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Safeguarding Cultural Heritage through Technical and Organisational Resources Management

D1.1: Current practice for management and conservation of Cultural Heritage

STORM Project
H2020 - Ethical/Societal Dimension DRS-11-2015: Disaster Resilience & Climate Change
Topic 3: Mitigating the impacts of climate change and natural hazards on Cultural Heritage sites, structures and artefacts

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### Abbreviations

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<td>CEN</td>
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<td>CENDIM</td>
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<td>CERG</td>
<td>European Centre on Geomorphological Hazards</td>
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<td>National Civil Protection Commission</td>
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<td>DASK</td>
<td>Compulsory Earthquake Insurance Pool</td>
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<td>DGEMN</td>
<td>General Directorate for Buildings and National Monuments</td>
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<td>Ground Control Point</td>
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<td>International Centre for the Study of the Preservation and Restoration of Cultural Property</td>
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<td>International Council of Museums</td>
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<td>ICOMOS</td>
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<td>IDNDR</td>
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<td>RILEM</td>
<td>International Union of Laboratories and Experts in Construction Materials, Systems and Structures</td>
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<td>RTK</td>
<td>Real-Time Kinematic</td>
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<td>SAR</td>
<td>Synthetic Aperture Radar</td>
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<td>SIOPS</td>
<td>Integrated System for Safety and Protection Operations</td>
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<td>World Meteorological Organization</td>
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Executive Summary

This document provides a wide panorama on current practices for management and conservation of Cultural Heritage (CH). The deliverable lists and reports on the analysis of current regulations and practices for management and conservation of Cultural Heritage in order to improve existing models and, if needed, develop new ones to be used as a basis for all STORM activities.

Before reporting the current practices, a framework on protection of CH is supplied as reference for the management and conservation of assets. Within this framework, the conceptual path in DRR (Disaster Risk Reduction) and conservation procedures is defined.

The panorama about current practices in management and conservation in CH assets was derived from literature research, from questionnaires gathered from STORM partners and actors involved in management and conservation of CH, and from direct interviews to the actors.

In the end, current practices are compared with the theoretical framework for DRR and conservation activities.
1 Introduction

According to the task for D1.1 reported in the project, i.e. list and report on the analysis of current regulations and practices for government, management and conservation of Cultural Heritage (CH), this document tries to define a general overview on current practices in management and conservation of cultural heritage. The task was quite arduous due to the presence of innumerable documents, guidelines, principles and recommendations developed in the past decades giving a solid theoretical base for CH protection and related activities. But, in current practice, often these guidelines are difficult to apply due to the lack of specific laws and regulations, professionals or funding addressed to CH protection, preservation, maintenance, conservation and management. Moreover, it should be stressed that CH contexts are quite difficult to generalise and the application of rigid regulations cannot be applied. For this reason, current practices can be better explained through case studies, which can supply good and best practice procedures in the management and conservation of CH, as also widely underlined by UNESCO (UNESCO 2014).

In order to have a general overview of the principles, recommendation, guidelines, procedures existing and/or applied in the phases of CH protection, from risk assessment to recovery processes, it was necessarily defined, as first step, the frame of reference (Chapter 3) reporting the main international documents on CH protection and also the DRR phases, as developed within the STORM activities.

Chapter 4 is the most relevant part of the document, reporting a general wide background on CH risk management and conservation processes. This background was based on a deep bibliographic research on the current situation around Europe on risk management, conservation approaches and actors involved. These same topics were then developed for single cases referred to the European Countries hosting the pilot sites selected for STORM project.

Chapter 5 is devoted to case studies that can be considered as notable examples of good or best practices for CH preservation and conservation. Good practices in CH management and conservation can be found in the literature and are also suggested as highly valuable examples and easier to understand than good advice (UNESCO 2012a). In this chapter a general table is proposed to compare the conceptual framework defined in chapter 3 with the current practices found in the research carried out for D1.1 preparation. Lessons learned from this research and comparison are summarized in paragraph 5.2.

The deliverable concludes with a conspicuous number of references (Chapter 6), and with the original questionnaires prepared and collected by TUSCIA from various institutions and STORM partners in order to obtain information about current practices in management, conservation and protection of CH.
2 Frame of reference for Cultural Heritage protection

2.1 Principles, Recommendations and Guidelines

Speaking about cultural heritage protection it makes imperative to define a general frame of reference, at international level, concerning the principles, recommendations and guidelines that during the time have been defined on the occasion of conference, symposia, meetings, etc.

