-prone areas, few studies have addressed how volcanic eruption hazard affects the cultural heritage of these areas [20].

2.3.3 Human-induced hazards

Extreme land use

Aggressive development is considered as one of the main threats to cultural World Heritage [38]. The continuous demand for resources and space inherent to traditional urban growth has put in danger cultural assets and landscapes, leading to the demolition of historical buildings or transformation of traditional agricultural landscapes in favour of industrial development (e.g. intensive farming and agriculture practices) or simply to make more room for housing. Even though in theory cultural heritage is regarded as a useful catalyst for sustainable development, it is in reality often considered an obstacle [39]. Such is so, that governments may prioritise development over cultural heritage protection (see section 2.3.5 – lack of awareness on cultural heritage values). Sites on the periphery of growing cities are particularly at risk, and there is a need to regulate urban expansion to prevent irreparable damage.

Extractive activities have been known to pose serious risks to cultural heritage sites [40]. The exploration, prospecting and exploitation of minerals and fossil fuels and extraction of gas are considered among the riskiest, as they do not only involve the extractive activities per se, but they are also linked to the construction of roads and supporting infrastructure, all of which can damage surrounding ecosystems either directly (e.g. destruction of vegetation) or indirectly (e.g through pollution). The deforestation and de-vegetation caused by intensive land use (may it be linked to agriculture, cattle farming, mining or other practices) can favour the incidence of events such as landslides or droughts.

Pollution

Air pollution is caused by natural or human activity that introduces in the atmosphere considerable amounts of gaseous pollutants (NO_2, SO_2, O_3,CH_2O) that can directly or indirectly (for example, through the formation of acid rain) impact on the lifetime and quality of cultural heritage places and objects [41]. With the perspective of increasing urbanisation, it is likely to persist in future. Gaseous pollutants, particulate matter and aerosol carbon fractions provoke effects such as stone decay, chemical change (e.g. sulphur oxide, nitric acid and nitrates react with some kinds of marble), or dry deposition on stone materials and crusting, resulting in loss of integrity and aesthetic value [42].

Armed conflict and wilful damage

Armed conflict has greatly impacted on the integrity of cultural heritage worldwide, and is still a major issue in countries such as Syria, Palestine, Iraq and Mali [43] [44] [45] [46]. Although in Europe, armed conflict has decreased in current times, it has caused great damage throughout the continent's history, with cities and towns being devastated, libraries burnt or communities displaced [47] [48]. Some physical testimony remains from past conflicts in historic centres partially or totally rebuilt after attack (e.g. Gernika in Spain, Breisach in Germany). Armed conflict does not only lead to the damage and destruction of cultural assets, but also unchain criminal behaviours such as the looting, theft, removal or illegal trafficking of cultural elements.

2.3.4 Biological-related

The action of living organisms may have an impact on the structure and composition of places and objectives of cultural heritage significance. Biological agents unchain transformation processes in the affected materials as a consequence of the metabolic activity connected to their growth or other functions [24]. Many biological organisms find in historic structures (including rock, wood, textiles and paper) an excellent substrate for their growth and development. Glass and metals are less susceptible to the effects of such organisms, except in isolated cases in which buried metal elements had suffered degradation caused by bacterial activity, or underwater glass structures had been colonised by algae [24].

This biotransformation occurs worldwide, but happens with more intensity in warm-humid climates where environmental conditions are most adequate for the biological growth of microscopical beings such as bacteria to macro-organisms such as fungi, lichens, plants and animals. The main types of damage are related to physical, chemical and aesthetical mechanisms and depend on the dimensions of the organisms involved, the type of material and conservation state, the environmental conditions, climatic exposure and the presence and type of environmental pollutants [24]. Whereas some organisms, such as fungi and lichen, contribute to the dissolution and weathering of minerals and colonisation of surfaces with undesired aesthetic effects, plants and weeds can cause with their root systems physical damage such as fracturing or collapse of structures [49]. Animals may use a building or object as habitat, leading to physical transformation and chemical degradation with their secretions. Furthermore, as the climate continues to change and humans continue to modify our environment, biological agents and animals may be displaced from their usual habitats and seek new ones, resulting in the proliferation of species in (natural or agricultural) cultural landscapes where they would not normally be found, with potential impacts on existing local species [38].

2.3.5 Drivers of deterioration (stressors)

Besides the climatic, geological, human-induced and biological-related hazards affecting cultural heritage, there are a number of factors limiting the capacity to effectively respond to them, or accelerating the deterioration of different assets, and these can serve to exacerbate the impacts caused. These factors can be understood as 'drivers' or 'stressors'. With respect to cultural heritage, many such stressors concern insufficient or ineffective management, care and maintenance of culturally significant places, and may be caused by a lack of awareness of what value cultural heritage really represents to society, lack of political support, lack of available capacity at administrative level or simply, or lack of available expertise. The most relevant stressors are summarised as follows:

Lack of awareness of cultural heritage values

One of the mains reasons that hamper cultural heritage protection is a lack of understanding –or acknowledgement- of what it really represents for society – and this point is closely linked to some of the other drivers below. Cultural heritage conservation is often perceived as a luxury, rather than a tool towards sustainable development, resilience-building and healthier communities. This can be illustrated using disaster risk management (see section 3.4 as a reference) as example. In face of a disaster, cultural heritage management is occasionally left aside from the first steps in the emergency response. This answers to basic needs at a certain extent, and it seems natural that most immediate efforts are directed to save people and critical infrastructure in first place. However, it also responds to a misconception of cultural heritage's connotations and its importance for social cohesion and identity – and therefore, for social resilience as a whole. Such misconceptions could result into **lack of political buy-in**, which is essential to secure the capacity and funds needed to undertake effective emergency, restoration and reconstruction efforts.

More generally, the lack of political buy-in could derive in policies and practices at local level that do not play in favour of cultural heritage preservation, such as unsustainable recreation and tourism or demolition of historic buildings for housing and infrastructure projects. Moreover, a municipality that does not enhance its cultural heritage may face higher risks of vandalism, theft and abandonment of cultural

Pixabay / Dimitris Vetsikas

heritage assets. On another hand, if companies and contractors involved in maintaining and rebuilding efforts lack awareness of cultural values (and traditions) that local communities associate with "their" heritage, there is an increased risk of losing these values completely, since they might not be considered when maintaining or rebuilding heritage.

Lack of capacity or economic resources at administrative level

This point is a consequence of the former one. When cultural heritage protection is not prioritised in political agendas, the availability of resources (economic, technical or human) allocated to conservation efforts may be compromised, which could result in neglect or abandonment of cultural assets. The limitation of resources is overall more frequent in small municipalities and settlements, which is especially problematic since these cities would enormously benefit from the capitalisation of their cultural assets, eventually boosting local economy. Resources also imply having the relevant administrative bodies – or the relevant experts– doing conservation work. This may be challenging, as the restoration and conservation measures may be echoing those used in ancestral times, which require a very particular type of expertise. The mastering of traditional techniques is deeply connected with sustaining the cultural integrity of the heritage assets, and is also a way of safeguarding intangible heritage that otherwise may get lost. On the other hand, there is a **lack of integration across sectors**: the culture sector lacks capacity for managing disaster risks and heritage professionals require specific training for risk mitigation, preparedness and response [50].


Pixabay / Trenna Sonnenschein

Relying on citizens and volunteers for cultural heritage protection or restoration actions could help overcome the scarcity of resources at administrative level, as well as promoting education on cultural heritage across all levels and ages (including across governmental sectors), which would additionally have a positive impact in raising awareness on its value.

Lack of relevant data and documentation

A key challenge for protecting cultural heritage assets is the lack of **baseline information** on their location or status. In general, the field lacks up-to-date inventories, geo-referenced data on heritage sites and their boundaries, hazard maps and other relevant resources [51]. Systematic collation of data and sharing it with relevant agencies during emergencies are some of the other challenges that have added to the complexity of the issue. There is a need for inventories of cultural heritage, specific location maps, country profiles, socio-political data or risk maps. Moreover, there is a need to identify heritage elements that play a key role in disaster risk management and adaptation to climate change, or supporting local communities in facing and overcoming their consequences. Where it does exist, such documentation is not stored adequately or spread across different sources, and its access is often restricted or difficult to secure.

2.4 The disaster risk management cycle

To understand how hazards to cultural heritage are being assessed and considered within the resilience -and climate change adaptation- fields, it is convenient to review a few concepts related to risk management.

Risk management refers to the systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster [52].

Related actions and measures are structured following a stepwise approach, which ensures maximum coordination between them, commonly known as the disaster risk management (DRM) cycle.

The ARCH project adopts the DRM cycle defined by Jigyasu et al [53] [54], exclusively targeting cultural heritage in urban areas, which is depicted in Fig 3.

Fig 3: Schematic representation of the DRM cycle

Adapted by MUOP from the Disaster Risk Management of Cultural Heritage in Urban Areas: A training guide: 1.4 Principles for Disaster Risk Management for cultural heritage.

Before disaster

This stage focuses on actions to reduce (or eliminate) hazard-related risks, including risk assessment techniques, prevention or mitigation methods and early warning systems. It typically contains two consecutive steps: risk assessment (the evaluation and prioritisation of potential hazards, vulnerabilities, exposure and impacts), and the prevention and mitigation of hazards (encompassing the elimination or reduction of hazards and vulnerabilities, the mitigation of impacts, and capacity building). Applied to cultural heritage, it involves reducing an asset's exposure and vulnerability to specific hazards, reinforcing its ability to resist impacts, applying technological systems to detect a disaster before it occurs (e.g.sensors) and conducting the necessary analysis to set up an effective emergency action plan.

During disaster

This stage encompasses both **emergency preparedness actions** and **emergency response procedures** (steps designed to manage, control or mitigate the immediate effect of an event). It implies the establishment of protocols that dictate how to act in case that an event/disaster occurs, and involves planning, organising, training, equipping, evaluating and taking corrective actions. In the case of cultural heritage sites or objects, such protocols should include potential evacuation routes (supported by maps and emergency equipment),establishing and training an emergency team, ensuring coordination across actors involved, and establishing alarm systems. All this should crystallise in an **emergency action plan** detailing the procedures to undertake in case of an emergency (including the assignment of responsibilities).

After disaster

This stage defines the steps to be followed after a disaster occurs. It involves **damage assessment**, treatment of damaged assets, **restoration**, **retrofitting** and **recovery** activities. The collective actions aimed at stabilising or reducing damages to cultural heritage assets are known as 'cultural heritage first-aid', and are usually only put in practice once the needs of people and critical infrastructure have been addressed. The **damage assessment** is based on detailed analysis and reporting by technical operators. Cultural heritage first-aid is only the first step to successful restoration and rehabilitation of assets. It needs to be followed by an action plan for recovery and rehabilitation involving detailed condition assessments, conservation methodologies for tangible heritage, future risk mitigation, restoration of services and improved use of heritage assets, and in order to ensure long-term effectiveness, all these actions need to be implemented in a coordinated, well-informed manner.

2.4.1 Integration of climate change adaptation with disaster risk management

DRM is closely related to climate change adaptation (CCA), with both demanding the assessment of risks and vulnerabilities as a basis for informed action. Both fields share a common interest in understanding and reducing the risk created by the interactions of human with their natural and physical environment. Both seek appropriate allocations of risk reduction, risk transfer, and disaster management efforts, for instance balancing pre-impact risk management or adaptation with post-impact response and recovery [55]. However, each is a distinct field of practice, and at a governmental level, each is typically managed and administered by different departments, and associated people, plans and policies.

The two fields have tended to follow independent paths and have on many occasions employed different interpretations of concepts, methods, strategies, and institutional frameworks to achieve their ends [61]. The main issue seemed to be the temporal scale: where disaster risk management has traditionally foreseen the alleviation of immediate or short-term impacts, adaptation to climate change adopts a mid- and long-term vision necessary to anticipate to future scenarios of a changing climate. In the last decade, growing efforts have been conducted to integrate CCA with DRM (e.g. through the concept of iterative risk management [56] [57][4]), however lack of integration between these complementary two fields remains common, risking duplicate efforts, lack of coordination and even the potential to undermine one another. While recognising the need for integration, for the purposes of this study we have chosen to adopt DRM and specifically the DRM cycle for its usefulness as a framework to organise and analyse the selected initiatives in Part 3.

4 The most outstanding attempt of such integration crystallized as a new concept- iterative risk management- recognising that the process of anticipating and responding to climate change does not constitute a single set of judgments at some point in time, but rather an ongoing assessment, action, reassessment, and response that will continue – in the case of many climate-related decisions – indefinitely. An overlap of both approaches would contribute to advance – and secure- short and long-term resilience.

Hrad Tematín

03 Mapping and classification of initiatives

This chapter gathers the 40 initiatives selected for this report, which have been classified according to a series of parameters such as the type of measures featured, the main hazards they respond to and the DRM's phase(s) they cover. All these initiatives contain information on their location, biogeographical region[5] and lead(s). 32 of them are featured as snapshots (where a brief description is provided, as well as links to relevant sources) and eight of them are featured as case studies (containing in-depth information on aspects such as main outcomes, factors of success and lessons learned, driving from the interviews conducted).

3.1 How to read through this classification

Each initiative contains information of the type of measure(s) covered.
All the initiatives have been categorised around four clusters:

Technological/Technical

Initiatives with a technological or technical component, including software and online tools, ICT, infrastructure (i.e. grey or green-blue), but also restoration techniques and methods. This category is subdivided into:

- Sensing and monitoring tools and methods
- Structural measures
- Models and simulations
- Repair techniques
- Decision-support tools

Managerial

Initiatives based in planning, management and governance processes, such as strategies, management plans, guidelines and governance models. This category encompasses:

- Guidance documents
- Maintenance and monitoring frameworks
- Management plans or strategies
- Governance models

5 The biogeographical regions defined by the EEA are geographical reference units for describing habitat types which live under similar environmental conditions in different countries. These can be consulted here: www.eea.europa.eu/data-and-maps/figures/biogeographical-regions-in-europe-2

Behavioural

Initiatives aimed at promoting behavioural change among residents, e.g. educational programmes or actions delivering training and capacity-building or promoting collaboration, as well as communication campaigns. This category is divided in two sub-categories:

- Awareness-raising and communication
- Training and capacity building (of residents)

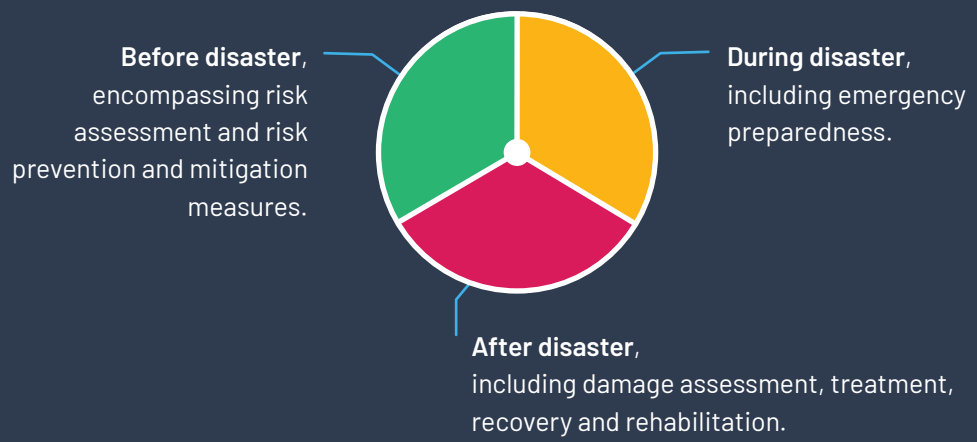
Institutional

Initiatives aimed at promoting collaboration among different actors involved in decision-making, as well as networking and advocacy. This category is sub-divided into:

- Networking and capacity-building (of institutions and experts)
- Advocacy

The initiatives also contain information on the phase or phases of the DRM cycle (see section 3.4) they respond to, for which they are accompanied by a schematisation of the cycle, where relevant phases are coloured as depicted in Fig. 4.

