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CULTURAL HERITAGE FACING CLIMATE CHANGE: EXPERIENCES AND IDEAS FOR RESILIENCE AND ADAPTATION

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Listening to the STORM: Preliminary Survey to Identify Needs in Risk Management Policies for Cultural Heritage Endangered by Natural Hazards

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Abstract: This paper shows the results of a preliminary survey regarding existing cultural heritage disaster risk management policies in five countries (Greece, Italy, Portugal, Turkey and United Kingdom), in the scope of H2020 STORM project, which aims to develop tools, methodologies and recommendations to support future legislations and procedures on prevention, mitigation, and response to the impacts of climate change and natural hazards on sites, structures and artefacts. The survey was conducted by DGPC with the contributions of all the STORM partners. The main goal was to identify governmental risk management programmes and strategies, as well as emergency plans/preparedness systems and procedures in practice, at the sites level. This work made possible a preliminary identification of gaps and needs in different key areas that should be the next urgent priorities to address.

Résumé: Ce document montre les résultats d'une enquête préliminaire sur les politiques du patrimoine culturel existantes dans la gestion des risques de catastrophe dans cinq pays (Grèce, Italie, Portugal, Turquie et Royaume-Uni), dans le cadre du projet H2020 STORM qui vise à développer des outils, des méthodologies et des recommandations pour soutenir les futures législations et procédures en matière de prévention, d'atténuation et la réponse aux impacts des changements climatiques et des risques naturels sur les sites, structures et artefacts. L'enquête a été menée par la DGPC avec les contributions de tous les partenaires de STORM. L'objectif principal était d'identifier les programmes gouvernementaux de gestion des risques et les stratégies, ainsi que des plans d'urgence / systèmes de préparation et de procédures dans la pratique, au niveau des sites. Ce travail préliminaire a permis l'identification des lacunes et des besoins dans différents domaines clés qui devraient être les prochaines priorités pour répondre aux urgences.

Key-words: cultural heritage management, disaster management, emergency procedures, safety plan, prevention, mitigation, climate change.

Mots-clés: gestion du patrimoine culturel, gestion de catastrophe, procédures d'urgence, plan de sécurité, prévention, atténuation, changements climatiques.

1. Introduction

In a span of just 20 years, between 1988 and 2007, about 75% of calamities occurring worldwide had natural causes aggravated by climate change. Besides their social, economic and ecological consequences, these events also impact at the level of cultural heritage.

In 2016 alone, we have witnessed disasters such as the Mondego river floods, in Portugal, caused by the Agueira dam discharges due to heavy rains, causing the flooding of *Santa Clara-a-Velha* monastery at 2,5 m high, with the recuperation costing more than 600 thousand Euros (fig. 1). In June, Seine river floods threatened the Louvre and posed a challenge to the security of a part of

1. - Monastery of Santa Clara-a-Velha in Coimbra, Mondego river floods 2016. Accessed July 25, 2017, http://www.dn.pt/sociedade/interior/mosteiro-de-santa-clara-encerrado-ate-domingo-4978620.html.
Le monastère de Santa Clara-a-Velha à Coimbra, inondation de la rivière Mondego, 2016.

its invaluable spoil; however, the existence of an effective emergency plan, as well as the immediate response of the authorities, have allowed for a successful evacuation of the assets and their adequate safeguard (Filipe & Pires, 2016).

The need to guarantee a cultural heritage disaster risk policy regarding natural hazards has long been recognized by all the agencies and organizations, centring in the importance of safeguarding cultural heritage as a highly valuable contributor to sustainable development, social cohesion and civilization identity.

2. - The Baths of Diocletian, Rome, Italy.
Les Bains de Dioclétien, Rome, Italie.

2. The STORM Project

Aiming to implement, at a practical level, a safeguard policy for cultural heritage endangered by climate change, the European Commission has created the Horizon 2020 programme, which finances the STORM project - Safeguarding Cultural Heritage through Technical and Organizational Resources Management (Topic 3: Mitigating the impacts of climate change and natural hazards on cultural heritage, sites, structures and artefacts", DRS-11-2015: Disaster Resilience & Climate Change). (http://www.storm-project.eu/).