For this reason, a short panorama on this general frame of reference will be reported in the present chapter.

The theoretical frame of reference is fundamental to understand the current practices that, in the absence of precise laws, are necessarily based also on guidelines, recommendations and principles defined by international organizations such as UNESCO, ICOMOS, ICCROM, etc.

2.1.1 Charter of Venice (1964) – ICOMOS

The *International Charter for the Conservation and Restoration of Monuments and Sites*, commonly known as *Charter of Venice* was prepared and defined during the “II International Congress of Architects and Technicians of Historic Monuments” of Venice in the 1964, and adopted by ICOMOS in 1965 (*International Charter 1964, ICOMOS 1998*).

The Venice Charter reports, in sixteen articles, internationally accepted standards that supply guidelines for conservation practice related to architectural contexts and sites.

The Charter of Venice is “based on the concept of authenticity and the importance of maintaining historical and physical contexts of sites and buildings” (GCI, n.d). The Venice Charter is today one of the most relevant documents in the field of conservation. The Charter of Venice affirms that monuments should “be conserved as works of art but also as historical evidence” (GCI, n.d.). The Charter also highlights the principles of preservation, and restoration of buildings with layers belonging to different periods.

2.1.2 Nara Document on Authenticity (1994)

The Nara Document on Authenticity was drafted by the 35 participants at the Nara Conference on Authenticity in Relation to the World Heritage Convention, held at Nara, Japan, from 1-6 November 1993, at the invitation of the Agency for Cultural Affairs (Government of Japan) and the Nara Prefecture (Stovel 1995 and 2008). The Agency organized the Nara Conference in cooperation with UNESCO, ICCROM and ICOMOS. The final version of the Nara Document was edited by Raymond Lemaire and Herb Stovel.

“The Nara Document builds on the Venice Charter in light of an expanding scope of cultural heritage concerns. It addresses the need for a broader understanding of cultural diversity and cultural heritage as it relates to the conservation. The document underscores the importance of considering the cultural and social values of all societies. It emphasizes respect for other cultures, other values, and the tangible and intangible expressions that form part of the heritage of every culture. There are no fixed criteria to judge value and authenticity of cultural property; rather it must be evaluated within the cultural context to which it belongs. Though responsibility for the care and management of heritage belongs primarily to the culture that
produced it, the document calls for adherence to the principles and responsibilities imposed by international charters. [http://www.getty.edu/conservation/publications_resources/research_resources/charters/charter55.htm].


This declaration was adopted on the occasion of a seminar on the Protection of Cultural Heritage in Emergencies and Exceptional Situations that was held at Radenci, Slovenia, in November 12-16, 1998 and was proposed by the “International Committee of the Blue Shield (ICBS) with the participation and support of UNESCO. Representatives of UNESCO, and of the four non-governmental organizations that constitute the ICBS: the International Council on Archives (ICA), the International Council of Museums (ICOM), the International Council of Monuments and Sites (ICOMOS) and the International Federation of Library Associations and Institutions (IFLA) took part, together with delegates from cultural heritage organizations in the following countries: Belgium, Bosnia and Herzegovina, Croatia, France, Hungary, Italy, Netherlands, Poland, Slovenia and Sweden. The participants, noting the great loss of cultural heritage in recent years due to armed conflicts and natural disasters and international efforts made to prevent such losses, examined experiences of mitigation and response in different countries and contexts, agreed on a series of principles that they defined in a document produced on the occasion of the seminar. [http://archive.ifla.org/VI/4/admin/emergcy.htm].

In this document some general recommendations are made concerning cultural heritage protection. First of all, protection and safeguard of CH contexts should “be included in policies and programs at international, national, regional and local levels”. In fact, “all institutions must take care for CH and all authorities responsible for it, should integrate risk preparedness and management within their operations to avoid loss or damage in both normal and exceptional events”.

CH losses must be avoided and, in case of emergency situations, prevention, preparedness, response and recovery measures should be improved.

The Radenci declaration then lists a series of strategic recommendations for reaching the best results in terms of CH protections. In particular, the Declaration stresses the importance of networks between partners involved, the necessity of creating an emergency plan which includes dissemination, and the relevance of training employers involved in CH protection.

The declaration proposes a series of means to reach the main aims. All these means are fundamental in a process of CH protection, for example funding and resources, collaborative agreements with institutions in terms of personnel, specialized equipment, and temporary refuges, relationships with emergency services. Among the proposed means, the relevance of information through the use of emergency procedure manuals and inventories of resources is stressed, along with the necessity to have inventories and documentation of the institution's
holdings, including remote backup copies. Training is also a fundamental mean in protection of CH assets and the support of voluntary networks, characterized by diverse competencies.