Fig 4: Schematic representation of the Disaster Risk Management Cycle with all its phases to be used as a reference in the classification of initiatives



Finally, the initiatives have been classified according to the main hazards or stressors they respond to, following the categorisation conducted in section 3.3, which also respond to some of the most common threats experienced by ARCH partner cities. Some of the initiatives do not respond to a specific hazard, but are well fitted to deal with a specific stressor –may it be lack of awareness of cultural heritage values, lack of capacity or economic resources at administrative level, or lack of relevant data and documentation.

3.2 Climate-related hazards

3.2.1

Assessing risk for the Mellor Heritage Project

Type: Technological/technical – sensing and monitoring
Main hazard(s): Extreme temperatures (cold), extreme precipitation

Location: Manchester, UK
Biogeographical region: Atlantic
Lead: Fair Dynamics Consulting s.r.l.

The H2020 STORM project (2016-2019), developed an integrated methodology of risk assessment and management for cultural heritage assets in response to the adverse effects of natural hazards and climate change-related events. This methodology was based on remote sensing and information technology (consisting of weather stations and a network of environmental sensors) tested in five pilot sites in Italy, Greece, UK, Portugal and Turkey. Sensors were used to monitor environmental parameters as well as deterioration processes in the cultural assets. The data was processed and analysed, generating risk maps made available at the STORM Collaborative Decision-Making Dashboard.

Each pilot site was analysed and matched with the most suitable technology according to local hazards and site characteristics. The outputs would serve to define appropriate risk treatment strategies (including risk mitigation, risk preparedness and recovery).

One of the pilot sites was the Mellor Heritage Project, in Manchester (UK). This complex includes three main sites with different micro-climatic conditions: a bronze-era burial site known as Shaw Cain located at the top of a hill and particularly exposed to extreme cold, precipitation and wind; Mellor Mill, a mill from an industrial period located by the river and particularly sensitive to humidity and freeze/thaw events; and the Old Vicarage Site, an iron-ditch sheltered by trees at one side of the hill. Sensors were placed in 30-40 locations throughout the complex, accompanied by weather stations. The data has proven to be effective in warning site managers and visiting archaeologists about weather events,as well asenabling monitoring of cracks, structural performance, electrical resistivity and sensitivity to freeze/thaw events.

Joseph Parry / British Library

For more information on Mellor Heritage Project, visit:
www.mellorheritage.org.uk

The Archaeological site Mellor, in Greater Manchester, was one of theproject's case studies. STORM proposes predictive models and improved methods of survey and diagnosis that will assess preventive actions and emergency responses in cultural heritage sites.

For more information on EU H2020 STORM, visit:
www.storm-project.eu/en/project

Other relevant sources:
Cultural heritage Resilience Against Climate Change and Natural Hazards [58]

3.2.2

Climate for culture's decision support tool

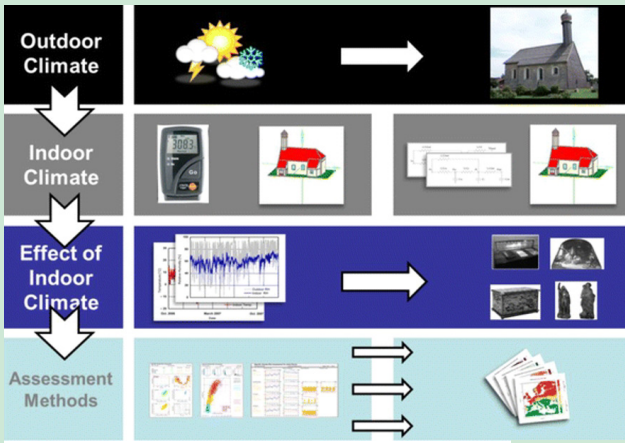
Type: Technological/technical – decision support tool
Main hazard(s): Extreme temperatures

Location: Europe and North Africa
Biogeographical region: Various
Lead: Fraunhofer (IBP, MOEZ and ISC)

Coordinated by Fraunhofer (IBP, MOEZ and ISC), and involving 27 partners, the CLIMATE FOR CULTURE project (2009-2014) estimates the impacts of changing climate conditions on historic buildings and their vast collections in Europe and the Mediterranean. By assessing the risk of damage to threatened cultural heritage sites, the project aimed to encourage the development of strategies to mitigate the effects of climate change, including through policy makers and the Intergovernmental Panel on Climate Change (IPCC) reports. Furthermore, the project provided insight into the possible socio-economic impacts of climate change, given the importance of cultural heritage to Europe's economy.

The project came up with a methodology for risk assessment based on a step-wise approach that includes the following consecutive steps: climate change simulations, building simulations, indoor climate monitoring, damage assessment from objects and prediction of future risks.

The project has produced a set of models and tools to identify the most urgent risks for specific regions, including a Decision-Making Support System „DMSS" and the software Digit Chart The DMSS is a synthesis of the results of several work packages, consisting of a software module for constant evaluation of climate data using existing damage data, and allows the prediction of indoor climate change based on the simulation of outdoor climate change. The software Digit Chart allows the transformation of analogue maps into digital format, to facilitate its reading and analysis.



Retrieved from: Leissner, J., Kilian, R., Kotova, L. et al. Climate for Culture: assessing the impact of climate change on the future indoor climate in historic buildings using simulations. Herit Sci 3, 38 (2015). https://doi.org/10.1186/s40494-015-0067-9

For more information on Mellor Heritage Project, visit: **www.climateforculture.eu**

Other relevant sources:
https://cordis.europa.eu/docs/results/226/226973/final1-publishable-summary-climate-for-culture.pdf

https://heritagesciencejournal.springeropen.com/articles/10.1186/s40494-015-0067-9

3.2.3

Guidance on risk management for collections

Type: Managerial– Guidance document
Main hazard(s): Extreme temperatures
Stressor: lack of awareness

Location: The Netherlands
Biogeographical region: Atlantic
Lead: Cultural Heritage Agency, Dutch Ministry of Education, Culture and Science

This guidance document, published in 2017 by the Cultural Heritage Agency of the Netherlands within the Shared Cultural Heritage Programme, aims to support collection managers, curators and conservators by offering methods, knowledge and tools to make suitable choices, set priorities and implement the appropriate measures to reduce loss of value of moveable heritage.

It offers detailed information on the main risks affecting museum collections, such as water, pests and plants, thieves and vandals, fire, light, contaminants and extreme temperature. It provides suggestions for management measures following the risk management process.

The publication can be accessed and downloaded here:
www.academia.edu/35377331/Risk_management_for_collections

Learn more on the Cultural Heritage Agency of the Netherlands here:
https://english.cultureelerfgoed.nl

3.2.4

PRESIOUS: Simulating the effects of erosion on cultural heritage objects

Type: Technological/technical – Model and simulation
Main hazard(s): Extreme temperatures, pollution

Location: Trondheim, Norway
Biogeographical region: Alpine/Atlantic
Lead: Norges Teknisk-Naturvitenskapelige Universitet Ntnu

The collaborative 3-year STREP project PRESIOUS (Predictive digitization, restoration and degradation assessment of cultural heritage objects, funded under the 7th Framework Programme of the European Commission 2013-2016) aimed at estimating and predicting monument degradation as well as producing visualisation tools to facilitate the reconstruction of damaged items. The innovative ICT tools and solutions produced would enable: 1) on-the-fly auto-completion for 3d digitalisation – enabling the visual reconstruction of a damaged object/monument' shape, 2) estimation and prediction of monument degradation based on measurement of a series of parameters (e.g. present surface shape, environmental factors, material behaviour) and 3) 3D fractured object restoration and completion.

The tools for estimation and prediction of monument degradation were tested on monuments at two significant heritage sites: the Nidaros Cathedral in Trondheim (Norway) and the Demeter Sanctuary in Elefsis (Greece)

For the Trondheim case study, erosion data was obtained from erosion chambers (which simulate atmospheric pollutants, the effect of saline intrusion and the freeze-thaw effect in a controlled environment). The study utilised a prototype software application that simulates surface mesh alterations of heritage objects and allowed to imitate processes of stone degradation phenomena like surface recession and crust formation after 3D scanning of the monuments.


Pixabay / Michelle Maria

For more information on the PRESIOUS project, visit:
www.presious.eu

The tools and software produced within PRESIOUS can be accessed here:
www.presious.eu/resources/software

Other relevant sources:
Simulating Erosion on Cultural Heritage Monuments [59]

PRESIOUS Final Evaluation Report:
http://presious.eu/file_downloads/PRESIOUS-D5.8-FinalEvaluationReport.pdf

3.2.5 CASE STUDY 1:

City of Regensburg Integrated heritage management planning

Type: Managerial – Management plan
Main hazard(s): Extreme temperatures, floods **Stressor**: lack of awareness

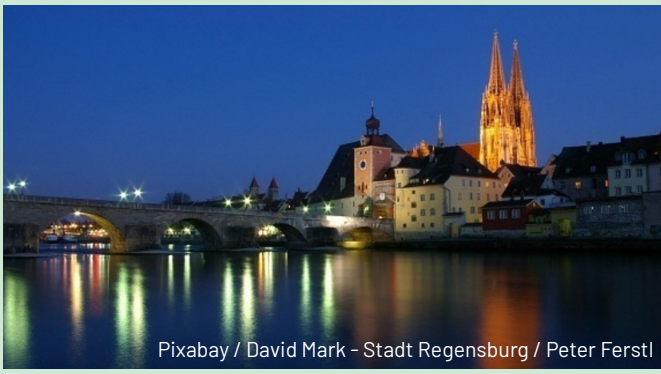
Location: Regensburg, Germany
Biogeographical region: Continental
Lead: The City of Regensburg

Background:

The City of Regensburg was inscribed on the UNESCO World Heritage List in 2006. The city administration has consciously used urban heritage to stimulate development in the sense of the improvement of quality of life for the inhabitants, with the support of an integrated heritage management plan, developed using a methodology from the project URBACT II Project HerO (Heritage as opportunity).This integrated approach has been adopted by many European projects, most recently to COMUS (Community led urban development) together with the Council of Europe. The approach fosters a holistic understanding of the historic urban fabric and the development of joint objectives and actions. With the integration of regional and national levels, funding for many proposed projects was secured. Challenges for Regensburg's urban heritage, like climate change or potential economic crisis were integrated in the concept. Today, heritage is part of the community's perception of Regensburg's identity and is diligently coordinated and communicated through an integrated governance system.

Case description:

To develop the World Heritage Management Plan for the Old Town of Regensburg, the City of Regensburg (specifically the departments on heritage and environment) started continuous cooperation with cultural operators, artists and local residents in a process to shape the future cultural landscape and lay down the conditions under which art and culture can unfold in the coming years. The resulting document is known as the Cultural Development Plan "Agenda 2020".The plan represents the action-guiding framework of cultural policy for the next few years. The cultural policy „Agenda 2020" is to be understood as part of the general urban policy. With this plan, the City of Regensburg honours its past and its cultural history and at the same time accepts current challenges. For assuring continuity and tradition on the one hand and the further development of a lively urban space on the other hand, the future role of a World Heritage title and its impact on civic life, and as part of this cultural life, had to be taken into account in the development.



Pixabay / David Mark - Stadt Regensburg / Peter Ferstl

For more information, visit:
www.regensburg.de

Contact info:
Sandra Schneider
Schneider.Sandra@regensburg.de

Matthias Ripp
Ripp.Matthias@regensburg.de

Relevant sources:
www.regensburg.de/welterbe/en/projects/completed-projects/management-plan

http://obs.agenda21culture.net/en/good-practices/integrated-world-heritage-management-plan-regensburg

Interview with Mathias Ripp, Senior Expert for Heritage and Urban Development

The local authorities of the city prepared Regensburg's management plan together with a strong community involvement (open access public participation) to identify several priority areas, concrete principles making use of the Historic Urban Landscape approach, objectives and key measures for each field of action needed for the city. In 2012, the World Heritage Management Plan was completed and made available online. The vivid public interest and engagement during the process shows the importance of civic participation especially in the field of heritage management and World Heritage. This collaboration brought a working group and a steady communication between stakeholders, where the public stays informed about the implementation of the management plan and takes part in its revision.

The World Heritage Management Plan for Regensburg was prepared by the Management Plan Work Group and the participants in the World Heritage Dialogue in Regensburg. Diverse stakeholders were invited to participate and collaborate in the elaboration process, amongst them not only city administration departments of all kinds, but also non-governmental groups within the city. In addition, regional level stakeholders as well as the regional government were integrated into the process and are still ensuring a broad representation of different opinions and interest groups.

Main outcomes and highlights:

- The World Heritage Management Plan's fundamental aim is to develop a new approach to manage historic urban areas by matching the inherited historic urban landscape and structure as well as the identity of the place with the modern demands of its users. This can be made possible by turning the cultural heritage, both tangible and intangible, into a prime resource to fulfil these competing demands, without downgrading its intrinsic qualities. All local stakeholders are to be identified and integrated into the process permanently, and a monitoring system has to further guarantee the successful implementation of the plan.
- The objective of this form of governance model of the World Heritage Management Plan of Regensburg was to not only detect and analyse the city in the spirit of the historic urban landscape (HUL) but also to entitle and capitalize on a governance system in which as many elements of the system as possible were considered. Even though the document was published in early 2012, the implementation is updated on a regular basis until now (with two updates having taken place, the most recent in 2019).
- Concrete action points were included on a range of themes including: tangible cultural heritage, culture and tourism, economic development, housing, mobility, urban planning and development, environment and leisure, awareness raising and research. With the participatory elaboration of an integrated heritage management plan, the direction for the upcoming years was recently set. Sustainability, resilience and the response to challenges and crises have been addressed following the six steps of the Historic Urban Landscape approach.

Factors of success

- The plan has put a strong emphasis on community engagement and the participation of interdisciplinary experts (participatory governance model).
- The process of developing the plan has placed cultural heritage as top political priority ensuring local and regional authorities value their heritage providing leadership to local stakeholders within their communities and helping secure the right environment to attract investment.
- The initiative has engaged politically and managerially with stakeholders and the local community to ensure public support for the cultural heritage strategy and management plan and thereby develop a coordinated and balanced approach that is sustainable over time.
- There has been a strong focus on action and project delivery ensuring consistent political and managerial support and commitment.

Lessons learned

- Effective governance of UNESCO World Heritage Sites demands a reframing of the role of management plans as a tool to significantly improve community engagement at local level and to be aware of their limitations.
- Cultural heritage may sometimes be perceived as a constraint to urban regeneration; a limiting or burdensome preoccupation with the past that stifles innovation and progress; there is a need to re-frame its importance and role for resilient development.
- Heritage needs to be seen as a strategic opportunity; locally, nationally and at the European level. This requires a new integrated approach to the sustainable management of historic towns - one that is policy-led with a clear focus on access to resources and effective project delivery.