STORM meets the propositions of the Action Plan on the *Sendai Framework for Disaster Risk Reduction 2015-2030*. One of the key areas of this plan includes the development of best practices on the integration of cultural heritage in the national disaster risk reduction strategies to be developed by Member States (UNISDR, 2015).

STORM is intended to advance preventive and responsive solutions to foster cultural heritage resilience against the effects of climate change, through a planned integrated and multi-sectorial approach, with the support of distinct experts, decision and policy makers, and society in general, leading to user-focused and citizen-centred processes. The project consortium includes 20 partners from seven different countries (Germany, Austria, Italy, Greece, Portugal, Turkey and United Kingdom) and an international organization (ICCROM). It is composed of a multidisciplinary team, with specialists in the fields of archaeology, conservation-restoration, civil protection, meteorology, cultural management and electronic engineering. In order to achieve the proposed goals, five sites, covering a varied range of building materials, chronologies, artefacts and risk scenarios, have been selected for pilot testing (http://www.storm-project.eu/).

2.1 The Pilot Sites

2.1.1 The Baths of Diocletian, Rome, Italy

The Baths were built, between 3rd/4th century AD and abandoned after the 5th century AD. In the 16th century, the complex was transformed into a Charterhouse, and it was presumably Michelangelo who outlined the general structure of the monastic ensemble. The problems identified by the Project are the increasing humidity both in the air and in the ground, which has been causing proliferation of biological infestations, as well as mould growth; local storms (a combination of high intensity wind and heavy rain) also affect the site with increasing frequency, like the mini tornado that occurred in 2008, that origin led to serious impacts in the archaeological vestiges (STORM, 2017) (fig.2).

2.1.2 The Old Town of Rethymno, Greece

The Old Town of Rethymno is located in the island of Crete and it is one of the most important Cretan urban centres, with a constant occupation spanning from the Hellenistic period (323-67 BC) up to present. In this site floods, that increased in the last years due to the growing of the wind intensity, last for a long period of time. Besides

3. - The Fountain of Rimondi in the old town of Rethymno, Greece.
La Fontaine de Rimondi dans la vieille ville de Rethymno, Grêce.

that the combination of wind, salt and external maritime environmental conditions, has been damaging cultural assets, by severely affecting the mortar between the stones of the fortress walls and the plaster of the buildings of the city centre (STORM, 2017) (fig.3).

2.1.3 Roman Ruins of Tróia, Portugal

The Portuguese pilot site is located in south-western Lisbon and was a large centre for the production of salted fish and fish sauces. Its construction took place in the first half of the 1st century AD and the complex was active up to first half of the 5th century, with occupation until the 6th century. Built very close to the shoreline to facilitate the transportation of fish, salt and amphorae, this archaeological site is nowadays threatened by marine erosion, due to the rise of the sea level and the nature of the sand sediment, that is easily and periodically removed by the tidal movement (fig. 4), by salt spray and biological colonisations (STORM, 2017).

2.1.4 The great theatre of the Ancient City of Ephesus, Izmir, Turkey

This ancient theatre was the city's most impressive and largest structure, with capacity for 24.000 people. Built around the 3rd century BC, it was extended by restorations in the Roman period and became the largest in Anatolia in

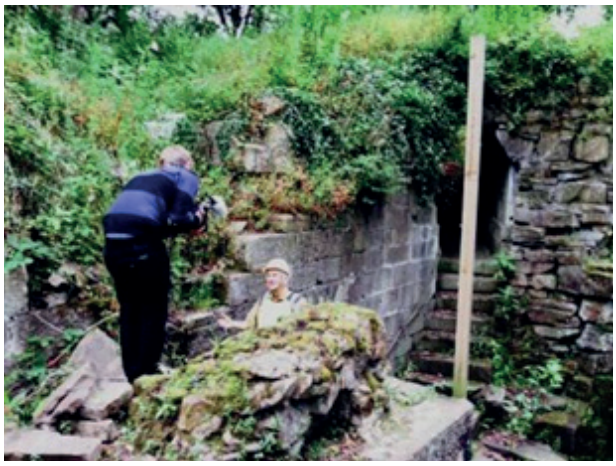
4. - Aerial view of the roman ruins of salting tanks (cetariae) in Tróia, Portugal.
Vue aérienne des ruines romaines des réservoirs de sel (cetariae) à Troia, Portugal.