2.1.4 Recommendations for the Analysis, Conservation and Structural Restoration of Architectural Heritage (2003) - ICOMOS

“These Recommendations are intended to be useful to all those involved in conservation and restoration problems, but cannot in anyway replace specific knowledge acquired from cultural and scientific texts” (ICOMOS 2003, n.p.). The Recommendations presented in the complete document of ICOMOS are developed in two sections and a final glossary:

- **principles**, “where the basic concepts of conservation are presented” (ICOMOS 2003, n.p.) in 3 different parts: I General criteria; II Research and diagnosis; III Remedial measures and controls;

- **guidelines**, “where the rules and methodology that a designer should follow are discussed” (ICOMOS 2003, n.p.) in 5 different parts: I General criteria; II Acquisition of data: Information and investigation; III The structural behaviour; IV Diagnosis and safety evaluation; V Structural damage, materials decay and remedial measures;

- **glossary**: “Only the Principles have the status of an approved/ratified ICOMOS document” (ICOMOS 2003, n.p.).


“The representatives of the founding members of the International Committee of the Blue Shield (ICA, ICOM, ICOMOS, IFLA) and of the National Blue Shield Committees of Belgium, Czech Republic, France, Italy, the former Yugoslav Republic of Macedonia, Madagascar, Norway, Poland, United Kingdom and Ireland, and Venezuela, and the representatives of Cultural Emergency Response and Cultural Heritage Without Borders, on the occasion of a meeting in Torino, Italy” (ICBS 2004, 1), established a series of recommendations. These recommendations were defined starting from some general declarations and conventions, such as the Universal Declaration on Cultural Diversity adopted by UNESCO in 2001, The 1954 Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict, including its First (1954) and Second (1999) Protocols and finally the objectives of ICBS fixed in the Charter of Strasbourg in 2000.

The Torino declaration, based on the above mentioned conventions, proposes a series of recommendations for protecting CH in case of human-made or natural disasters devastating both movable and immovable cultural heritage.

Drawing from these conventions, the Torino Declaration asserts “to include protection of movable and immovable CH in the mandate of peace support operations” (ICBS 2004, 1) of the UN and other international organisations. The same necessity is reaffirmed for the national governments. The Torino Declaration also confirms the importance of risk preparedness, response and recovery, to be included in the programmes and activities of professionals and actors involved in CH. Lastly, the Torino Declaration recommends that
ICA, ICOM, ICOMOS and IFLA national members create a National Committee of the Blue Shield, in case of absence at national level, and lobby for national authorities to support these committees so that they can operate in “protect movable and immovable cultural heritage in the event of natural or man-made disasters” (ICBS 2004, 1). The role of ICBS should be strengthened and made visible.

2.1.6 International Committee of the Blue Shield (ICBS): The 2006 Hague Blue Shield Accord (2006)

“The representatives from ICBS and National Blue Shield committees met in The Hague on September 27th and 28th 2006 to discuss and agree on the most effective way to support the new International Committee for the Protection of Cultural Property in the Event of Armed Conflict, established under the Second Protocol of the 1954 Hague Convention, and how best to respond to the generous offer of funding and facilities made by the Municipality of The Hague.

They agreed upon the creation of a new board - the Association of National Committees of the Blue Shield (ANCBS)” (ICBS 2006, 1) whose board would “[comprise] representatives from the national committees and observers of ICBS” (ICBS 2006, 2). In this meeting, the responsibilities of all ICBS-related organisms: the National committees; the ANCBS; and the ICBS itself were furthermore clarified. In particular, the purpose of ICBS was agreed as “To promote the protection of CH assets (as defined in The Hague Convention) against all threats typologies and to intervene strategically with decision makers and relevant international organisations to prevent and to respond to natural and man-made disasters.” (ICBS 2006, 2).