3.2.6 CASE STUDY 2:

Patios de la Axerquía: Regenerating historical courtyards through social innovation

Type: Managerial –Governance model
Main hazard(s): Extreme temperatures, drought, desertification

Location: Cordoba, Spain
Biogeographical region: Mediterranean
Lead: PAX- Patios de la Axerquía

Background:

With a growing tourism industry and very little industrial activity, Cordoba (a city of some ca. 300,000 inhabitants) is now transforming itself and gradually becoming gentrified. The city is rich in architectural and intangible cultural heritage, and agriculture is very relevant for the economy. The unemployment rate in Cordoba is amongst the highest in Spain (at 28.5%).

Case description:

The historic district of Cordoba is suffering de-population as long-term residents abandon their courtyard houses seeking a more comfortable life away from mass tourism. In April 2018, PAX (Patios de la Axerquía) Association was established by local groups to regenerate the historic centre by restoring the abandoned courtyard houses (casa-patio) of the Axerquía (neighbourhood) together with resident groups constituted in housing cooperatives. An innovative operation of governance has been applied by the group fostering a change to the conventional urban development model based on speculation to one of rehabilitation of neglected areas, avoiding tourist-focused gentrification and allowing the people of Cordoba to reclaim their city's historic environment and its intangible heritage. PAX is a local experiment that is expected in the near future to evolve into a larger scale 'start-up' of urban governance facing gentrification processes.

PAX provides a new style of governance in relation to urban regeneration, incorporating social innovation in a heritage city by acquiring vacant houses and cooperatively using them; implementing multi-level co-management between the city administration and the local residents, and among the residents themselves. The project is pursuing urban regeneration of a specific vulnerable area by greening the city, recovering the architectural and intangible heritage value of the courtyard houses and forming a social and solidarity-based economy; therefore, the model bridges multiple concepts.


Pixabay / Frank Nürnberger

For more information on PAX, visit:
http://patiosaxerquia.org

Contact info:
Gaia Redaelli
gaia@patiosaxerquia.eu

Relevant sources:
www.built-heritage.net/gaia-redaelli-issue9

Courtyard Housed of Axerquia

El País article on Pax in the Mediterranean frame

Interview with Gaia Redaelli, co-founder and president of PAX

Main outcomes and highlights:

- A good preservation and development of heritage communities helps to protect and enhance collective historical memory; this may happen by moving from speculation to a rehabilitation culture, while introducing a layer of resident empowerment.
- The initiative helped to repopulate and regenerate the city's historical centre; it also helped to revitalise the neighbourhoods and created a sense of built environment and public spaces that work as a 'collective courtyard': by promoting energy efficiency in the housing stock and supporting the sustainable urban rehabilitation of public buildings as well as degraded parts of the city (e.g. industrial areas that are in disuse).
- The project has so far reinforced heritage-related micro-employment, and supported the flourishing of collective projects that include refugees and migrants.
- The Courtyard Houses of Axerquía have been included on the 2020 World Monuments Watch list to place a spotlight on local efforts to repopulate the historic district and encourage further stakeholder and government engagement.
- Recognised as part of the Faro Convention Network by the Council of Europe in 2018 for applying social heritage values in an urban context, PAX was invited to the 15th International Architecture Exhibition La Biennale in Venice in 2016 and has been declared a 'best practice' project by the Madrid City Council for improving the social economy in a neighbourhood (2018).

Factors of success

- The potential to re-use the existing city through revitalising abandoned patio-houses in a central neighbourhood that is earmarked for future gentrification, has provided the impetus to generate a bottom-up strategy in terms of housing policy, heritage, urban regeneration, and social cohesion by updating the use of the courtyards through a cooperative and inclusive process.
- The unique feature of PAX compared with other housing cooperatives that have been established as an alternative to property ownership and rental agreements is that it operates in a high-value heritage environment, reinforcing the coexistence that has traditionally characterised the Mediterranean city.
- Energy monitoring has been possible using a passive air circulation system that was made possible due to the design and treatment of the vegetation of the patios.
- This innovative urban project is transferable to other Mediterranean cities (Marseille, Sicily).

Lessons learned

- The applied process requires many efforts to achieve synergies between the interests of public authorities and those of the local dwellers based on the social value of cultural heritage.
- The acknowledgement of local stakeholders and development of the social stakeholder mapping in a co-creational, cooperative form have been demanding and time consuming processes.
- A significant implementation obstacle is the time needed to change to a culture of rehabilitation at the local level scale, as the global market and speculation are operating at a much higher speed.
- The COVID-19 virus outbreak in early 2020 is bringing uncertainty to the renovations (many of which are put currently in idle mode), while social distancing and remote working put additional stress on developing and maintaining effective working and social relationships.

Pixabay / David Sánchez

3.2.7

Flood protection measures for the historic centres of Cesky Krumlov and Prague

Type: Technological/technical– structural measure(s)
Main hazard(s): Extreme precipitation, pluvial and fluvial flooding

Location: Prague and Cesky Krumlov, Czech Republic
Biogeographical region: Continental
Lead: Czech Ministry of Agriculture, The Czech Ministry of Environment and Prague City Hall

A flood control system based on a combination of green-blue and grey infrastructure was implemented in the historic centres of Prague and Cesky Krumlov, following up what was recognised as the most expensive weather-related disaster in the history of the area: the 2002 flooding.

Before this event, none of the municipalities had adaptation measures in place, being climate change a fringe topic in local political agendas. Measures implemented consisted mostly on grey infrastructure such as fixed and mobile barriers and safety valves in the canalisation network along the Vltava River. Such measures were combined with green infrastructure interventions as support to coping with flash-flooding. The implemented measures were assessed using a cost benefit analysis which showed that the benefits would be greater than the costs even if only one event with a return period of 50 years is considered. Measures were effectively tested in the following 2013 flood.


Pixabay / Peter Tóth

This initiative is one of the case studies featured in the EU FP-7 project BASE – Bottom-Up Climate Adaptation Strategies towards a Sustainable Europe.

For more information on the project BASE, visit:
https://base-adaptation.eu

Other relevant sources:
https://climate-adapt.eea.europa.eu/metadata/case-studies/realisation-of-flood-protection-measures-for-the-city-of-prague

https://base-adaptation.eu/sites/default/files/case_studies/14_Prague_CSLD.pdf

3.2.8

Refurbishment of the International Maritime Museum in Hamburg

Type: Technological/technical -Structural measure (s)
Main hazard(s): Extreme precipitation, flooding, extreme temperatures (cold)

Location: Hamburg, Germany
Biogeographical region: Atlantic
Lead: International Maritime Museum in Hamburg (IMMH)

The aim of the initiative was to transform in 2006 a 10-storey historic brick warehouse into the International Maritime Museum of Hamburg (IMMH), ensuring that the requirements needed to hold its exhibits were met. The refurbishment included the integration of a new heating system and a domestic engineering system to create an appropriate climate in the building based on a low-energy consumption. Both the engineering system and an engine for an elevator were installed in the basement.

The basement had been flooded on different occasions prior to the refurbishment, so measures were implemented to make it waterproof. A new layer of concrete was installed in the inner side of the original brick wall of the basement and the ceiling. Additional concrete was also added to prevent the uplifting of the structure. The historic window frames were kept, and slit deliberately to ensure the warming of the cold air from the outside when flowing indoors. In combination with this last measure, a floor-heating system was integrated in the new ground floor to provide an adequate temperature for the collections.

Fred Romero / CC BY

For more information on the museum, visit:
www.imm-hamburg.de

This initiative is featured in the Co2olBricks Project (2010-2013), focusing on how to reduce the energy consumption of historical buildings without destroying their cultural value and identity.

For more information on the Co2olBricks, visit:
www.co2olbricks.eu

Other relevant sources:
www.hamburg.de/hamburg-nord/planen-bauen-wohnen/4496960/co2ol-bricks

3.2.9

Pro Monumenta: preventive maintenance of immovable cultural monuments in Slovakia

Type: Managerial – Maintenance and monitoring framework
Main hazard(s): Extremeprecipitation, extreme temperatures

Location: Slovakia (Nation-wide)
Biogeographical region: Pannonian
Lead: Monuments Board of the Slovak Republic

Pro Monumenta (2014- 2016) was a project focusing on the preventative maintenance of immovable cultural monuments and looking into aspects such as the technical diagnostics of the state of the buildings in cooperation with their owners. Specific actions included on-site monument monitoring, the elaboration of monitoring reports, drafting of recommendations and small defect repairs. Free-of-charge inspections were carried out on state monuments, involving the use of drones.

The project was supported by the EEA Financial Mechanism, partnering with the Norwegian Monuments Board - „Riksantikvaren." The basic project aim was to build up the system of preventative monitoring of immovable cultural monuments filed in the Central List of monuments as per the section 22 of the Act No. 49/2001 Coll. Additionally, guides and manuals were produced for the owners of national monuments on how to protect the assets from various hazards. Expert training centres were provided within the administration of Monuments Board of the Slovak Republic.

Pixabay / Jandzur

For more information on Pro Monumenta, visit:
www.promonumenta.sk

The funding of the project was supported by the EEA Financial Mechanism, which funds projects of different topics, including a big share of initiatives involving cultural heritage protection.

More information on the initiative and the funded projects can be found here:
https://eeagrants.org/search?key=cultural+heritage

Other relevant sources:
www.coe.int/en/web/culture-and-heritage/-/pro-monumenta

3.2.10

Monitoring deterioration processes in the Palace of Knossos

Type: Technological/technical – Sensing and monitoring tools and methods
Main hazard(s): Wind, extreme precipitation, air pollution, biological action

Location: Heraklion, Greece
Biogeographical region: Mediterranean
Lead: Consiglio Nazionale DelleRiserche

Description: the Minnean Palace of Knossos (built in 1700 BC and covering an area of 22,000 sqm) was built on the top and the slopes of the low hill of Kefala. The complete excavation of the monumental complex was achieved in 1902 by Arthur Evans (Curator of the Ashmolean Museum in Oxford). The fragile building materials proved extremely sensitive to weathering. After 1925, Evans attempted the full reconstruction of the palace including a large-scale use of reinforced concrete, the reconstruction of the upper stories and main architectural elements, the revamping of timber frames and wooden Minoan columns and the restoration of the frescoes at different spots of the site.

The palace has suffered since them extensive damage mainly due to the combined action of the climatic conditions, biological agents, air pollution and human's interventions. During the 1990s, the Ministry of Culture took measures for its preservation and restoration. Under the authority of the Ephorate of Antiquities a great part of the concrete slabs of Evans' restoration of the Palace was conserved, and paths for the visitors were developed, which reduced the wear of the monument and gave the visitors a more complete view of it.

Main weathering agents are regularly monitored through the HERACLES Project using technologies such as a Spaceborne radar COSMO-SkyMed, UAV-Drone geometrical survey and Terrestrial Laser Scanner. A weather station was installed to measure climatic parameters.


Pixabay / Jandzur

The Minnean Palace of Knossos is one of the four testing sites of H2020 European Project HERACLES, which aims to design, validate and promote responsive systems/solutions for effective resilience of cultural heritage against climate change effects.

More information on the Project can be found here:
www.heracles-project.eu

Other relevant sources:
www.heracles-project.eu/project-test-beds/test-bed-1-palace-knossos-heraklion-el

https://meetingorganizer.copernicus.org/EGU2020/EGU2020-7010.html

3.2.11 CASE STUDY 3:

Local heritage plans strengthening local competence and capacity through planning

Type: Managerial – Management Plans
Main hazard(s): Extreme precipitation, flooding

Location: Norway
Biogeographical region: Alpine/Atlantic
Lead: The Norwegian Directorate for Cultural Heritage

Background:

Norway protects national cultural heritage mostly through the Cultural Heritage Act (1979) and the Planning and Building Act (2008). The latter Act defines a crucial role for Norwegian municipalities in safeguarding and managing cultural heritage assets, including to mobilise and engage local stakeholders and secure the necessary resources, tools and instruments. However, they face challenges mostly related to a lack of political buy-in on the importance of cultural heritage (which results in inefficient planning and management procedures), scarce knowledge on cultural heritage assets' status and locations, high dependency on external stakeholders (such as museums, NGOs and civil groups) for cultural heritage management and insufficient coordination of local competence to ensure proper protection.

Case description:

The Norwegian Directorate for Cultural Heritage has developed a series of initiatives to address the aforementioned challenges in municipalities. In 2011, it launched a programme to support municipalities in strengthening local competence and capacity through the production of local heritage plans. Such plans do not have to adopt a mandatory structure, but need to include the following elements: introduction, goals and targets, background information, legal and economic incentives used, historic overview, inventory of cultural assets and implementation plan. The programme was based on economic incentives (up to €10,000/municipality) granted to those municipalities holding the political authority to develop these plans and interested in establishing cooperation models with external institutions and organisations (such as museums or NGOs). Additionally, the programme would seek the establishment of local networks and arenas for knowledge exchange and promote capacity building and training through associations, web-pages, and social media and guidance

Unsplash / Oliver Cole

The Directorate for Cultural Heritage

The Directorate is the Ministry of the Environment's advisory and executive body for the management of architectural and archaeological monuments, sites and cultural environments. It is responsible for the implementation of national cultural heritage policy.

For more information on the Directorate for Cultural Heritage, visit:

www.regjeringen.no/en/dep/kld/organisation/Subordinate-agencies/the-directorate-for-cultural-heritage/id85702

Relevant sources:

www.coe.int/en/web/culture-and-heritage/-/local-heritage-plans-strengthening-local-competence-and-capacity-through-planning

Heritage and Sustainable Urban Transformations [61]

Interview with Kari Larsen, Directorate for Cultural Heritage, Norway

documents. In 2014, the Directorate launched a campaign for more towns and cities to establish their own antiquarians and assisted with the creation of 11 new positions in a trial scheme between 2014-2016, strengthening in this way the local knowledge in relation with cultural assets [60].

Main outcomes and highlights:

- By 2019, 90 % out of the 422 Norwegian municipalities were working or had already adopted a local heritage plan.
- Dueto the Directorate's initiatives, there has been a notable rise insocial and political awareness, participation and involvement regarding cultural heritage aspects, leading to a feeling of "social pride" for local history and cultural sites.
- The work of the municipalities and the identification and designation of new cultural sites through the development phase of their local heritage plans has created a broader and more diverse historic and cultural repertoire.
- Some urban social benefits such as, education, recreational/ out-door activities, well-being and public health have been enhanced with the improvement of the local cultural heritage status.
- The Directorate's activities –with emphasis on the strengthening of local heritage plans – have been included in the European Heritage Strategy for the 21st century Golden Collection of Good Practices.

Factors of success

- Economic incentives are important to motivate municipalities in taking action.
- Taking into consideration how and when to involve the different agents (NGOs, citizens etc.) during the planning process to have a successful local participation process has been fundamental.
- The creation of a "trust atmosphere" is another factor that has helped in the success of the initiative, by leaving the decisions to the locals and only 'nudging' from the state level.

Lessons learned

- The preparation of the plans is time consuming, ca. 2-4 years should be expected for each.
- The cooperation models arealso resource-intensive, requiring municipalities to coordinate dialogues across different stakeholders, arrange meetings, meet all partners, etc. It is important to consider the lack of capacity of small municipalities (e.g. where there might be just one person allocated to cultural heritage).
- At first, it is recommended not to be too ambitious in the preparation of the heritage plan, and it is encouraged to compile and summarise existing knowledge before supplementing the plan with new documentation.

3.2.12 CASE STUDY 4:

Local historical knowledge to inform climate stress tests in the Netherlands

Type: Technological/technical– Models and simulations
Main hazard(s): Extreme precipitation, flooding

Location: The Netherlands
Biogeographical region: Atlantic
Lead: The Cultural Heritage Agency of the Netherlands

Background:

Located in the North-West of Europe, the Netherlands form part of the European River Delta, linked to major European rivers (e.g. the Rhine, Meuse and Scheldt). Flanked by the Northern Sea, the country has 1,275 km of coastline [62] with 26% of the national territory lying below sea level. All these geographical and climatic features, along with high levels of urban density and climate change, make the Netherlands especially vulnerable to flooding [63].