antiquity. Ephesus Great Theatre is in a prone seismic area, and has suffered from earthquakes along its history, causing damage in the structure and risk of collapse. Also, according to a study on Ephesus in terms of Climate Change, using a regional climate model, the site can experience extreme temperature, expecting the increase of 1.5º – 2º C during the winter season, and over 2.5º C during the summer season. This may cause structural deformation due to material deterioration (STORM, 2017) (fig. 5).

2.1.5 Mellor Heritage Site, UK

This site includes a pre-historic area, a bronze cairn and a mill from 19th century, all situated at relatively high elevation. Winds, and

5. - The Great theater of the ancient city of Ephesus, Izmir, Turkey.
Le grand théâtre de la cité d'Ephèse, Izmir, Turquie.



6. - Mellor Heritage Site, UK.
Le site culturel de Mellor, UK.

accelerated winds resulting from climate change, cause the fall of trees near-by to the archaeology remains and infrastructure. The more common intense rains may directly damage the masonry of the sites, whilst prolonged rain may lead to inundation and landslides. Also the vegetation growth is becoming a threat to the sites (STORM, 2017) (fig. 6).

2.2 STORM Methodology

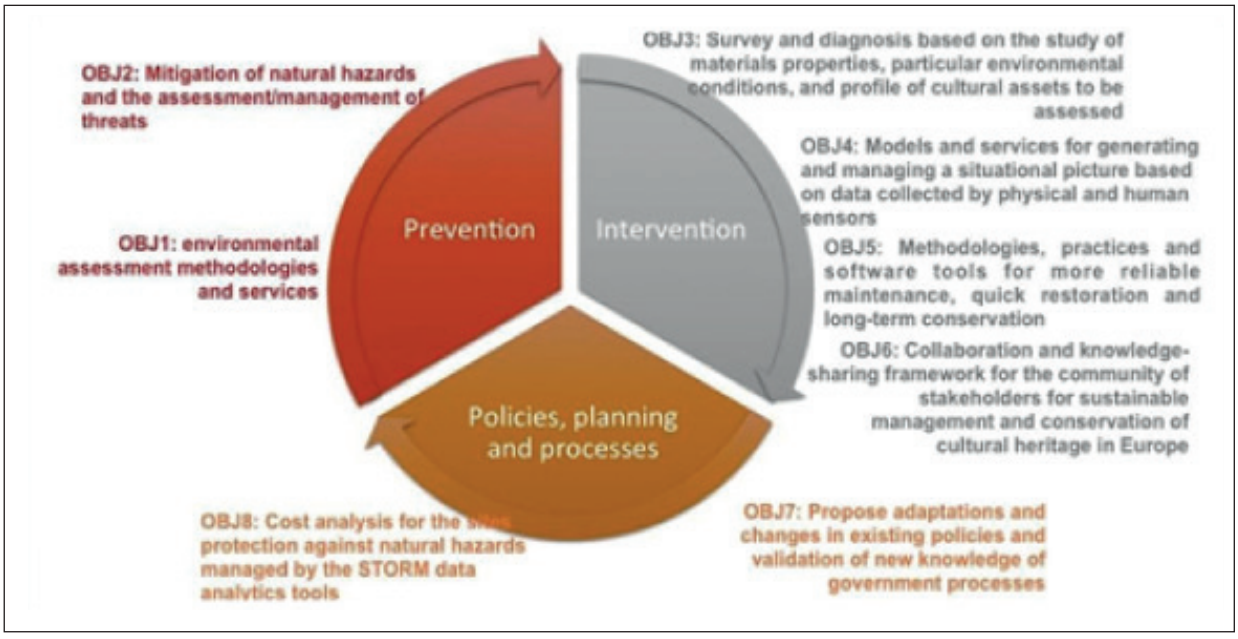
The project is structured in three areas: Prevention; Intervention; and Policies, Planning and Processes. The STORM methodology is based in a previous assessment of the current situation in what relates to legislation, procedures and technologies for the management of risks affecting materials, structures and buildings (fig.7).