2.1.7 New Delhi resolution Impact of Climate Change on Cultural Heritage (2007)
(http://www.icomos.org/climatechange/pdf/New_Delhi_Resolution_EN.pdf)

ICOMOS International Workshop on Impact of Climate Change on Cultural Heritage in New Delhi, 22 May 2007, signed a resolution based on a series of assessments and texts (ICOMOS 2007). One of ICOMOS starting points was “the increasing evidence of the unprecedented changes in global climate patterns and the impacts these have on [cultural] heritage” (ICOMOS 2007, 1) contexts. The resolution of ICOMOS was also based on the reports of IPCC and UNFCCC for climate change mitigation and adaptation and on the text of the 1972 World Heritage Convention and “the decisions of the World Heritage Committee of UNESCO in 2005 and 2006 for concerted action in documentation, monitoring, and provision of appropriate adaptation for the impact of climate change on the World Heritage Sites.” (ICOMOS 2007, 1)

Lastly, this ICOMOS resolution was based on that derived from the 15th General Assembly of ICOMOS at Xi’an in October 2005 aimed at “document[ing] the impact of climate change on CH and at develop[ing] a strategy for reducing the risks to cultural heritage” (ICOMOS 2007, 1), and on the document “Case Studies on Climate Change and World Heritage” published by the UNESCO World Heritage Centre in 2007.
The experts participating in the New Delhi Workshop established a series of important principles concerning the impact of climate changes on CH: “[They] acknowledge[d] […] the complex issue of the impact of climate change on cultural heritage, which would require sustained research, studies and documentation involving collaboration among experts from multiple disciplines. [They] recognise[d] the need to assess the risks to cultural heritage due to climate change […] and that such assessments should be [made] at macro level […] and micro level ([…] on specific heritage sites […]”) (ICOMOS 2007, 1). The experts suggested that the strategies for cultural heritage adaptation to climate changes should be considered in comparison to the existing methodologies for preservation and conservation of CH contexts by developing specific standards and protocols.

An important statement is supplied by the experts regarding the institutional level; in fact they underlined the necessity that “cultural heritage needs and concerns should be mainstreamed into institutional processes and policies for disaster reduction” (ICOMOS 2007, 2).

The experts underlined the great relevance of CH for different aspects of a country (economies, tourism, community bonding, etc.) and so they invite governments and international organisations to acknowledge this relevance.

They also recommended that governments operate in order to “involve the governmental and non-governmental organisations, academic institutions and individuals concerned with raising awareness, conservation and protection of cultural properties with the national and international protocols for disaster risk reduction and climate change adaptation” (ICOMOS 2007, 2).

Furthermore, the experts invited governments, inter-governmental, non-governmental organisations and the private sectors to find and promote finding of resources for the protection of CH assets in order to avoid and reduce damages and losses.

2.1.8 Protecting the cultural heritage from natural disasters (2007)


This study was promoted by the European Parliament's committee on Culture and Education in order to provide a framework on issues related to Cultural Heritage against Natural Hazard.

“The study examines current national and international instruments and activities to protect cultural heritage from natural disasters, giving examples of best practices and describing problems and shortcomings. Based on an analysis of current and forthcoming EU legislation, priorities for action are defined. Given the increasing occurrence of natural disasters and their impact on cultural heritage, the authors recommend horizontal integration of the protection of cultural heritage from natural disasters into relevant EU policies” (IP/B/CULT/IC/2006_163 2007, i).

In this document, the current situation for preparedness to protect cultural heritage from natural disasters is developed in the chapter 2. Then chapter 3 gives a base for the protection of CH against natural disasters. Chapters 4 and 5 supply information on EU protection instruments and cooperation programs and Chapter 6 defines the Priorities for action.
2.1.9 **International Committee of the Blue Shield (ICBS): The Seoul Declaration (2011)**


“The International Conference of ICBS, held at the National Museum of Korea in Seoul, Republic of Korea, from 8 to 10 December 2011, discussed the paramount importance of protecting cultural heritage in emergency situations.

The Conference brought together professionals concerned with this issue, encompassing a wide range of expertise including heritage, military, meteorological, humanitarian assistance and information technology” (ICBS 2011, 1).

On the occasion of conference of Seoul, ICBS adopted a new declaration concerning CH protection, partially reaffirming previously reported declarations and assessments.

The concepts derived from Seoul conference again underlined the importance of CH for peoples and countries and the necessity that all should be aware of “the damage to cultural heritage induced by environmental degradation and climate change, and by the development and rising complexity of armed conflicts, as well as political and economic crises” (ICBS 2011, 1).

The ICBS, as also stated in the Radenci Declaration of November 1998, encouraged “the development of training activities in emergency preparedness and response for CH institutions, […] and […] professionals” (ICBS 2011, 2) involved.

Moreover, ICBS advocated for “the improvement of monitoring methods [by applying new] information technologies and geographic information systems” (ICBS 2011, 2) in order to better evaluate risks and possible impacts on assets.