Dutch cities have been repeatedly exposed to flooding events over history, having to learn to adapt. Recent research [64] indicates that some of these cities have had in place for some time an integrated policy connecting urban water, a water board administration and even engineering projects that enabled safe living conditions. The current case study explores how Dutch cities are integrating historical knowledge to advance adaptation efforts in the face of current and future climate-related hazards.

Case description:

In 2018, the National Government launched the Delta Plan on Spatial Adaptation (Deltaplan Ruimtelijkeadaptatie) in order to render the Netherlands climate proof and water-resilient. The policy calls for cities to perform climate stress tests, which are based on GIS models to assess which areas and assets in a city have higher risks of flooding or heat stress, based on hydrological, geological and geophysical variables. Following these models, the local authorities can address the risks with specific adaptation policies. However, they only take into account present-day surface aspects, neglecting historical information.

The Cultural Heritage Agency of the Netherlands (RCE) aims to help municipal departments integrate traditional knowledge(e.g. construction techniques and historical reasons for certain construction choices) into their stress tests by looking at aspects such as historical water systems, natural landscape dynamics, climate change, urban morphology and traditional measures and knowledge of flood protection. The evolution of such aspects can be extracted by analysing

The city of Deventer at the IJssel river by Jacob van Deventer mapped between 1557 and 1559. Source: Rutte, R. and B. Vannieuwenhuyze (2018). Stedenatlas Jacob van Deventer. (Bussum 2018).

The Cultural Heritage Agency

The Cultural Heritage Agency of the Netherlands is responsible for executing a part of the Dutch government's policy on shared heritage by means of its Shared Cultural Heritage Programme, and works on three main topical areas: Maritime Archaeology, Built Environment and Collections. It works together with ten partner countries.

To learn more about the Cultural Heritage Agency, visit:

https://english.cultureelerfgoed.nl

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Link to academia profile:
https://cultureelerfgoed.academia.edu/MenneKosian

historical maps such as the 'Waterstaatskaarten' (a series of 1:50,000 scale maps regularly updated from 1865 onwards providing a complete descriptive overview on polder levels, water management systems and hydrological engineering works), which are then digitalised and contrasted with the modern GIS models generated as part of the climate stress tests. The Agency offers support to municipalities by providing historical maps, generating new GIS data and advisingon how to perform comparative analysis to identify gaps and existing solutions. Capacity building and training (in the form of workshops, lectures and consultations) is also delivered by RCE's experts as per the municipalities' request, without additional costs.

Main outcomes and highlights:

- Cities such as Kampen and Dordrecht have so far successfully integrated historical knowledge into the climate stress tests.
- The initiative has contributed to reinforcing the cultural identity of the municipalities, resulting in adaptation policies that are tailored to their local conditions and existing heritage. Such respect for the local character has contributed to win residents' support.
- All the data generated is made free and accessible through the RCE's website.
- The initiative has contributed to establishing a more integrated approach towards adaptation, bringing together different departments that are generally not used to cooperate, such as the sewage, the archaeological departments and even the municipal police (e.g. in Dordrecht).

Factors of success

- The Netherlands has an extensive repository of historical maps (including city maps, paleo-geographical maps and engineering plans) conserved in the Water Boards, which are still operative and make the access of such documents easy.
- Municipalities have traditionally considered the protection of cultural heritage as an expensive luxury. With this initiative, cultural heritage is presented as a solution that can be integrated in other sectors and policies (for instance, adaptation and resilience), and therefore can be covered by a broader range of funding sources.

Lessons learned

- Before applying the step-by-step guidance, people working in cities need to be aware of the fact that they are already flood-adaptive and they have valid systems which have been systematically tested by history. This is important in terms of securing political and social buy-in early in the process.
- The approach towards adaptation varies enormously among different municipalities based on their specific characteristics and ways of operating. In some cases, different departments are already cooperating closely, in some others there are silos; in these last cases, broader efforts are needed in terms of bringing the different departments together.

Sources:

https://erfgoedenruimte.nl/sites/default/files/attachments/RCE_Stresstest_posterA1_594x841mm_V7_0.pdf

www.chnt.at/wp-content/uploads/eBook_CHNT23_Kosian.pdf

www.academia.edu/38645950/The_Importance_of_History_for_Modern_Climate_Adaptation_Strategies

Interview with Menne Kosian, Spatial Analysis Researcher at the Landscape Department at the Cultural Heritage Agency of the Netherlands

3.2.13

Flood protection in the Venetian lagoon: Modulo SperimentaleElettromeccanico (MOSE)

Type: Technological/technical– Structural measure(s)
Main hazard(s): Sea-level rise, coastal flooding, storm surges

Location: Venice, Italy
Biogeographical region: Continental
Lead: Venice Water Authority in partnership with Consorzio Venezia Nuova

During the last decades, the Venice lagoon has been subject of increasing natural and anthropogenic hazards and land use management has resulted in loss of 25cm of land level in the last 100 years. This, along with the prognostic of increasing temperatures due to climate change places Venice in a vulnerable spot.

The main intervention in Venice lagoon relates to the MOSE integrated system, consisting of a series of mobile gates located at the inlets of the lagoon. When floodgates are inactive, they are underwater and lie completely invisible in housings placed in the backdrop. In the event of a particularly high tide event which could cause flooding of the territory, compressed air is introduced into the sluices which empties it from the water. As the water exits the sluice gates, rotating around the axis of the hinges, they rise up to emerge and block the flow of the incoming tide in the lagoon.

MOSE is complemented with other measures designed to protect the Venice Lagoon area against flooding. Different measures include the reconstruction of the beaches along 63 km of coastline, the reinforcement of breakwaters, the local defence of urban centres (including raised pavements) and the securing of polluted sites through phyto-biopurification.

Magistrato alle Acque di Venezia / Consorzio Venezia Nuova / CC BY-SA

For more information on MOSE, visit: **www.mosevenezia.eu/lagoon**

Other relevant sources:
www.coastal-management.eu/measure/example-mose-system-mobile-flood-barriers-venice-it

3.2.14

IG-WRDRR: An International Group working on Wind-related Disaster Risk Reduction

Type: Institutional– Networking and capacity building (for institutions)
Main hazard(s): Severe Wind

Location: Geneva, Switzerland
Biogeographical region: Continental
Lead: IAWE, UNISDR Secretariat, UNU, TPU Global COE, ADRC, SEEDS

The International Group for Wind-Related Disaster Risk Reduction (IG-WRDRR) was launched in Geneva (Switzerland) in 2009 at the Global Platform for Disaster Risk Reduction organised by the UN and other NGOs. The initiative was conceived to establish linkages across policy-makers, researchers and agencies responsible for carrying out DRR and DRM at local community level, implementing the Hyogo Framework for Action in the area of wind mitigation.

It is comprised by eleven different organisations, including the International Association for Wind Engineering, (IAWE), the International Center for Water Hazard and Risk Management (ICHARM), the United Nations/International Strategy for Disaster Risk Reduction (UN/ISDR), the World Metereorological Organisation (WMO) and the International Federation of Red Cross and Red Crescent Societies (IFRC).

The initiative generated a series of events, such as the International Forum on Tornado Disaster Risk Reduction at Bangladesh (Dhaka, Bangladesh, 2009, 2013), the workshop on Wind-related Disaster Risk Reduction activities and the Interorganisational Collaborations and the pre-Conference Event on Climate Change and DRR strategies in Asia-Pacific Region (Incheon, Korea, 2010), the 5th International Disaster and Risk Conference (IDRC, Davos, Switzerland, 2014), the IAWE Public Forum at the 3rd World Conference on Disaster Risk Reduction (Sendai, Japan, 2015).

Unsplash / Francois Hoang

For information on the Working Group, visit:
www.iawe.org/WRDRR

Other relevant sources:
www.sciencedirect.com/science/article/pii/S0167610512000402

www.preventionweb.net/files/globalplatform/519f7c6e76cd2Shuyan_GP4_IG-WRDRR.pdf

3.3 Geological-related hazards

3.3.1

Assessing seismic risk in Pompeii

Type: Technological/technical– sensing and monitoring tools and methods
Main hazard(s): Earthquakes, mass movements

Location: Pompeii, Italy
Biogeographical region: Mediterranean
Lead: ISPRA, NERC, CUT, UNIMIB, IGME

PROTHEGO was conceived to monitor European monuments and sites inscribed on UNESCO World Heritage List at risk from geohazards, using sensed information (i.e. ground stability and motion), advanced modelling and field surveying. Information is mostly collected using space technology based on radar interferometry (InSar).

PROTHEGO intervention in Pompeii, jointly led by Italian Institute for Environmental Protection ISPRA together with the POMPEII Archaeological Park, aims at the analysis and interpretation of ground motion measures obtained by satellite InSAR data, and at the evaluation of the geomorphologic processes affecting unexcavated areas. A collection of data and images with information on recent instability processes of the Park was made. The purpose of this compilation was to produce a high-resolution morphological map which could categorize types and mechanisms of phenomena since year 2005. The results underlined the potential of the interferometry satellite technique for identifying pre-collapsing deformation trends for predictive purposes.

Pixabay / Duotone

Funded in the framework of the Joint Programming Initiative on Cultural Heritage and Global Change (JPICH) — HERITAGE PLUS, PROTHEGO aims to make an innovative contribution towards the analysis of geohazards in areas of cultural heritage in Europe.

For more information on PROTHEGO, visit:
www.prothego.eu

Other relevant sources:
www.prothego.eu/docs/posters/PROTHEGO_Pompei_poster.pdf

www.researchgate.net/publication/319178970_Satellite_monitoring_applied_to_natural_hazards_and_cultural_heritage_the_PROTHEGO_project

3.3.2

Building capacity to cope with earthquakes in Central Italy: CERHER

Type: Institutional– Networking and capacity building
Main hazard(s): Earthquakes

Location: Central Italy Macro Region (Umbria, Tuscany and Marche)
Biogeographical region: Mediterranean
Lead: UNISDR, ENEA, INGV, UNICAM, LINCEI, Firenze 206 Project Coordination Committee)

The CERHER - Center of Resilience on Heritage, established in 2017, is an integrated skillscentre operating in the macro-region of central Italy which aims to develop the resilience of art cities to natural disasters (and apply the Sendai Framework for Disaster Risk Reduction to cultural heritage assets).

CERHER'sprimary objective is to act in the context that surrounds cultural heritage, building a network of active protection and risk mitigation, capable of optimising the resilience of the art cities. The Centrepromotes and encourages initiatives such as the development of innovative technologies for diagnostic and structural monitoring of cultural heritage and assessment of risks and vulnerability of museum assets; creation of an open access documentation centre for the collection and analysis of scientific publications on resilience; establishment of a permanent forum for discussion on unresolved scientific and technical issues related to resilience of cultural heritage and the education and training activities for the public (including youth).


Pixabay / Valter Cirillo

For more information on CERHER, visit:
www.cerher.org

Other relevant sources:
www.undrr.org/news/italy-establishes-heritage-resilience-centre

3.3.3

Building resilience to cope with earthquakes: Istanbul Seismic Risk Mitigation and Emergency Preparedness Project

Type: Managerial – Management plan
Main hazard(s): Earthquakes

Location: Istanbul, Turkey
Biogeographical region: Mediterranean
Lead: Istanbul Project Coordination Unit (IPCU)

The objective of the Istanbul Seismic Risk Mitigation and Emergency Preparedness Project (2005-2018) was to transform Istanbul into a city resilient to a major earthquake.

The Project was based in four main components: enhancing emergency preparedness of public safety organisations to earthquakes both at provincial and municipal level, undertaking seismic risk mitigation for public facilities, ensuring their functionality through the emergency and post-disaster recovery phases (including retrofitting of hospitals, schools and other public facilities), enforcement of building codes and compliance with land use plans and provision of support to the Istanbul Provincial Administration to implement the project in an efficient and transparent manner as well as building the necessary capacity to do so.

The project managed to cover 176 cultural heritage buildings under the Directorate of Surveying and Monuments within the Ministry of Culture and Tourism, recording historical information about the assets.

Pixabay / Hilmi Ceper

The Project was financially supported by the World Bank. The World Bank Group has helped funding several projects in the theme of cultural heritage.

An overview can be found here:
https://projects.worldbank.org/en/projects-operations/projects-list?searchTerm=cultural%20heritage

Other relevant sources:
http://documents1.worldbank.org/curated/en/415551468121763183/pdf/32173.pdf

https://ieg.worldbankgroup.org/sites/default/files/Data/reports/ppar_turkeyseismic.pdf

3.3.4

Reconstruction of the Emilia-Romagna Region after major earthquakes

Type: Institutional– Networking and capacity building
Main hazard(s): Earthquakes

Location: Emilia Romagna Region, Italy
Biogeographical region: Continental
Lead: Regional and Local Governments of Emilia Romagna Region

On the 20th and the 29th of May 2012 two earthquakes of medium intensity (magnitude 5.9 and 5.8 on the Richter scale) affected the Province of Modena, Ferrara, Bologna, Reggio Emilia (Emilia Romagna Region) and Mantova (Lombardy Region), with 28 deaths, 300 injured, 45,000 homeless and dramatic impact on buildings, houses, schools and industrial plants (damage of €13.2 billion).

A committee for emergency governance was immediately created, consisting of local and regional government authorities. The commitee designed a plan for reconstruction with the local communities at its heart, identifying a set of priorities. The main one was community cohesion (schools, workplaces and homeless shelters were main targets for reconstruction, followed by a democrative and participative governance model during emergency and post-disaster recovery phases). The model was succesful and adopted by firms and other authorities around the world.

Pixabay / Valter Cirillo

This initiative, along with many others, is featured in the Interreg BhENEFIT project's inventory of good practices. You can access the booklet here: **www.central2020.eu/Content.Node/Bhenefit/BhENEFIT-D.T1.2.1-Best-Practice-Inventory.pdf**

BhENEFIT focused on improving the management of historic built areas, combining the dailymaintenance of historic heritage with itspreservationand valorisation in asustainable way.

For more information on BhENEFIT, visit:
www.interreg-central.eu/Content.Node/BhENEFIT.html

3.3.5 CASE STUDY 5:

Appignano del Tronto: How to react after a disaster

Type: Managerial – management plan
Main hazard(s): Earthquakes, mass movements

Location: Appignano del Tronto, Italy
Biogeographical region: Continental
Lead: Appignano del Tronto Municipality

Background:

The socio-economic context of the village of Appignano del Tronto presents three trends: a) a trend towards depopulation that has intensified due to earthquakes in 2016 and 2017; b) a trend towards deindustrialisation that has intensified due to the European economic crisis from 2008 to 2013; and c) an economic flourishing of small and medium enterprises (SMEs) and micro-companies (especially in the agricultural and farming sectors) which are mostly family businesses.

Case description:

This case encompasses both tangible and intangible elements of heritage combined with the high risk of earthquakes. Earthquakes have shaken the village between 2016 and 2017, leaving almost 50% of homes in its historic area destroyed. This situation had a huge impact on the preservation of public and private heritage as well as leading to a significant psychological destabilisation of the residents. The Appignano del Tronto Municipality has taken a resilient and holistic approach since then, which led to a number of interventions aiming to create a new model of development through the effective and adaptive use of Cultural and Natural Heritage (CNH).