The first phase of the project intends to select and integrate innovative environment assessment methodologies and services to effectively and accurately process, analyse and map environmental changes and/or natural hazards, as well as mitigation methodologies and actions for the protection of cultural heritage.

On a second stage, the consortium based in the results of hazards scenarios will develop and implement non-invasive, non-destructive and sustainable tools in order to survey and monitor the cultural heritage sites and assets. It will also develop a community platform to share the data and knowledge to different stakeholders involved in the critical and emergency phases.

Finally, an evaluation of norms and guidelines and the perfecting of technological instruments will be made in order to propose more effective models destined to streamline cultural heritage preparedness, response and recovery capacities, enhancing its resilience and mitigating its vulnerability to risk factors.

The results of STORM are expected to cause impact at the level of the relationship between the



7. - STORM objectives.
Les objectifs de STORM..

public and private decision-makers, as well as the citizens and cultural heritage, giving priority, in the European context, to the risk-preparedness and management processes (http://www.storm-project.eu/).

2.3 Portuguese Directorate-General for Cultural Heritage (DGPC) role

DGPC is the responsible authority for managing cultural heritage in mainland Portugal. Participates in STORM as a national authority with competences to develop policies and regulate the actions regarding the management of architectural and archaeological built heritage (http://www.patrimoniocultural.gov.pt/en/quem-somos/bem-vindo-ao-website-da-direcao-geral-do-patrimonio-cultural/).

DGPC is leader of a work package focused on the assessment and proposals of governmental policies and procedures. For such it has already delivered a report, in November 2016, based on a survey and a preliminary analysis of governmental policies and procedures, in five of STORM partner countries (Greece, Italy, Portugal, Turkey, United Kingdom), currently used to guarantee preservation and conservation of cultural heritage threatened by natural phenomena. All the information compiled has been taken from questionnaires, specifically produced for the collection of data among national administrations and other governmental entities, STORM partners, bibliographical research, and, when required, institutional websites. The questionnaire addresses legislation, norms and procedures, both generic and specific, directed towards the protection of movable or immovable heritage assets.

The analysis of the information took into account the legal frameworks for cultural heritage management and emergency services, trying to identify the operative structures and cooperation schemes, when dealing with a major hazard or a calamity. The results achieved intend to contribute to the definition of priorities and to provide a knowledge basis for the development of recommendations of policies and procedures on risk management for cultural heritage, in the end of the project (STORM, 2016).

3. Policies and procedures for management of hazards

3.1 References to cultural heritage

In the majority of countries analysed in this report, the implementation of a risk management strategy for the safeguard of cultural heritage is still far from reality. Nevertheless, some individual efforts have been developed regarding a certain number of natural threats, mainly through the creation of fire safety plans and the definition of seismic prevention and mitigation measures. At the administrative level the existing mechanisms and resources are aimed at the safety of life and property, frequently neglecting the safeguard of cultural heritage.

Although national authorities responsible for the superintendence of cultural heritage and civil protection are aware of this situation, few political initiatives, if any, have been developed in order to deliver the proper legislation, to implement locally adapted procedures to face natural disasters and climate change, and to generate synergies among competent entities (STORM, 2016). The figure 8 shows per country the hazards that are mentioned in legal or normative documents for the disaster management and the existence of procedures (fig. 8).

3.1.1 Greece

The legislation on cultural heritage does not mention any measures or risk management plans relating disasters. At the level of the prevention of emergency situations or disasters, it was reported the existence of a regulatory document for Seismic Protection of Monuments, proposed in 2010, that among other issues, establishes rules for the structural interventions to be executed. In Rethymno some mitigations measures are foreseen but have never been implemented.