In the ICBS document, other relevant aspects linked to the protection of CH in emergency situations were reported, such as the necessity of funding, of planned procedures, and of forming partnerships to improve processes and actions.

2.1.10 **Venice declaration on building resilience at the local level towards protected cultural heritage and climate change adaptation strategies (2012)**

(https://www.unisdr.org/we/inform/publications/32399)

“The Mayors and Local Government representatives together with National Government Officials, representatives of the Council of Europe, the European Commission, the Private Sector, UNESCO, UN-Habitat and UNISDR […] participated in the event “Building Cities Resilience to Disasters: Protecting Cultural Heritage and Adapting to Climate Change” organized by the City of Venice and UNISDR” in March 2012.

The conference in Venice was the occasion to make relevant assessments on protection of CH and on strategic solution development for climate changes.

Also in this case a series of affirmations were produced, giving raise to the Declaration of Venice of 2012 with a breakdown into nine points.
The main concepts established in the Venice Declaration, can be summarized as follows: the relevance of good practices, related to disaster risk reduction, that should be shared within all involved in CH management and conservation; the improvement of resilience to disasters “by promoting and embracing the objectives of Making Cities Resilient Campaign”; the necessity of integrating CH aspects into national and local disaster risk reduction policies and plans; the relevance of improving partnerships with the private sectors in order to examine the possible cause of non-resilient activity in the urban contexts.


“This Communication [from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions,] examines [in three chapters] what the EU can do to enhance heritage's intrinsic value and take advantage of its economic and societal potential. The European experience shows how it [can be] possible to [start] from [the] appreciation of […] one's own CH [uniqueness] to an interest in and respect for the heritage of others” (EC 2014, 13). The aim of this communication is to stimulate all stakeholders to the themes of “long term and sustainability value of European CH, and [to the] develop[ment] of a more integrated approach to preservation and valorisation [of CH]” (EC 2014, 13). The topic of cooperation is stressed in chapter 3 of the document (The way forward: strengthening policy cooperation at all levels).


http://unfccc.int/paris_agreement/items/9485.php

The fundamental aim of the Paris Agreement “is to strengthen the global response to climate change […] and the [capabilities] of [all] countries to deal with the impacts of climate change” (UNFCCC n.d.). To reach the goal a series of measures, actions, technological items, financial flows, are necessary and should be addressed to reach the aim.

One of the main relevant elements is the necessity, stated in the art. 2, “to limit the global temperature increase to well below 2 degrees Celsius, while pursuing efforts to limit the increase to 1.5 degrees” (UNFCCC 2015).


“The Sendai Framework for Disaster Risk Reduction 2015-2030 was adopted at the Third UN World Conference in Sendai, Japan, on March 18, 2015. It is the outcome of stakeholder consultations initiated in March 2012 and inter-governmental negotiations from July 2014 to March 2015, supported by the United Nations Office for Disaster Risk Reduction at the request of the UN General Assembly. The Sendai Framework is the successor instrument to the Hyogo Framework for Action (HFA) 2005-2015: Building the Resilience of Nations and Communities to Disasters” (UN 2015).
The Sendai Framework, starting from previous works and activities made by States and stakeholders under the HFA, added some news derived from consultations and negotiations.

The primary responsibility of states to prevent and reduce disaster risk was stressed in the document. The Sendai Framework also articulates other basic points in risk management, taking into consideration management, preparedness, “recognition of stakeholders and their roles”, risk-sensitive investment, “strengthening of international cooperation and global partnership”, etc. (Wahlström 2015, 4)


The Action Plan constitutes an effort to implement the Sendai framework. The Action plan develops practical activities related to risk such as knowledge, funding, preparedness and resilience.

One of the priorities of the Plan is to create synergic actions between DRR and climate change approaches, and also to allow the cities to improve their capability in management of disaster risks.


2.1.15 Work Plan for Culture 2015-2018 – European Union


The Work Plan for Culture (2015-2018) operates, both at national and EU level, “in the context of globalisation and digitisation” (EC n.d.). The Plan is a four-year framework setting out the “priorities for promoting access to culture and audience development” (EC n.d.), and therefore dealing with the management of CH in Europe More specifically, all concrete actions and projects to be developed and fostered within this Action Plan will be traceable to one to the following priorities: A. Accessible and inclusive culture; B. Cultural heritage; C. Cultural and creative sectors: creative economy and innovation; D. Promotion of cultural diversity, culture in EU external relations and mobility.