Many local stakeholders have been involved in this process (ca.40 local stakeholders); among them: local communities, farmers, local companies, residents, local authorities, policy-makers, cultural associations, non-profit associations, universities/academia, the Italian National Institute of Geophysics and Volcanology (INGV), UNESCO and many more.

These stakeholders have been working on several action plans focusing on CNH, including co-learning to build earthquake-proof buildings and choosing suitable safe areas; using seismic micro-zoning and emergency planning to safeguard the village against disasters; providing crowdfunding tools/ funding together with residents; endorsing good farming practices that help to reduce geological risks; implementing a local land maintenance plan to manage physiological impacts, enhancing capacity building & training activities for community resilience and providing technological

Appignano del Tronto Municipality

Appignano del Tronto Municipality is one of the 38 partners of **RURITAGE**, a project funded by EU Horizon2020 programme. This project turns rural areas into laboratories to demonstrate Cultural and Natural Heritage as an engine of regeneration.

In addition, Appignano del Tronto is involved in many projects funded by **Local Action Group GAL Piceno** and by Marche Region (i.e. agro-environmental agreement about climate change adaptation and mitigation in agriculture).

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Comune di Appignano del Tronto

Ruritage.eu: Appignano del Tronto

Interview with Sara Moreschini, Mayor of Appignano del Tronto


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infrastructures, amongst others. The cost of the interventions has so far amounted to €5-6million.

Main outcomes and highlights:

- The most tangible resultat the time of writingis the Rural Heritage Hub: a community of local stakeholders as well as a physical meeting place where co-creation activities take place;
- A number of open spaces for gatherings like social and community events that involve public and community participation for local engagement have been developed and maintained;
- Local action plans and groups have emerged; this in addition involves a strong representation of women the decision-making processes.

Factors of success

- The time spent with local stakeholders during one-to-one meetings has been essential especially during the first months; a key factor to guarantee the long-term impact and sustainability of the project.
- So-called "RURITAGE Stories" (named after the supporting European Commission-funded project)have enabled preservation of stories based on oral traditions that have been known or shared in the past.
- Public consultation took place through surveys, gatherings, social and community events with educational purposes (e.g. trainings involving games), but also making use of a crowdfunding tool.
- The Rural Heritage Hub of Appignano del Tronto was created and promoted; an open space to practice innovation and organise community events in the project has been promoted among other European projects/networks.
- The adopted bottom-up approach has been fundamental to design tailored solutions for local challenges on CNH.
- International networking is very helpful to learn and adapt other successful experiences in your own context.

Lessons learned

- *Spatial*: a small village like Appignano Del Tronto has not the "critical mass" to exponentially multiply the positive effects that a co-design process can usually generate in an urban context.Socio-cultural: the local stakeholders' attitude towards EU funds is, mostly, not to use them as an opportunity for improving innovation, internationalisation and strategic development for their business, but it's rather an extra fund for their ordinary activity; something that is of course to be expected and valued in such contexts.
- Stakeholder involvement and community resilience can generate local awareness, a change of mind-set and social acceptance for Cultural and Natural Heritage.
- *Financial*: due to the characteristic of local socio-economic context (mostly micro companies and family business), the financial capacity to invest generating additional (private) funds is not available; to tackle this situation, the local administration has put together a plan to introduce tax incentives to incentive private investments, for example through the Impact Finance mechanism.
- Cultural events have become important to keep the local dwellers from moving out of the village.
- *Regulatory*: there have been many regulation attempts to tackle the seismic risks in the area. However, this has been delayed due to the bureaucratic procedures.
- *Transferability*: the measures and initiatives taken thus far might not be applicable in big cities, but rather in rural areas and small cities (e.g. Crete, Greece).
- This is a small community that learnt to together to achieve the same goal of making the historic area more resilient for and with its dwellers.

3.3.6 CASE STUDY 6:

Mikulov Urban Conservation Area

Type: Managerial -management plan
Main hazard(s): Earthquakes, floods and fires

Location: Mikulov, Czech Republic
Biogeographical region: Continental
Lead: The Mikulov municipality

Background:

Within this project, the Mikulov municipality developed an integrated management plan, in addition to an international database (through funding from Interreg and specifically the BhENEFIT project)), based on the INSPIRE directive, designed to support European strategies for cities and communities in the Danube Region (also known as the Danube Strategy). In particular, the MPR Mikulov project pursues the protection and the security of cultural heritage of the area around the Mikulov Municipality. The project allowed the drafting of statistics about the area's risk exposure, in particular to earthquakes, floods and fires.

The City of Mikulov has been the principal managing institution and has established effective cooperation with other actors including the private sector. Besides the building owners, the municipality also cooperated with cultural and tourism service providers, and academics (e.g. the MENDELU Faculty of Horticulture).

Within the BhENEFIT project, new approaches to sustainability as part of the program (environmental, economic and social issues) were proposed, which have met with a high level of social acceptance.

Case description:

For the implementation, Mikulov followed the 'BhENEFIT methodology', which was validated by 12 partners, including cities, regions, researchers and SMEs in 7 different areas, and applied to specific issues (earthquake, pollution, touristic flows, energy efficiency etc.). New tools, like action plans and ICT tools, were developed to increase the cooperation among stakeholders involved in sustainable management of Historic Built Areas (HBA), enhance their awareness and skills, increase availability of data and information, and to monitor and plan more effectively. The following areas of action were implemented:

- Restoration and maintenance of technical infrastructure; urban and architectural care, particularly in compliance with approved regulations of spatial planning;


Pixabay / Lubos Houska

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Sofia Salardi
sofia.salardi@comune.mantova.gov.it

Relevant sources:
www.interreg-central.eu/Content.Node/Bhenefit/Urban-walk-in-Mikulov.html

Interview with Karel Barinka, Project Manager for Interreg at Mikulov Municipality

- Completion of the public areas with small architectural structures and greenery, establishment of traffic-restricted and pedestrian zones;
- Care for and restoration of existing and defunct historical greenery, and sensible establishment of new public green;
- MPR recovery, especially the Square, as a historical public centre of the city with appropriate business and public activities and operations focusing on the long-term concept and goals of the city; restoration and care of the quality of natural components of the environment and its ecological stability;
- Encouraging the city's inhabitants to participate in regeneration - to instigate and support cultural and educational activities.

Main outcomes and highlights:

- Public participation was increasing during the development of the new strategic documents. A contemporary and pro-active approach to the rehabilitation process for many historic buildings was adopted, while project management was conducted in a multi-sectoral and participative way (following also the updated urban regeneration strategy of 09/2017).
- Financing establishment of a register of costs for the re-construction of the housing stock in buildings within the MPR area was not unlimited, and as a result, the city had to struggle to find and allocate other financial sources (private investment) beyond the frame of state and municipal subsidies. The project team followed existing legislation and organisation to negotiate and approve the new local plan, which ended up in the review of the MPR Regulation Plan (assignment was discussed and approved by the Mikulov city council, 02/2017).
- The municipality's approach under the program was highlighted as a good practice for the BhENEFIT project.

Lessons learned

- Capacity, technical support and finance is never enough; constant monitoring and re-thinking of the activities was needed throughout the project design and implementation
- Processes in HBA are always more demanding, organisationally and especially financially.
- In general, the issue of sustainability and climate change is problematic in the context of HBA. This is also due to the conservative NPU (National heritage authority) approach.
- Long-term conceptual measures that exist, there are good results (especially in last 15-20 years), responses to the city's and inhabitants needs.
- Lack of (partially) population interest, cumbersome legislation in CR (very long-term approval processes, building permits, etc.), some NPU procedures, and HBA financial requirements.

Factors of success

- Funding from multiple sources (national, regional, EU, etc.), has been organisationally demanding and challenging. Projects are focused on restoration and reconstruction of monuments and public spaces; sustainability and climate change are still taken indirectly. This is actually changing, the importance of measures (sustainability, climate change, etc.) rises.
- For example, a financial instrument for projects to reduce the energy performance of buildings. So far, it is a state of intent. An obstacle is the conservative approach of the monument protection authority.
- Public funding instruments for example from the Environment Ministry, partially also Ministry of Regional Development, and Ministry of Culture were employed to combine funding streams.

3.3.7

Preventing landslides in the Umbria Region

Type: Technological/technical - Models and simulations
Main hazard(s): Mass movement

Location: Region of Umbria, Italy
Biogeographical region: Mediterranean
Lead: Regional and National Governments of the Umbria Region

The region of Umbria is especially vulnerable to landslides due to the historic development of the towns around towers, castles and medieval villages located at the top of the hills. Increased urbanisation has also brought erosion of the hill slopes.

For this critical situation, the Regional and National Governments developed the Hydrological-geological assessment Plan of the Tevere river basin, where 174 risk areas where identified (some of which correspond to historic settlements such as Orvieto, S.Eutizio or the Spoleto town) using information extracted from the analysis of a multitemporal landslide inventory map. Such map is obtained by merging landslide inventory maps prepared through the analysis of stereoscopic aerial photographs of different ages.

Flickr / Brett L

The plan can be consulted here (in Italian):
www.regione.umbria.it/documents/18/473522/Testo+Tevere/93cd786e-040d-46b0-8c0a-22ec6328682e

3.3.8

Structural measures to prevent rockfalls in Delphi

Type: Technological/technical – Structural measures
Main hazard(s): Mass movements, earthquakes

Location: Prefecture of Phokis, Greece
Biogeographical region: Mediterranean
Lead: Ministry of Culture, Education and Religious Affairs, through the Ephorate of Antiquities of Phocis

This monumental complex, designated a 'success story' by UNESCO, stands out for its integrity (it has remained practically unaltered through the centuries) and its authenticity (it coexists in harmony with its natural environment, being subject to only very minor interventions over time).

Some of the latest interventions include a fire protection system operative 24 hours per day and temporary metal fences against falling rocks. The Central Archaeological Council has approved a study for the fastening of the rock slopes in order to provide a permanent solution to this last issue. The site contains an Archaeological Museum to protect moveable heritage associated to the site. Improvements on the visitor's facilities have been carried out to enable access to visitors with disabilities. Different educational measures such as information signs have been put in practice. The restoration of the monuments is carried out on a regular basis by the Archaeological Museum.


Pixabay / Debra Jean

For more information on the UNESCO DELPHI site, visit:
https://whc.unesco.org/en/list/393

This initiative, along many others, is part of the UNESCO World Heritage Sites. You can find more about this network here:
https://whc.unesco.org/en/list

Other relevant sources:
https://whc.unesco.org/en/soc/1676

www.isocarp.net/Data/case_studies/2055.pdf

3.3.9

HYPERION integrated resilience approach in Tønsberg

Type: Technological/technical– Models and simulations
Main hazard(s): Landslides, rockfalls

Location: Tønsberg, Norway
Biogeographical region: Norway
Lead: Greek Institute of Communication and Computer Systems

The H2020 project HYPERION (2019-2023) aims at delivering an integrated resilience assessment platform by leveraging existing tools and services (i.e. climate/extreme events models, building materials decay models) and novel technologies (i.e. satellite imaging and machine learning), all of it aimed at the protection and sustainable reconstruction of historical centres.

By using existing tools, HYPERION will analyse the elements affecting cultural heritage in local ecosystems and the interactions among different elements, while securing community participation and supporting business models and funding mechanisms.

HYPERION will test tools and models in four demo sites: Rhodes (Greece), Granada (Spain), Tønsberg (Norway) and Venice (Italy). HYPERION will monitor from five to eight objects in three-four medieval ruins in the Viking town of Tønsberg, located under a cliff area that makes it especially vulnerable to landslides and rockfalls. The result will be a modelling of the historic area of the city, which will allow for a better risk assessment and identification of appropriate measures for its preservation and management.

Pixabay / Andrea Klose

For more information on HYPERION project, visit:
www.hyperion-project.eu

Other relevant sources:
www.hyperion-project.eu/demonstration-case-d-in-the-city-of-tonsberg-tonsberg-norway

3.3.10

PROTHEGO: monitoring European cultural heritage at risk of volcanic eruptions

Type: Technological/technical – Structural measures
Main hazard(s): Mass movements, earthquakes

Location: Southern Europe
Biogeographical region: Atlantic, Mediterranean
Lead: ISPRA, NERC, CUT, UNIMIB, IGME

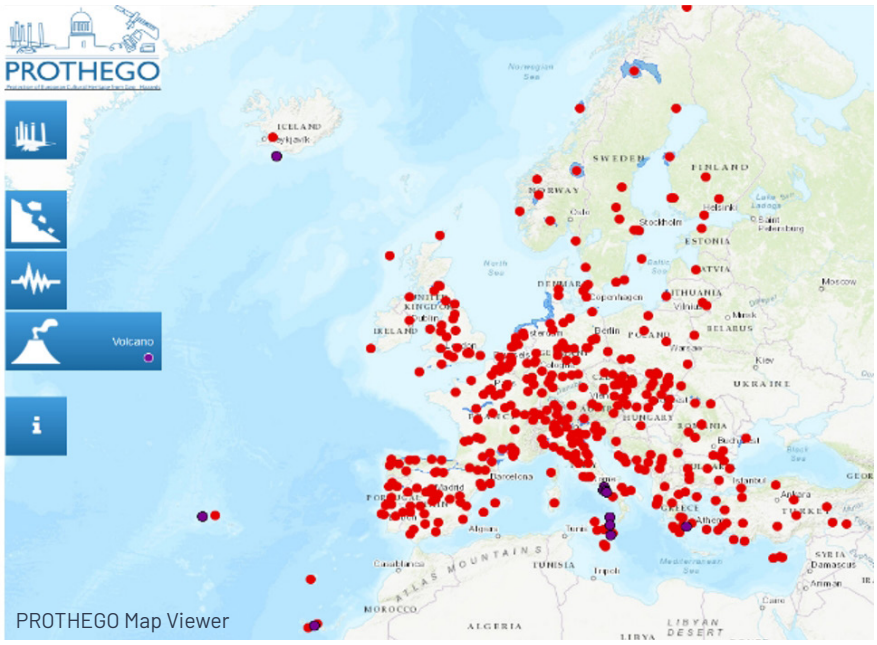
The FP7 PROTHEGO (PROTection of European Cultural HEritage from GeO – hazards) project, Led by the Italian Institute for Environmental Protection and Research, and in collaboration with NERC British Geological Survey, Geological and Mining Institute of Spain, University of Milano-Bicocca and Cyprus University of Technology, applied InSAR techniques to monitor monuments and sites that are potentially unstable due to landslides, sinkholes, settlement, subsidence, active tectonics as well as structural deformation.

The analysis includes 450 sites on the UNESCO World Heritage List in Europe, of which 11 are at risk of volcanic eruption (one in Iceland, one in Portugal, one in Spain, one in Greece and seven in Italy). All of them are displayed on a map where additional information on their UNESCO heritage site (and their criteria), their potential hazards and available satellite data is made available to the public.

Funded in the framework of the Joint, under ERA-NET Plus and the Seventh Framework Programme (FP7) of the European Commission, the project PROTHEGO aims to make an innovative contribution towards the analysis of geohazards in areas of cultural heritage in Europe.