National emergency planning for buildings, museums and archaeological sites results from the cooperation between fire departments and the regional services of the Ministry of Culture. These plans include measures to apply in case of fire, seismic activity and storms, although there is no mention to specific procedures for the protection of cultural heritage. However, regional

	GREECE	ITALY	PORTUGAL	TURKEY	UK
Legal Framework			Fire Flooding	Earthquakes Fire	
Strategy **Action Plans** **Circolare** **Diretiva** **Guidance**	Earthquakes	Fire Earthquakes Heavy rains Strong winds Snow Thermic excursions Flooding Landslides Volcanic Eruptions	Risks in general	Earthquakes Fire Flooding Landslides Rock falls	Flooding
Emergency plans	Fire Earthquakes Heavy Storms	Fire Earthquakes Flooding Explosions, etc	Fire Earthquakes Flooding Lightning Bomb menace robbery	Earthquakes Fire	Fire Flooding
Procedures in place	Fire Earthquakes Strong winds	Fire Earthquakes Explosions	Fire Earthquakes Flooding Strong winds	Earthquakes Fire	Fire

Tab. I - Policy documents and procedures concerning hazard management that includes references to cultural heritage.
Documents politiques et procédures concernant la gestion des risques incluant des références au patrimoine culturel.

services do implement some emergency response procedures for monuments, even if they are not part of the national plans (Storm, 2016).

3.1.2 Italy

Italy is the paradox of all countries surveyed once it has been developing, for several years already, a risk map as well as a series of norms – circulars and directives to complement legislation, which focus the enforcement of the elaboration of the emergency plans for cultural heritage, having in consideration different risks associated to places and assets (fire, seismic, explosions, floods, etc.). The Ministry of Culture services (MIBACT) also developed a directive to implement response actions in case of natural calamities affecting the cultural heritage, like heavy rains, snow, thermic excursions, strong wind, floods, landslides, earthquakes and volcanic eruptions. For the first time, a document intends to define coordination between the different actors (Ministry, Crisis Units, Firefighters, Civil Protection) and how they should proceed to understand damages in the cultural heritage and minimize them in the aftermath of an emergency. However in the forefront of emergency management situations still, and in practice, the emergency plans do not always reflect the guidance given by MIBACT, and the procedures are more focused on the safety of people and rarely on cultural heritage protection, mainly because of the lack of cooperation and training between the different emergency services and cultural heritage managers (STORM, 2016).

3.1.3 Portugal

Portuguese legislation makes no reference to the implementation of risk management programmes or plans on the area of cultural heritage. Museums Framework, Law no. 47/2004, of 19 August, determines that museums must have

a safety plan, regularly tested, in order to ensure risk prevention and neutralization for movable heritage, infrastructures, visitants and staff.

There is a legislation from 2008 (220/2008) re-acted in 2015 (224/2015) that establishes the legal regime of fire safety in buildings, and determines self-protection measures. It also determines some prevention, monitoring and response procedures, training of staff, and drills. Another decree issued to complement the previous, also in 2008, specified that this rules must be implemented in buildings and compounds, including museums and galleries, but other kinds of cultural or historical buildings and archaeological sites are not mentioned. In what relates to the protection of cultural assets, this law refers that all places reserved to their storage, or to conservation and restoration activities, should be fully equipped with automatic systems of fire extinction that guarantee the preservation of cultural assets. Even so, most recommended measures focus mainly in guaranteeing the safety of people, and they do not include risk assessments or detailed reports on the state of conservation of cultural assets.

Based on the collected information, we were able to verify that all museums run by DGPC have their own safety plans for the protection of staff and visitors regarding fire, seismic, flooding, lightning storm, bomb menace and robbery threats. Since the legislation for buildings security and safety is focused on fire protection, the plans are more developed for this kind of hazard. Such plans include preventive and emergency procedures, awareness and training of staff, and drill scheduling. They also provide a form for selecting priorities for salvage. At the moment, these plans are trying to be implemented. However, they do not include detailed measures for cultural heritage in the course of emergency situations (STORM, 2016).