The Plan maintains the Open Method of Coordination as “the main working method of cooperation among Member States in the field of culture […] However, other methods could be applied such as] ad-hoc expert groups or thematic seminars convened by the Commission, stock-taking meetings informal meetings of officials from Ministries of Culture and Ministries of Foreign Affairs and also conferences, studies and peer learning initiatives.”
2.2 Implementation of Disaster Risk Reduction in the Cultural Heritage sector

2.2.1 Introduction

Disaster Risk Reduction (henceforth DRR) is a designation that denounces the growing awareness of the need for a stronger focus on preventive approaches that presides over disaster risk management strategies today; DRR may be defined as encompassing two key elements:

Risk reduction, which “refers to efforts to limit risks due to hazardous situations. This can be achieved by good prevention.” (Ammann 2013, 171)

Disaster management, which “signifies the need to reduce or limit the resulting damages caused by a disaster. This can be achieved by good preparedness, an efficient disaster or crisis management system and an effective recovery process.” (Ammann 2013, 171)

DRR terminology seems to still be missing exact globally-agreed definitions for the different stages of a disaster cycle (Baird 2010). In most of the consulted sources, four to five phases are generally cited as integrating the emergency or disaster cycle, with definitions varying slightly depending on the agency; in the European Union, however, only four phases seem to be generally mentioned: prevention – preparedness – response – recovery (EC 2009; EC 2010; EC 2013), with the Directorate-General for European Civil Protection and Humanitarian Aid Operations (DG ECHO) mostly following the UNISDR 2009 terminology (EC 2013; UNISDR 2009).

Within STORM, the EU phase-designation was essentially kept. Nevertheless, and taking into account the Sendai Priorities for Action, and particularly Priority 1: Understanding Disaster Risk (UN 2015, 14), and its recommendation for a disaster risk management (DRM) approach – where DRR is extended to encompass a Risk Assessment phase – dictated the need for considering five DRR phases: Risk Assessment – Prevention & Mitigation – Preparedness – Response – Recovery.

This extension is in agreement with the definition of DRM: “Application of disaster risk reduction policies, processes and actions to prevent new risk, reduce existing disaster risk and manage residual risk contributing to the strengthening of resilience.” (UNISDR 2015a, 13). Viewing DRR as a policy and DRM as its practical application instrument prompts a further clarification: “Disaster risk management includes actions designed to avoid the creation of new risks, such as better land-use planning […] (prospective disaster risk management), actions designed to address pre-existing risks, such as reduction of health and social vulnerability, retrofitting of critical infrastructure (corrective disaster risk management) and actions taken to address residual risk and reducing impacts on communities and societies, such as preparedness, insurance and social safety nets (compensatory disaster risk management).” (UNISDR 2015a, 13-14). In the table below (Table 1) are shown the DRR phases and the corresponding definitions.
### Table 1: Proposed DRR/DRM phases and definitions

<table>
<thead>
<tr>
<th>DRR Phase</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk assessment</td>
<td>“Risk assessment is the overall process of risk identification, risk analysis and risk evaluation” (ISO/IEC 2009). Risk assessment is “a methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihoods and the environment on which they depend” (UNISDR 2009).</td>
</tr>
<tr>
<td>Prevention &amp; mitigation</td>
<td>Prevention corresponds to the outright avoidance of adverse impacts of hazards and related emergencies. Prevention expresses the concept and intention to completely avoid potential adverse impacts through action taken in advance. When the complete avoidance of losses is not feasible, the task transforms to that of Mitigation: the lessening of the potential adverse impacts of physical hazards (including those that are human-induced) through actions that reduce hazard, exposure, and vulnerability. (adapted from UNISDR 2009, 19-20; IPCC 2012, 561).</td>
</tr>
<tr>
<td>Preparedness</td>
<td>Preimpact activities that provide the trained personnel plans and procedures, facilities, and equipment needed to support active response at the time of disaster impact. (Lindell 2013, 264). It includes planning efforts to prepare for response and recovery (Stovel 1998, vii).</td>
</tr>
<tr>
<td>Response</td>
<td>The reaction to an incident or emergency to assess the damage or impact to the site and its components, and actions taken to prevent people and the property from suffering further damage (UNESCO-WHC et al. 2010, 58). Includes Cultural First Aid: initial actions taken to secure and stabilize endangered cultural heritage during a complex emergency. (ICCROM/The Smithsonian Institution 2015, 2)</td>
</tr>
<tr>
<td>Recovery</td>
<td>The process (decisions and actions) of returning the institutions to normal operations, which may also involve the repair and restoration of the building or site (UNESCO-WHC et al. 2010, 58). It includes measures taken to overcome physical, social, environmental and cultural losses (Stovel 1998, vii), aligning with the principles of sustainable development, including build back better to avoid or reduce future disaster risk” (UNISDR 2015a, 25-26).</td>
</tr>
</tbody>
</table>

These phases should be seen completing a full cycle and even overlapping at times: for instance, conservation measures implemented at the recovery phase may also be regarded (and implemented) as preventive/mitigation measures, aiming at reducing the impact of future...
hazards; many of the actions in the response phase will pave the way to recovery, and the same is valid for the prevention/mitigation and preparedness phases.