More information on PROTHEGO can be found here:
www.prothego.eu

And the Map viewer accessed here:
http://mapapps2.bgs.ac.uk/prothego/index.html



PROTHEGO Map Viewer

3.3.11

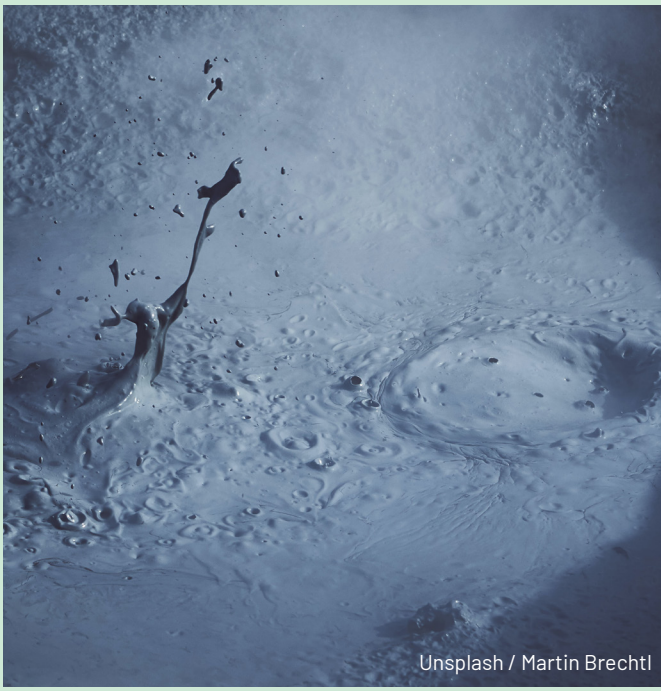
Turning risks into opportunities: Katla Geopark

Type: Behavioural – Awareness raising and communication
Main hazard(s): Volcanic eruption

Location: Skaftártunguvegur, Iceland
Biogeographical region: Arctic
Lead: Katla UNESCO Global Geopark

Situated within a great geographical diversity and an outstanding geological landscape that present high risks related to various natural hazards, Katla UNESCO Global Geopark, in Iceland, is one of RURITAGE project's Role Models.

Their natural wonders populated with ice-capped active volcanoes, tuff mountains, and black volcanic beaches attract a big number of visitors yearly. By making use of landscape storytelling, merging holistic concepts of protection, education and sustainable development, Katla created a network of governmental agencies that provide guidance and assistance to the local population and tourist on how to protect themselves and cooperate with rescue squads during and after a disaster event, teaching prevention and safeguard strategies, increasing awareness regarding survival of natural hazards as well as promoting the local culture by placing a strong emphasis on nature tourism. The park counts on a Destination Management Plan (DMP) result of an extensive participatory planning process with contributions of many stakeholders from the geopark.



Unsplash / Martin Brechtl

For more information:
www.katlageopark.com

RURITAGE is a 4-year EU-funded project under the Horizon 2020 programme aimed at establishing a new heritage-led rural regeneration approach, transforming rural areas into laboratories for sustainable development, building on the enhancement of their unique Cultural and Natural Heritage potential.

For more information on RURITAGE, visit:
www.ruritage.eu

Other relevant sources:
www.ruritage.eu/role-models/katla-geopark

www.katlageopark.com/news/article/2018/11/09/ruritage-cultural-heritage-as-a-driver-for-sustainable-development

3.4 Human-induced hazards

3.4.1

Complete restoration of the Oka River's upper estuary

Type: Technological/technical – Structural measures
Main hazard(s): Extreme land use, sea-level rise

Location: Urdaibai, Spain
Biogeographical region: Atlantic
Lead: Service of the Urdaibai Biosphere Reserve Department of the Environment, Territorial Planning and Housing of the Basque Government

This initiative sought to improve the environmental conditions of a degraded ecosystem of great ecological and cultural value located within the Urdaibai Biosphere Reserve. Main objectives were to recover the area's original landscape (greatly affected in the last decades by the agriculture, cattle raising, the construction of a shipyard and the canalisation of part of the river) and to protect the estuary from negative effects of climate change, mainly sea-level rise and alterations of the water regime. The area has a strong cultural value as it hosts antique buildings and structures, and it is linked to local legends, traditions and myths.

Actions taken included the environmental recovery of a flooded area (Barrutibaso) and the functionality of part of the lower section of the Oka River's channel, the establishment of a 14 km network of pedestrian footpaths –including a cycling bridge– to enhance connectivity between urban areas, the development of resources for interpretation and dissemination (including informative panels and an appcontaining info on local habitats, species and cultural elements), and theeradication of invasive alien species.

Unsplash / Iam Os

For more information, on the project visit:
www.euskadi.eus/informacion/proyecto-de-restauracion-del-estuario-superior-de-la-ria-del-oka/web01-a2ingurd/es/#5770

Urdaibai'sBiosphere Reserve ispart of theUNESCO's Biosphere Reserves, aninternationalnetwork of 688 sites of outstandingecological and cultural value.

Find out more on the network here: www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/biosphere-reserves

Other relevant sources:
https://climate-adapt.eea.europa.eu/metadata/case-studies/restoration-of-the-oka-river2019s-upper-estuary-part-of-the-urdaibai-biosphere-reserve

3.4.2

Monitoring natural and human-induced driven deterioration in Koules Fortification

Type: Technological/technical– Sensing and monitoring tools and methods
Main hazard(s): Pollution (air), wave action

Location: Heraklion, Greece
Biogeographical region: Mediterranean
Lead: CONSIGLIO NAZIONALE DELLE RICERCHE

This fortification, built by the Venetians in the early 16th century, has been exposed to the action of the sea for centuries. Since then, its stonework and foundations have been constantly damaged and repaired, until restoration works stagnated in the 1970s.The Greek Ministry of Culture resumed restoration works in the 2000s through the Ephorate of Antiquities and more recently setting a National Strategic Reference Framework Project concerning the Restoration and Conservation of the Fortress (2011-2016).

Actions included the removal of former interventions in the masonry, consolidation and preservation of the lions reliefs, replacement of cannon openings' old frames with new stainless ones and the removal of salt crusts and biodeterioration signs from the Stone surface, among others. Climate change and air pollution are likely to affect the fortress in the near future, accelerating deterioration processes. The HERACLES Project is supporting the anticipation to future risks through frequent, high-detailed analysis and monitoring of climatic conditions, material composition and the source of weathering features using optical and laser streptoscopic analysis, as well as a meteorological station.

Unsplash / Krakauer1962

For more information on the interventions, visit:
www.heracles-project.eu/project-test-beds/test-bed-2-sea-fortress-koules-heraklion-el

Koules is one of the four testing sites of H2020 European Project HERACLES, which aims todesign,validateandpromote responsive systems/solutions for effective resilience of cultural heritageagainst climate change effects.

For more information on HERACLES, visit:
www.heracles-project.eu

Other relevant sources:
www.heracles-project.eu/project-test-beds/test-bed-2-sea-fortress-koules-heraklion-el

3.4.3

Roșia Montană mobilises against industrial mining

Type: Institutional – Advocacy action
Main hazard(s): Extreme land use, pollution

Location: Rosia Montana, Romania
Biogeographical region: Anatolian, continental
Lead: Pro Patrimonio and Cultura Nostra

The landscape of Roșia Montană (covering 2,500 km^2 approx.) is well known for its rich deposits of precious metals (mostly gold and silver) and has been subject of mining activities since Dacian and Roman times. These activities have left many sites and buildings from different historical periods, including a gallery network of 150km^2.

A major threat to the site has been a more recent large-scale open-cast mining project promoted by a Canadian company, which is the main shareholder of the Roşia Montană Gold Corporation (RMGC). In December 2015, the Romanian Ministry of Culture put an end to the proposed mining project by classifying the town of Roșia Montană and its surroundings as a Category A historic monument. The region was officially inscribed on Romania's Tentative List of UNESCO World Heritage Sites in October 2016. In January 2017, the nomination dossier for World Heritage inscription was submitted for consideration. In June 2018, Europa Nostra also supported ICOMOS' recommendation to inscribe Roșia Montană both on the World Heritage List and on the List of World Heritage in Danger.

The local association AlburnusMaior is leading strong advocacy efforts in collaboration with other local actors such as the Association ARA. Together, they have created a programme for the conservation of local cultural heritage fuelled by voluntary participation and contributions from individuals and small grants from public organizations.

For more information on the initiative, visit:
www.wmf.org/project/ro%C8%99ia-montan%C4%83-mining-landscape

The submission as UNESCO World Heritage Site and its progress can be consulted here:
https://whc.unesco.org/en/tentativelists/6082

As well as the Nomination for Inscription:
http://rosiamontana.world/wp-content/uploads/2016/12/Rosia-Montana-Executive-Summary.pdf

Other relevant sources:
www.europanostra.org/europa-nostra-appeals-romanias-parliament-opt-alternative-sustainable-development-rosia-montana

www.wmf.org/blog/ro%C8%99ia-montan%C4%83-birth-movement

3.4.4

Preventing fire risks at the Serra de Xurés Natural Park

Type: Technological/technical – Structural measures
Main hazard(s): Fires, wildfires

Location: Galicia, Spain
Biogeographical region: Atlantic
Lead: Tecnalia

The Natural Park Serra do Xurés in Galicia, conforms together with the Peneda-Garés National Park, the nucleus of the Geres-Xurés Transfrontier Biosphere Reserve. With a total of 267.958 ha.,this area marks the transition between the Mediterranean and Atlantic climates and host a vast amount of habitat and species of outstanding ecological value, as well as an extensive collection of tumuli (mámoas) and archaeological sites from the Romanisation period. Unfortunately, the area is at great pressure from the incidence of forest fires, especially during summer period.

The H2020 project SHELTER (2019-2023) will particularly focus in providing tools and methods to increase the park's natural and historical elements' resilience by fostering local communities' participation. Two tools will be developed; one to hinder the progress of large fires (prevention) and another focused-on restoration after the fire (recovery). With the help of different government levels (regional and local), the academia, local research institutions and business, the project will design nature-based solutions against fires' risk including prevention, preparedness response and recovery phases including landowners for testing and validation. Interventions will include humidity of thalwegs by hardwood species as limiters of fire, identification of species in soil restoration and community-led silviculture practices. Thermos-cameras and soil humidity sensors will provide early warning signals in case of fire, give indications on critical situations (periods of draught) and monitor post-event restorations.


Flickr / Xoacas

Serra do Xurés is one of the five European Open Labs featured in SHELTER. The project aims at developing a data-driven and community-based knowledge framework bringing together the scientific community and heritage managers, to reduce vulnerability and promote better and safer reconstruction and management of historic areas.

SHELTER framework will be implemented in multi-scale and multi-source data driven platform aiming to provide the necessary information for adaptive governance.

For more information on the project, visit:
https://shelter-project.com

Other relevant sources:
https://shelter-project.com/openlab/4/serra-do-xures-natural-park-in-galicia

3.4.5

Female military trained by the UNESCO in protecting cultural heritage

Type: Behavioural – Training and capacity building
Main hazard(s): Armed conflict

Location: Beirut, Lebanon
Biogeographical region: Mediterranean
Lead: UNESCO

This initiative led by UNESCO looked at securing the protection of cultural heritage in areas where armed conflict is still prevalent, while at the same time integrating a gender perspective in cultural heritage resilience.

40 female members of the armed forces of Lebanon, Iraq and Jordan (as well as female peacekeepers from the United Nations Interim Force in Lebanon [UNIFIL]) were brought together in Beirut to discuss how to advance women's participation in cultural heritage protection in face of an armed conflict event.

The training took place as a workshop from the 1st to the 3rd of October 2019. Participants visited a UNESCO World Heritage site in Tyre, where they reviewed on-the-ground scenarios of securing and protecting a cultural site and artefacts. The training course provided a platform for both international and local experts and female officers to deliberate on the protection of cultural heritage in the course of military operations.


Unsplash / Marten Bjork

For more information on this initiative, visit:
https://whc.unesco.org/en/news/2047

Other relevant sources:
https://unifil.unmissions.org/unifil-female-peacekeepers-join-military-officers-region-protecting-cultural-heritage

3.5 Biological-related hazards

3.5.1

Coping with deterioration of mineral materials: BioDAM

Type: Technological – Treatment measures
Main hazard(s): Biological

Location: Scotland, Spain and Germany
Biogeographical region: Various
Lead: ICBM

BioDAM aims to safeguard movable and immovable cultural heritage from biological hazards such as biofilms (layers of microorganism that are aesthetic and can cause degradation of the stone). Traditional biocides used against biofilms impact negatively the environment and other organisms, among them humans. BioDAM was in charge of searching more environmentally friendly methods to face this issue. The main goals of this project were: 1. Identifying the damage potential of biofilms (Physical damage, Chemical damage, Aesthetic damage) 2. Finding ways to inhibit biofilms 3. Keeping mineral surfaces clean for extended time periods.

Several treatments were tested (against bacteria, fungi and algae commonly found in deteriorated stone materials) in the laboratory and in the field (Scotland, Spain and Germany) on different substrates like sandstone and lime stone. The results showed that the combination of biocides with permeabilizers and photodynamic treatments is a very useful conservation tool, enabling a considerable reduction of applications of poisonous chemical compounds.

Pixabay / Momentmal

For more information on BioDAM, visit: **www1.biogema.de/biodam/htdocs/index.php?choosenmenu=objective&choosenlang=EN**

Other relevant sources:
www1.biogema.de/biodam/htdocs/download/BIODAM_Ex._Sum_Website.pdf

3.6 Stressors

3.6.1

Education for cultural heritage protection: The Autumn School of Architecture 2019

Type: Behavioural – Training and capacity building
Main hazard(s): Lack of awareness on cultural heritage values

Location: BanskáŠtiavnica (Slovakia)
(Umbria, Tuscany and Marche)
Biogeographical region: Pannonian
Lead: Faculty of Architecture, Slovak Technical University in Bratislava

The main goal of this activity is togive additional education to students in order to participate in research, protection and presentation of cultural heritage (departments of history, archiving, art history, architecture, archeology, restoration and geodesy) and at the same time raise the awareness of the citizens about cultural sites with a relevant historic value. Part of the workshop is dedicated to the presentation of results - in the form of presentations and an exhibition of posters destined to a professional public. This is complemented with a cultural program (professional lectures, excursions, etc.). These workshops are held in cooperation with ICOMOS Slovakia.

Unsplash / Wanja Njama

For more information on the initiative, visit:
www.fa.stuba.sk/sk/dianie-na-fakulte/aktuality/jesenna-univerzita-architektury-2019.html?page_id=6955

Other relevant sources:
www.fa.stuba.sk/sk/dianie-na-fakulte/aktuality/jesenna-univerzita-architektury-2019.html?page_id=6955

3.6.2

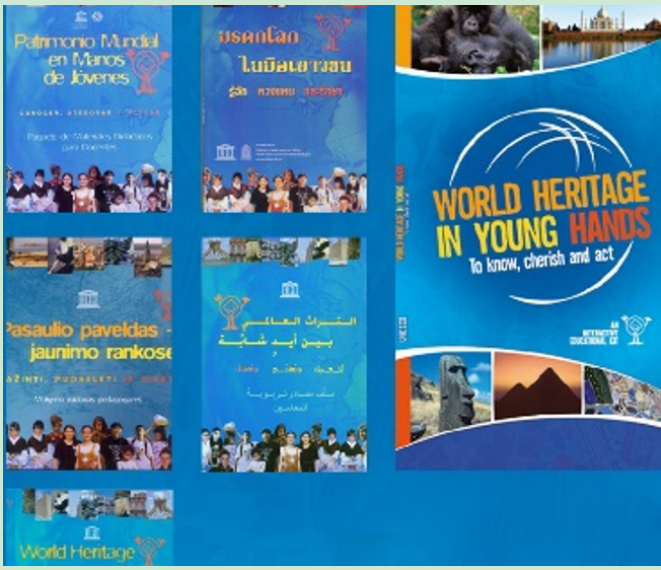
Involving youth in World Heritage conservation: an educational kit

Type: Behavioural – Training and capacity building
Main hazard(s): Lack of awareness on cultural heritage values

Location: Slovakia
Biogeographical region: Various locations
Lead: Foundation for Cultural Heritage Preservation in Slovakia, Slovak National Commission for UNESCO (in Slovakia)

Developed in 1998, the World Heritage in Young Hands Educational Resource Kit for secondary school teachers is one of the main tools of the UNESCO World Heritage Education Programme. The kit is an attempt to incorporate world heritage in the school curricula. It is based on creative and participatory methods of teaching, involving students in aspects such as data collection and analysis, role-plays and simulation exercises, information and communication technologies and field trips.