3.1.4 Turkey

Turkey has a Resolution for immovable cultural property protected by law, as well as buildings outside the protected areas, that defines the necessary actions and procedures of mitigation related to earthquake hazards. The definition of these actions are due to the Earthquake National Implementation Strategy, so thoroughly developed in Turkey. In order to increase the earthquake resistance of the immovable cultural assets, Turkey implements repair and strengthening/ retrofitting works to any building in a risk prone area (Sungay & Dikmen, 2016). There is also a Regulation, from 2007 regarding fire protection of buildings, that states overall preventive actions. For other type of hazards, like floods, landslides, rock falls and similar disasters, the answers point out to the existence of normative documents that state the implementation of principles and strategies to make cultural heritage, and protected areas, more durable and safe. The procedures that the participants admit to put into practice regard mostly to fire and earthquake for immovable and movable heritage (STORM, 2016).

3.1.5 United Kingdom

According to the survey, there is no organization responsible for the disaster management of cultural heritage in the UK. However, knowing that the risk of flooding is likely to increase as a result of a changing climate and the effects of increased urban development, Historic England published in 2015 guidance on *Flooding and Historic Buildings* (Pickles, 2014), which reflects the necessity to manage floods with an integrated approach. For such, it is also stated the necessity to raise awareness, and co-operate with national agencies and the local level authorities. A good example are the local flood resilience forums, referred as having a fundamental role in helping manage the risks as well as providing integrated emergency management. In this way, population and communities are seen as contributors for a more resilient heritage and environment. Also, the development of scientific studies and research on the impact on heritage of climate change, particularly regarding fire, flooding and coastal erosion hazards, have contributed to implement actions in North West England sites (STORM, 2016).

For the phase immediately following a disaster, Historic England identifies the actions to put in practice in case of fire, namely evaluate damage, inform insurance company, make the area safe, and remove movable heritage to a safe store.

3.2 STORM survey results: Gaps

3.2.1 Legislation/Guidelines

On the whole, it was possible to identify, for all countries involved, a lack of strategic action plans in the context of multi-risk management for the cultural heritage. Some norms, guidelines, directives and guidance are being developed at national level, but these are not usually included in the scope of wider national programmes aiming to reduce disaster risk. Consequently, those regulations are not interrelated, and often comprise inefficient or inadequate procedures.

3.2.2 Funding

In the absence of a national strategy for disaster management and, consequently, of a related mechanism of cost evaluation, funds destined to emergency and disaster situations are insufficient to assure the efficient response and recovery of endangered or damaged cultural assets. Existing funds created for emergency situations relating to cultural heritage are very difficult to obtain, or even apply for.

3.2.3 Emergency planning

In what regards to emergency plans for cultural heritage sites, most countries indicate that those are mainly focused in personal safety, although some measures do indirectly contribute for the protection of cultural heritage. According to the questionnaires, the existing response teams haven't got enough training, or haven't ever participated in drills, thus compromising the capacity to give an efficient response in emergency situations.

3.2.4 Cooperation schemes

Generally speaking, all countries claim to have developed cooperation schemes based in plans, memorandums and agreements to implement between emergency services and cultural heritage authorities or site managers. We can highlight the Italy example, since MIBACT has created a Crisis Unit (*Unità di Crisi*), i.e., an executive coordinating structure specifically designed to guarantee the safeguard of cultural heritage in the case of an emergency, which has no parallel in the group of countries analysed in the report. This unity is meant to cooperate with the Civil Protection, the fire departments, the safety forces, and several other public and private entities, in order to guarantee an integrated response. It aims for the supervision of emergency actions, the restoration and consolidation of structures in post-disaster situations, data management and the coordination of seismic monitoring in cultural heritage.

3.2.5 Risk maps

The absence of updated risk maps is a wide reality. Once again, only Italy has developed a risk map for cultural heritage that takes into consideration its vulnerability and exposure to the distinct hazards, based on scientific principles, methodological assessments and the different typologies of cultural heritage (STORM, 2016).