### 2.2.2 Breakdown into specific actions

Each one of the phases described in the previous table will encompass several activities; the table below (Table 2) lists the most common actions and processes associated with each phase in the specific context of cultural heritage emergency management.

#### Table 2: DRR/DRM phase breakdown

<table>
<thead>
<tr>
<th>Phase + Involved processes/actions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk Assessment</strong></td>
</tr>
<tr>
<td><strong>Defining context and goals</strong></td>
</tr>
<tr>
<td>- outlining of the scope and goals of the assessment, including what is covered (by the assessment) and, if pertinent, what is not covered;</td>
</tr>
<tr>
<td>- defining the context of application, including space and time frames;</td>
</tr>
<tr>
<td>- establishing the risk criteria against which the obtained risk levels will be judged.</td>
</tr>
<tr>
<td><strong>Identifying risks to the heritage asset</strong></td>
</tr>
<tr>
<td><strong>Step 1. Analysing hazards and threats</strong></td>
</tr>
<tr>
<td>- identifying and analysing natural hazards, climate change-related events, potential secondary hazards and human-induced threats;</td>
</tr>
<tr>
<td>- profiling the hazards of interest in the region and consider which ones are priorities based on their probability of occurrence, potential magnitude, and past impacts on the heritage site (FEMA 2004, 2-1).</td>
</tr>
<tr>
<td><strong>Step 2. Analysing exposure and vulnerability</strong></td>
</tr>
<tr>
<td>- identifying and listing heritage assets and their associated values; write statements of significance, authenticity and integrity (UNESCO-WHC et al. 2010, 23)</td>
</tr>
<tr>
<td>- analysing structural sensitivity of the heritage attributes to the hazards and threats;</td>
</tr>
<tr>
<td>- evaluating the coping/adaptive capacity of the heritage property. This includes the performance evaluation of existing management systems and risk preparedness plan (UNESCO-WHC et al. 2010, 25)</td>
</tr>
<tr>
<td>- identifying and analysing the underlying risk factors, including poor restoration done in the past, threats in surrounding environment, existing damage and deterioration patterns, and present irreversible interventions, activities or physical planning (UNESCO-WHC et al. 2010, 25).</td>
</tr>
<tr>
<td><strong>Step 3. Identifying potential impacts/losses</strong></td>
</tr>
<tr>
<td>- compiling sufficient and reliable data on the heritage assets at risk (Romão, Paupério, and Pereira 2016, 697)</td>
</tr>
<tr>
<td>- establishing cause-effect relationships and developing a scenario dynamics of potential emergencies (EMA 2010, 24) to identify potential impacts of the hazards and threats on particular assets/components of the heritage sites;</td>
</tr>
</tbody>
</table>
Phase + Involved processes/actions
- developing a risk map by overlapping hazard, heritage and vulnerability maps.

Analysing the risks
- assessing the probability of a particular disaster scenario impacting the heritage assets;
- assessing the severity of the multidimensional consequences of the disaster scenario on the heritage assets;
- assigning each identified risk (potential impacts) a rating in accordance with the agreed risk criteria (e.g. pre-defined probability and consequence acceptability levels) (EMA 2010, 31).

Evaluating the risks
Comparing the level of risk found during the analysis process with pre-defined risk criteria (established when the context was considered). If the level of risk does not meet risk criteria, the risk needs treatment, i.e. risk control measures (ISO/IEC 2009, 13).