Currently the World Heritage in Young Hands Kit exists in 38 national languages, including versions with two interactive DVD versions of the Kit in English and French.



Kits can be downloaded here: **https://whc.unesco.org/en/educationkit/#downloadkit**

The kit is part of the UNESCO World Heritage Education Programme initiated in 1994.

Learn more about it here: **https://whc.unesco.org/en/wheducation**

3.6.3

Making forgotten heritage visible: CierneDiery

Type: Behavioural – Awareness raising and communication
Main hazard(s): Lack of awareness on cultural heritage values

Location: Slovakia
Biogeographical region: Pannonian
Lead: ČierneDiery

This initiative led by UNESCO looked at securing the protection of cultural heritage in areas where armed conflict is still prevalent, while at the same time integrating a gender perspective in cultural heritage resilience.

40 female members of the armed forces of Lebanon, Iraq and Jordan (as well as female peacekeepers from the United Nations Interim Force in Lebanon [UNIFIL]) were brought together in Beirut to discuss how to advance women's participation in cultural heritage protection in face of an armed conflict event.

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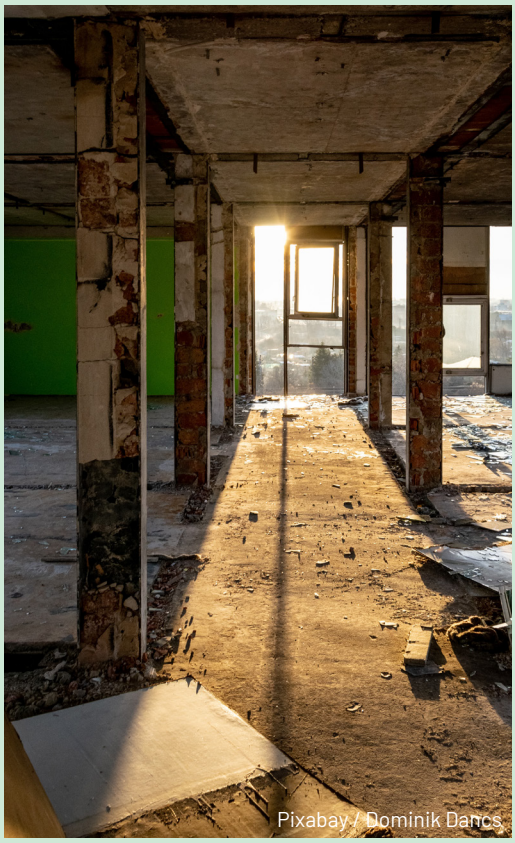

Pixabay / Dominik Dancs

For more information, visit:
www.ciernediery.sk

Other relevant sources:
https://spectator.sme.sk/c/20454499/new-map-shows-industrial-past-of-bratislava.html

3.6.4 CASE STUDY 7:

Adopting cultural heritage monuments and buildings: an initiative from Pirkanmaa Museum

Type: Behavioural – Capacity building and training
Main hazard(s): Lack of awareness on cultural heritage values, lack of capacity or economic resources at administrative level

Location: Pirkanmaa, Finland
Biogeographical region: Boreal
Lead: Pirkanmaa Museum

Background:

Regarding cultural heritage, Finland faces several challenges that are common in other European states and cities, among which the misuse and neglect of existing cultural sites is one of the most important ones(for instance, changes in agricultural policies and land-use have resulted in the misuse and removal of traditional rural buildings and structures. Moreover, some cultural sites are unknown to the public, or present difficult access, which translates into lower public interest towards them. Altogether, the neglect of cultural sites and the decreasing interest of citizens results in a loss of identity of local communities.

Case description:

The 'Adopt a Monument' scheme was conceived by the Pirkanmaa Museum to help communities become actively involved in the conservation and interpretation of their local archaeological and cultural heritage sites. It is based on the training and involvement of volunteers ("adopters") in aspects such as the monitoring, maintenance and promotion of a cultural asset of their choice, which may correspond to any site with historic or aesthetic value (e.g. an archaeological site, a traditional farm or other type of historic building). The initiative is led by the Museum, which provides the necessary training to volunteers through meetings, technical support, shadowing opportunities or workshops, and is supported by landowners, local communities, schools, associations and private companies.

The initiative, which originated elsewhere in the City of Tampere, has been adopted across the country by different museums. Once the museum assesses that a monument is suitable for adoption, a management plan is developed (including a description of the site, its natural surrounding and historical background, and detailed maintenance instructions)and an agreement is signed between the owner, the museum and the adopters (including suitable uses of the site, safety issues and Contact info).The adoption can be long- or short-term. Maintenance actions may include the trimming or removal of vegetation, litter picking, painting

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Relevant sources:

https://adoptoimonumentti.fi

www.coe.int/en/web/culture-and-heritage/-/adopt-a-monument

Interview with Tuija-LiisaSoininen, Project manager at the Pirkanmaa Regional Museum

or simple restoration actions (among others)and the organisation of voluntary work events by the adopters' can also be considered a programme activity. On its origin, the project received a grant of €30,000 from the Finish National Heritage Agency, to conserve and maintain archaeological sites. After that, between 2014 and 2016, the Ministry of Cultural Dedication granted the project with €90,000 to also include built heritage. Nowadays, the Adopt a Monument programme runs as part of the regular duties of the museum, with permanent staff allocated.

Main outcomes and highlights:

- Currently 6 regional museums are part of the Adopt a Monument initiative. The number of adopted sites in the whole of Finland is 48, with more than 3,000 volunteers involved.
- Over 12 years in operation, not a single adoption contract has been cancelled. The programme has fostered the understanding, assimilation and acceptance of Finnish culture while promoting social inclusion and tolerance towards other cultures.
- The activities that volunteers perform help to give more visibility and accessibility to monuments that had in some cases been left vacant for years.
- The initiative contributes to strengthening elements such as well-being, public health and social inclusion within the benefited communities
- The initiative has won awards including the European Heritage Awards/Europa Nostra Awards in 2016, Finland Annual AwardinMuseum Pedagogy in 2015 and the Finish Green Year Medal and Recognition Award.

Lessons learned

- Throughout the development of the initiative, it was observed that searching for suitable adopter groups first and then looking for a site to adopt was more efficient than doing it in the opposite way, which requires more time and persuasion.
- At the beginning there was a top-down approach with the museum adopting a "do-gooder" role, with not much space for flexibility. This view was changed and the organisers adopted a listening and facilitating role, respecting people´s different need and wishes.
- By allowing volunteers to have some flexibility and ownership regarding methods and rules, the Museum contributed to build trust among them, which translated into more effective commitment.

Factors of success

- The project is based on soft measures, which are not linked to restrictive regulation and allow for flexibility, which makes people more open to collaborate.
- The proposed activities are very attractive because they save money to public actors thanks to the voluntary labour, solving in that way capacity issues in the city administration.
- The idea of this project has its origin in Scotland, "Adopt a Monument" running there since 2007. Tampere was able to replicate and adapt the idea and methodology according to the Finnish needs, using 'softer' protective guidelines.

3.6.5

Volunteer camps for heritage conservation in France: the Union Rempart

Type: Behavioural – Training and capacity building
Main hazard(s): Lack of capacity or resources at administrative level, lack of awareness on cultural heritage values

Location: France (different sites across National Territory)
Biogeographical region: Atlantic, continental, alpine and Mediterranean
Lead: Local REMPART member association and local partners)

The Union Rempart, founded in 1966, is a union of heritage protection and community education associations whose role is the restoration of monuments. The 180 associations in the Union all share a common aim: to restore and protect a heritage item and give it a new lease of life, contributing to local and regional development, particularly in rural areas. Most of them organise worksites for volunteers, enabling thousands to take part in voluntary-sector projects each year to protect and revitalise heritage

Some of the activities sustained by Rempart include: the sustainable restoration and preservation of buildings, education and training of volunteers, networking opportunities and funding support. Until today, the Union has led to the restoration of 800 heritage sites, collaborating with 50 partnerorganisations in 30 different countries. It is estimated that 3500 volunteers are involved in worksites every year.

Unsplash / Peter Bucks

For more information on the initiative, visit:

www.rempart.com/en/rempart/who-we-are/values

The Union Rempart is featured in the Strategy 21 – Good practices section, along with many other initiatives seeking to preserve and restore cultural heritage assets.

Other relevant sources:

www.coe.int/en/web/culture-and-heritage/-/heritage-mission-international-volunteer-worksites-union-rempart

3.6.6

Applying traditional reconstruction methods in Medieval castles: CHAM

Type: Behavioural – Training and capacity building
Main hazard(s): Lack of resources, lack of awareness

Location: France (different sites across National Territory)
Biogeographical region: Atlantic, continental, alpine
Lead: C.H.A.M - Chantiers Histoire& Architecture Mediévales

Chantiers Histoire& Architecture Mediévales (C.H.A.M) is a national non-profit association founded in 1980 whose mission is to promote the conservation and preservation of historical buildings through educational and volunteering activities involving voluntary worksites, summer schools, integration programmes, technical training courses and lectures. It trains volunteers in ancient arts such as traditional stonemasonry and bricklaying techniques while at the same time provides them an understanding of what are the mayor risks to cultural heritage assets.

C.H.A.M is approved by the Ministry of Culture, with national Youth and Popular Education certification and the endorsement of the Civic Service Agency. In 2018 it was awarded the European Year of Cultural Heritage seal of approval. It currently operates in more than 150 sites.

Unsplash / Tom Parkes

For more information on C.H.A.M, visit:

www.cham.asso.fr/les-chantiers-cham

C.H.A.M makes part of the Fondation Du Patrimoine, a French foundation currently supporting 1891 restoration and conservation projects in national and international locations. More information can be found here:

www.fondation-patrimoine.org/fondation-du-patrimoine/qui-sommes-nous

Other relevant sources:

www.coe.int/en/web/culture-and-heritage/-/promoting-an-active-commitment-to-heritage-mediaeval-history-and-architecture-worksites-chantiers-histoire-et-architecture-medievales-cham-

3.6.7

The Urban Heritage Observatory: neighbours managing cultural heritage

Type: Managerial – Governance Model
Main hazard(s): Lack of awareness on cultural heritage values, lack of capacity and resources at administrative levels

Location: Lyon, France
Biogeographical region: Continental
Lead: The City of Lyon

The Urban Heritage Observatory was set up in 2016 with the following main objectives: 1)To develop an observation as well as a decision-making tool based on qualitative and quantitative data to feed the management and evaluation processes that have been developed as part of the CH Management Plan of the City of Lyon, 2) To provide more visibility and coherence in the analysis of the situation on UNESCO-listed site allowing the definition and implementation of future appropriate sectorial urban planning policies and actions and 3) To develop an information base for decision making of urban planning stakeholders and exchanges with the public.

The Observatory is meant to be a living initiative, evolving with the public participation, flexible and not expert-oriented. The focus group of ten people approx. will hold five meetings a year, allowing temporary guests to attend. New ideas, challenges and solutions will be analysed and integrated throughout the process, and precise actions are to be defined after each meeting. The monitoring will be carried out considering quantitative and qualitative parameters. An auto-evaluation tool will be also put in place.


Pixabay / Loic Tijsseling

The Focus Group on new usages that complements the traditional work of the Urban Observatory has been set up and coordinated as part of the H2020 ROCK project.

For more information on H2020 Rock Project:

https://rockproject.eu

Other relevant sources:

http://nws.eurocities.eu/MediaShell/media/2019_ROCK_CaseStudies-Governance-Lyon.pdf

https://rockproject.eu/uploads/news/documents/RzEZphYEVjh0TreKEt9U6I2FB1KFEL6iHWD6gviX.pdf

3.6.8

Promoting sustainable tourism in the Historical Centre of Florence

Type: Managerial – management pan
Main hazard(s): Lack of awareness on cultural heritage values, unsustainable tourism

Location: Florence, Italy
Biogeographical region: Continental
Lead: SiTI – IstitutoSuperiore sui SistemiTerritoriali per l'Innovazione

This project has a two-fold objective. On one side, it sought to identify alternative ways of managing tourist flows within the city in an attempt to relieve the most crowded places from mass-tourism undesired effects. On the other side, it aimed at improving and enhancing the value of underused areas.

The project included aspects such as a supply-and-demand analysis and a Cartographic Touristic Offer Analysis via statistics and data analysis, field research (including a questionnaire), a communication products analysis and a GIS analysis.

Main outputs were three updated guidelines for the protection, conservation and dissemination of heritage value. One of them was focusing on training to offer broader knowledge of the opportunities of the cities and different sites of interest. Another focused on communication to raise attractiveness of certain areas and another on valorisation to promote actions to make the tourism experience more engaging. The guidelines feed into a strategic plan for tourism use and effective management of tourism flows.

For more information on the Tourism management plan, visit:

www.firenzepatrimoniomondiale.it/destinazione-firenze

This initiative along with many others are featured in Interreg BhENEFIT Project, focusing on improving the management of historic built areas, combining the dailymaintenance of historic heritage with itspreservationand valorisation in asustainable way.

For more information on BhENEFIT, visit:

www.interreg-central.eu/Content.Node/BhENEFIT.html

Other relevant sources:

www.academia.edu/40197591/The_Management_Plan_of_the_Historic_Centre_of_Florence_UNESCO_World_Heritage_Site

3.6.9 CASE STUDY 8:

The preservation of Tematín castle

Type: Managerial – Management plan
Main hazard(s): Lack of capacity and resources at administrative level, lack of awareness on cultural heritage values

Location: Trenčín Region, Middle Považie, Slovakia
Biogeographical region: Pannonian
Lead: OZ Hrad Tematín

Background:

Slovakia is among the countries with the highest concentration of castles in Europe (Gúčik & Marciš, 2018), a total of almost 300, of whichwhich109 are listed as sites of National Cultural Heritage significance (Ižvolt & Smatanová, 2014). Since the beginning of the 20th Century, national castles have received attention from the tourism sector and later by the State as a means to preserve the country's character and boost local economy.

Despite the State's increasing efforts to conserve these castles, some of them are still in poor condition due to lack of maintenance, and lack of specialists experienced in medieval building techniques (Ižvolt & Smatanová, 2014). In the case of Tematín castle, these initial challenges were aggravated by the monument's reduced accessibility.

Case description:

The Tematín castle is located at the top of the side ridge of Považský Inovec hill and is one of the most remote castles of the country. Built around 1250, it used to guard the western borders of the Kingdom of Hungary, adopting the role of an important signalling point. The castle was greatly damaged in 1710 and remained unoccupied from 1726 onwards. Currently, it is mainly constituted by torsal architecture, subject to erosion caused by winds and freeze/thaw cycles.

The castle is protected since 2007 by OZ Hrad Tematín, a local non-profit organisation led by Mojmir Choma in collaboration with a core group of experts. The activities performed are greatly based on volunteer work. The pool of experts gathers regularly (mostly during weekends) in the castle to discuss conservation priorities and measures, which encompass masonry, carpentry works, general maintenance and monitoring of the conservation status; complemented with awareness-raising actions.