3.3 STORM survey results: Needs

Based on the received answers and the identified gaps, it was possible to understand some of the needs felt by the different services. This was identified in the scope of four main themes requiring improvement.

3.3.1 Legislation

According to data gathered from all partner countries, disaster risk and climate change effects management policies should be integrated in the existing legislative frameworks for the safeguard of cultural heritage. The development of national action plans with a comprehensive, cross-sector and multi-risk approach should be compulsory, in order to guaranty efficient performances throughout the several prior and post emergencies stages.

It is obvious that the proper implementation of national plans demands for a policy of cooperation between cultural heritage services, civil protection, fire departments, health emergency services, and all other entities involved in disaster management. It is also fundamental to establish specific funds for the managing of emergencies that are operational and capable of meeting actual requirements for money and resources, which involves the revision and/or development of new legislation.

3.3.2 Procedures

Although disasters cannot be completely avoided, they can be foreseen and planned for. Appropriate measures can be taken to reduce the risk of potential disasters and to minimize their impact on cultural heritage.

Based in the results of the report, we can see that risk assessment for cultural heritage is an essential step for the identification and understanding of threats and safeguard intervention priorities in cultural assets, representing a supporting tool for decision-making in heritage protection policies. It is universally recognized that this process should engage specialists from several areas related to cultural heritage and civil protection. A leading example might be the Italian Risk Chart, further improved and adapted to the new technologies. Another aspect worth highlighting is the need to create a cost-effectiveness methodology for the conservation of cultural heritage, in order to support decisions and action measures, and which is currently being promoted in the scope of the STORM project.

In what relates to damage assessment procedures following a disaster, several different methods of collecting data have been identified, meaning that it is fundamental to create intervention protocols and implement standardized data sheets for each type of risk and asset (STORM, 2016).

Finally, it is also extremely important to acknowledge that STORM partners identified training as a priority for investment in the culture heritage and civil protection sectors. Not only response teams in cultural sites should be adequately trained and prepared, but also civil protection and fire departments must be knowledgeable on how to deal with endangered cultural assets.

3.3.3 Commitment

In order to promote a culture of disaster risk management for cultural heritage, we face the urgent need to foster synergies and congregate efforts among all competent authorities for the efficient use of available resources, the dissemination of knowledge and the subsequent implementation of national programmes for risk reduction on cultural heritage.

A political compromise is essential, in order to:

- Implement integrated and trans-sector strategies concerning cultural heritage, civil protection and humanitarian and environmental agencies, namely through a common legal basis;
- Enable local authorities and communities, allocating resources creating incentives, and holding them accountable, as active partners, for the preservation of cultural heritage.
- Raise awareness in the civil society to the importance of risk reduction on cultural heritage, and to its role as a factor of resilience for communities facing a crisis.

3.3.4 Dissemination

It is fundamental to disseminate best practices and lessons learned with the several study cases, both at national and international level. As such, we must emphasize the importance of promoting scientific studies on the impact of climate change on cultural heritage, assigned to independent researchers, whenever these are needed to support the development of useful legal frameworks that can effectively protect cultural heritage.

The enrolment of the general public is also essential in this process, and demands for greater efforts to disseminate the project results among the whole community, contributing to the increase of knowledge and the people's capability to actively participate in the protection of cultural heritage, thus making it more resilient. (STORM, 2016).

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Resort, Nova Conservação, Lda. Turkey – Izmir Directorate of Surveying and Monuments, Izmir Regional Directorate of Preservation of National Heritage, Board No: 1, Directorate of the Izmir Central Restoration Conservation Laboratory, Directorate for the Conservation, Implementation and Supervision of Cultural Assets, Ephesus Museum Directorate, Selçuk Municipality. United Kingdom - Greater Manchester Archaeological Advisory Service, Historic England. Special thanks to Isabel Raposo Magalhães, Mafalda Ramos and Maria Catarina Coelho.

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