OZ Hrad Tematín forms part of a network of 28 organisations known as Save the Castles,which benefit from a State-led initiative that promotes the inclusion of unemployed people in the protection of national heritage (Programme 1.4[6]). OZ Hrad

Hrad Tematín

For more information, visit OZ Hrad Tematín website:
www.tematin.eu

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Relevant source(s):

www.hs-rm.de/fileadmin/persons/ckausxxx/European_Heritage_Volunteers_Programme_2019.pdf

Interview with MojmarChomir, Head of OZ HradTematín

6 The Governmental Programme 1.4 was launched in 2011 after being successfully implemented in three pilot projects, as a partnership between the Slovakia Ministry of Culture and the Slovakia Ministry of Labour, Social Affairs and Family. The programme was an attempt to promote local economy by attracting tourism and creating job opportunities, and by bringing communities closer to the conservation of their cultural heritage. The Ministry of Culture is responsible for expenditure related to material and technical support to the amount of approximately €800,000 in every year of the programme. The salaries of the workers are covered from the resources of the European Social Fund, with a total budget of €3,272,000for the three years of the programme's duration.

Tematín is in charge of employing staff from municipalities and villages nearby, whereas their salaries are covered by the Slovakia Ministry of Labour, Social Affairs and Family upon approval. Candidates are trained by Mojmir to undertake conservation work using traditional techniques, which helps them acquire technical and interpersonal skills that could be applied in other contexts, increasing their employment chances. Additionally, OZ Hrad Tematín is cooperating with the European Heritage Volunteers Project, which organises two-week training camps for young volunteers, mostly students or recent graduates that want to acquire new skills or develop a dissertation or thesis in the field. In exchange for their work, volunteers in Tematín castle are offered food and accommodation. Some of these volunteers, through their universities, help advance research on aspects such as the main drivers of the castle's degradation and associated risks, or the effectiveness of the applied restoration techniques.

Main outcomes and highlights:

- OZ Hrad Tematín has managed to preserve the existing architecture against further damage, enabling safe conditions for visitors, since the beginning of its work in 2007. Special emphasis has been put on the perimeter walls, to minimise falling rocks.
- Since 2014, Oz Hrad Tematín has employed 10 new people as part of the Programme 1.4.
- Since 2015, Oz Hrad Tematín has been working on the restoration of the neglected Očkovská mound together with residents
- The initiative has won awards including the European Heritage Awards/Europa Nostra Awards in 2016, Finland Annual AwardinMuseum Pedagogy in 2015 and the Finish Green Year Medal and Recognition Award.
- All the work performed is assessed and approved by the Monuments Board of the Slovak Republic.

Lessons learned

- According to current legislation, the maintenance of National Cultural Heritage assets shall be provided by their owner. However, the process of restitution and 'de-nationalisation' of land and properties caused a situation in which many of the castles were not even listed in the Land Register, did not have a recognised owner, or were listed just as forestry lands. In practice this meant that no one had the responsibility to care for these monuments, but, at the same time, no one had the right to maintain the castles either. Currently, OZ Hrad Tematín is in the process of solving property issues.
- Since OZ Hrad Tematín's interventions to improve the castle's condition, increased tourist numbers have started to become a conservation challenge as well. Currently, the NGO is in the process of establishing a tourism management process.

Factors of success

- A constant and committed core of volunteer experts has been essential.
- The integration of local unemployed people in OZ Hrad Tematín's activities contributed to positively change local people's perception towards the initiative. The organisation has managed to connect local populations with the castle, which is now perceived as a key element of cultural identity. So far, up to ten new people have been hired to perform conservation work in Tematín castle.
- As OZ Hrad Tematin has gained acceptance among the locals, some of them have suggested selling their products in the castle as a means to obtain funds for its conservation.

04 A framework to assess replicability

Innovating and testing new approaches, processes, technologies or policies is an important step in creating long lasting effect and/or change. In the process of implementing these initiatives, cities collect valuable experience with new and possibly challenging approaches, experiences that they can pass on. At the same time, cities are looking for practical examples to replicate, rather than reinvent the wheel each time. In this context, replication should be understood as a means to transfer and tailor existing good practices to other cities wishing to undertake similar actions. This process should take into account the baseline conditions of the cities where the actions are meant to be replicated.

According to **ICLEI Europe**, and based on relevant work in various projects, replication can be understood as:

"Copying the specific features of a sustainable urban development approach that made it successful in a pilot setting and re-applying these in the same or another setting, taking into account that the framework conditions could be quite different from those in the piloted community or region. Replication may also encompass the management process that was used in the pilot scheme or the cooperation structure between critical stakeholders."

4.1 Recommendations for successful replication

Each city that would be interested to replicate and transfer an initiative or parts of it in their local specific context should consider the following lessons learnt, outcomes of the replicability assessment and analysis and of a thorough look into the design and implementation details of each case study. The following lessons learnt are grouped per topic.

Knowledge transfer:

There are definite knowledge transfer mechanisms that have been proven quite effective in different settings; these include multi-stakeholder workshops, and co-creation or co-design meetings that involve citizens in public participation processes. Important for an effective knowledge transfer process is the creation of a common understanding of what can be replicated and transferred on cultural heritage resilience from city to city or region to region and how this would actually improve the overall, long-term resilience of the area.

Community and stakeholder engagement:

Key aspects identified as critical for a successful replicability process include amongst others the involvement of different stakeholders in early stages of planning, the development of internal capacity building processes, the adoption of innovative ways to initiate projects, and the transparent communication to citizens about the goals and measures implemented. It is important to foster a flexible approach that invites for participation and builds an atmosphere of trust in order to secure the commitment and motivation of those involved. But, how can a city and its representatives ensure the replication process encourages followers to stay committed? Evidence is still needed to support this activity as the direct benefits of a successful replicability process, but also its underlying conditions are context, sector and conditions specific. Regular face-to-face meetings, dialogues and events help in the process.

Stakeholders involved in a replicability process should represent multiple sectors, disciplines, and related areas of expertise.

The city should consider including representatives from neighbouring cities, regional bodies, and higher levels of government. Also, it is important to engage with less obvious stakeholder groups, in example, gender and youth and organisations, indigenous and local communities and their organisations, professional associations, as they all have much to contribute to local resilience and city planning and subsequent action no cultural heritage preservation. Driving in external actors, such as local NGOs, institutions or civil associations is also a way of gaining citizens' support in cultural heritage conservation actions, as well as to overcome capacity issues within the city administration.

Importance of community commitment and political support:

Internal and external variables are able to influence a replicability process. Political, technical, financial and social challenges need most of the times to be overcome during the assessment and planning phase of implementation. People tend to accept what they know and perceive as their own. Building new narratives on how cultural heritage is communicated to the citizens, highlighting aspects such as the cultural and social identity, is essential to drive citizens into conservation actions. Educational packages and training programmes delivered by cultural institutions and organisations – at school or adult level- have contributed to build capacity in the relevance of cultural heritage, and traditional methods.

Importance of visibility:

A project or initiative that brings the necessary buzz and publicity to the city is always welcome by politicians, stakeholders and citizens. Cultural heritage receives more attention in policy agendas when it is perceived as a tool to achieve results in other fields beyond conservation. For instance, and as it is the case of The Netherlands, cultural heritage in the form of maps and documentations has proven to be a tool for better adaptation to flooding in current cities.

Importance to align with other processes and plans:

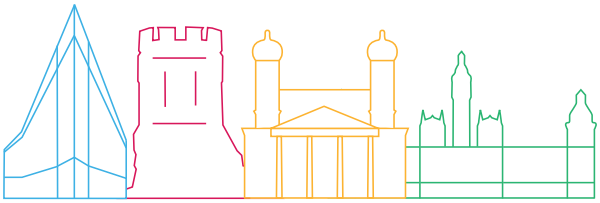
Clear frameworks and strategic documents can solve problems of complexity and confusion in which cities are tending to be stuck. Additionally, the interview and desk research results have shown that complex situations in some cases combined with chronic stresses or other simultaneous hazards cannot be solved by implementing simple or narrow technical solutions. Also, cities that are more advanced when it comes to resilience planning may have be faced with competing strategies; therefore, they would need to identify which plans are those that can incorporate effectively cultural heritage and urban resilience considerations. The mainstreaming of cultural heritage in other areas ans sectors of the city administration (beyond the cultural) has helped securing financial resources for its conservation and management in some of the initiatives showcased.

Direct climate change mitigation benefits:

Are always very crucial for the success of a replicability process; the potential for significant CO_2 reductions, but also, as an add-up, co-benefits through strengthening public investment management, and policy reforms may maximize the replicability potential of an initiative or project. Important here is to note that there are context specific variations in the control of local air pollutants and in the proved evidence for economy-wide benefits from climate change mitigation (Hamilton et al, 2017).

Learning from the past:

Historic cities have a long story of adapting to natural and man-made hazards. They should be perceived as a source of knowledge, and some practices from the past should be considered in contemporary urban planning and management.



For projects that would require a Public-Private Partnership:

To be introduced and implemented, which means that they would be fully or partially relying on availability payment schemes, an affordability analysis before deciding upon pursuing a replicability process is needed.

Flexibility is important for resilient systems in general:

good practices that are flexible enough, are able to enable and allow for re-organizing and integrating existing context/ specific practices, plans and strategies under one guiding principle for resilience planning processes while systemizing work, boosting efficiency and providing a multitude of positive outcomes.[7]

To summarize, after assessing the replication potential of an initiative or action, and taking the decision to replicate, the replicator city should consider:

1. if there is enough political support, which can go beyond traditional political cycles;
2. if there is adequate support from the public, combined with enhanced citizen engagement;
3. if the city has the necessary financial means to enable a successful process, but also to make sure that the project will receive proper implementation requirements and maintenance;
4. if there are enough enabling, location specific factors, such as composition of the city, natural landscape, geographical position, climatic conditions; and finally
5. if the city has the necessary skills and knowledge within the implementing team.

The European Commission has devoted substantial efforts to fostering scale-up and replication of innovation in European cities.[8] The analysis around replication and replicability that has been provided in this report aims to provoke and support ongoing discussion around the topic that may result in the replication of innovative solutions and practices from cities in the upcoming years which will enhance the resilience of cultural heritage sites and not only; aiming always at creating a sustainable and resilient vision for European cities.

7 www.din.de/blob/297796/8e4862e244910feb6d12d620a2b87211/cwa-17300-standards-series-flyer-data.pdf

8 www.eusew.eu/scale-and-replication-smart-cities-what-lies-beyond-buzz

4.2 Criteria for replicability assessment

The criteria presented here could serve as support material for cities within or outside the project consortium, wishing to transfer and/or replicate initiatives in their own local context.

ARCH	REPLICABILITY SCORECARD					
CASE STUDY	Insert case study name					SCORE
CRITERION	SCORING					
	1	2	3	4	5	
1 **Answer to local needs** Does the initiative respond to a specific need or challenge of the local community?	No important improvement of life quality for community members	Some improvement of life quality for those community members directly connected to the initiative in terms of location or work relationship	Significant improvement of life quality for some or all community members	Advanced improvement of life quality for all community members, the initiative even attracts audience from outside the city borders	Exceptional improvement of life quality for all community members that exceeds the city borders	
2 **Integration/cross-sectorial collaboration** Does the initiative promote the integration of various departments to the design and implementation phase? Does it promote and support cross-sectorial collaboration?	No integration aspects – the work is carried out by one department	Low potential for integration and collaboration with other departments and sectors	Moderate potential for integration and collaboration with other departments and sectors	High potential for integration and collaboration with other departments and sectors	Proven record for integration and collaboration with other departments and sectors	
3 **Flexibility** Is it an initiative that can be easily adapted to changing circumstances (due to physical, institutional or governance changes)?	No flexibility or adaptability to changes	Low flexibility or adaptability to changes (i.e. high dependence on sites or political support)	Moderate flexibility or adaptability to changes	High flexibility or adaptability to changes (i.e. changing political situation has no real influence)	Extreme flexibility or adaptability to changes	
4 **Alignment with other policies** How possible is it to integrate the initiative into existing policies at local or regional level.	No possibility to integrate into existing policies at local or regional level	Significant problems to integrate into existing policies at local or regional level	Moderate problems to integrate into existing policies at local or regional level	Some problems to integrate into existing policies at local or regional level	No problems to integrate into existing policies at local or regional level	
5 **Sustainability** What is the initiative's viability over time, when it comes to implementation ofgoals, organizational stability and long-term benefits?	Up to 5 years	Up to 10 years	Up to 15 years	Up to 20 years	Over 20 years	
6 **Affordability** What are the costs for the transfer to your own city's context and the potential implementation of the initiative (when it comes to upfront capital cost and/or future maintenance expenditure)?	Significant cost increase on city budgets	Moderate cost increase on city budgets	Slight cost increase on city budgets	No increasing costs on city budgets	Cost reduction	

ARCH	REPLICABILITY SCORECARD					
CASE STUDY		Insert case study name				SCORE
	CRITERION	SCORING				
		1	2	3	4	5
7	**Potential for direct climate mitigation benefits** Does the initiative contribute to the city achieving climate targets for 2030/2050?	Slight reduction of CO_2 emissions (0-10% in comparison to local average)	Moderate reduction of CO_2 emissions (11%-50% in comparison to local average)	Significant reduction of CO_2 emissions (51%-99% in comparison to local average)	No CO_2 emissions	Negative CO_2 emissions	
8	**Community and stakeholder engagement** How involved are stakeholders from the quadruple helix (public, private, academic civil society) in the design and implementation of each initiative?	Stakeholders are only informed about the initiative	Stakeholders participate in consultations, to give feedback on the design and implementation of the initiative	Stakeholders are involved in the process and their aspirations are constantly understood and considered	Stakeholders are invited to collaborate, and partner on the decision making around the initiative	Stakeholders are empowered to get deeply involved in the decision making process around the initiative	
9	**Feasibility** How feasible is it to consider the transfer to your own city's context and the potential implementation of an initiative when it comes to availability of time and capacity, financial and other resources, market demand, as well as technical aspects?	Low feasibility, demand for a large human and financial capital to implement the initiative	Moderate feasibility, the initiative demands specific resources for implementation	Significant feasibility, the initiative demands resources, but solutions like co-funding and/or other innovative formats can be explored and implemented	Advanced feasibility, the initiative does not demand much human and financial capital, is easy to transfer and implement	Extreme feasibility, the initiative is ready to implement and requires only minimum availability of funds or human resources	
10	**Social acceptance** To your knowledge, has the community embraced (or not) the initiative?	Very limited acceptance, the community is not making or is rejecting the initiative	Moderate acceptance, some members of the community are making use or promote the initiative	Significant acceptance, the community is promoting the initiative and considers it a good addition to the city and community life	Advanced acceptance, the city and the community are promoting the initiative and seek similar opportunities	Extreme acceptance, the community has embraced the initiative, which attracts appraisal from outside the city borders; in addition the community starts planning for similar opportunities	
11	**Visibility** Is this an initiative that will bring a lot of positive buzz and visibility to the city at national and international channels?	Very limited visibility of the initiative, only at local channels	Moderate visibility of the initiative, mainly on local and some regional channels	Significant visibility of the initiative in local and regional channels, initiative ranked as good practice at least once	Advanced visibility of the initiative in local, regional and national channels, initiative ranked as good practice more than once	Extreme visibility of the initiative in national and international channels, initiative ranged as good practice in several channels	

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