Risk Control

Phase 1: Prevention & mitigation
- reducing risks at source (Stovel 1998, 26); hazard source control and area protection
- reinforcing the ability of a property to resist or contain the consequences of a crisis (Stovel 1998, 26)
- undertaking preventive conservation measures, to prevent/reduce the occurrence of persistent hazards
- raising awareness and appreciation of the values of cultural heritage among community members and the officials involved (Stovel 1998, 29)
- developing, within the community, a good understanding of significant hazards and the related vulnerability of cultural heritage (fostering community vigilance and security). (Stovel 1998, 29)
- procuring funding for preventive conservation measures
- cooperation with stakeholders responsible for territorial planning and environment to implement preventive or mitigation actions/measures

Phase 2: Preparedness
- providing adequate warning of impending emergency (Stovel 1998, 26)
- developing emergency-response plans and ensuring their availability during the emergency (Stovel 1998, 26)
- conduct simulations, training and drills using realistic emergency scenarios (Stovel 1998, 26)
- engage emergency control organizations/task forces via periodic meetings (Stovel 1998, 37)
- secure emergency funding
- ensuring the availability of the required material and human resources during the emergency

Phase 3: Response – Cultural First Aid (ICCROM/The Smithsonian Institution 2015)

Step 1. Situation Analysis (see STORM Glossary)
- nature of the critical event and its causes
Phase + Involved processes/actions
- heritage-specific SWOT analysis
- context and legal framework
- obtaining access
- actors and local capacities
- preparation for deployment

Step 2. On-site Survey (see STORM Glossary)
- initial damage assessment
- priorities for intervention
- risk assessment
- security and stabilization planning
- community consultation & consensus building

Step 3. Security & Stabilization Actions (see STORM Glossary)
- security
- triage & in-situ stabilization (immovable heritage)
- evacuation
- salvage, triage & stabilization (movable heritage)
- full damage assessment & recovery needs
- temporary storage
- preparing for recovery.

Phase 4: Recovery
- conservation and restoration;
- returning salvaged assets (movable heritage);
- lessons learned and build back better efforts to reinstate and enhance preparedness and mitigation measures, including the improvement of contingency policies, plans and programmes;
- informing the public and raising awareness;
- disaster memorialization.

2.2.3 Actors

As pointed out vis-a-vis the Sendai Framework, DRR “is not a sector in and of itself” (UNISDR 2015b, 6), and therefore, in what concerns its application, “It is for policy makers and practitioners to develop and implement sector instruments, policies, programmes, guidelines, standards as well as business practices” (UNISDR 2015b, 6). In the heritage conservation field, this development and implementation of sector instruments, etc. relies on a wide array of relevant actors, whose roles may be described at an institutional or at a professional level.

This chapter attempts to summarily describe these actors and their relevant roles (actual or potential) within heritage DRR, starting with the responsibilities of institutions, and followed by the contributes that different professional profiles may bring to the different DRR phases.

This section is dedicated to the roles that different institutional organizations and professionals can play within DRR initiatives specifically dedicated to the safeguarding of
heritage assets, as shown in the Table 3. Please note that the grouping of institutions below is artificial – for instance, ‘Emergency services’ are evidently (also) ‘Government bodies’ –, as it tried to emphasise the more prominent roles that some institutions are charged with.

Table 3: Roles of institutions in heritage DRR.

<table>
<thead>
<tr>
<th>Actors – Institutions</th>
<th>DRR phase</th>
<th>Main roles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government bodies (sp. policymakers)</td>
<td>RA; RC1; RC4</td>
<td>- Define sector-specific DRR policies and framework; - Ensure and fund research, development and implementation of DRR instruments and strategies; - Articulate DRR strategies with spatial planning policies and sustainability requirements.</td>
</tr>
<tr>
<td>- National/ Central (incl. Ministries of Finance; Interior; Planning; etc.)</td>
<td>RC2; RC3</td>
<td>- Ensure (human and material) resource availability for the emergency phases; - Define emergency protocols, following advice from heritage authorities and civil protection services.</td>
</tr>
<tr>
<td>Heritage authorities</td>
<td>RA; RC1; RC4</td>
<td>- Lobby for heritage DRR funding; - Manage Risk maps for Cultural Heritage; - Advise policymakers on (heritage) DRR strategy development and implementation; - Promote heritage-dedicated DRR research; - Support a paradigm shift towards increasingly prevention-focused approaches to heritage risks; - Define risk assessment guidelines, especially risk criteria, that allow for the prioritization of risk control measures; - Define ‘build-back-better’ guidelines; - Ensure the safeguarding of heritage significance throughout all DRR processes; - Develop and propose regulations and procedures for all the phases of DRR for CH.</td>
</tr>
<tr>
<td>- Regional - Local</td>
<td>RC2; RC3</td>
<td>- Frame and ensure the definition and implementation of emergency/disaster protocols; - Mobilize cooperation with Emergency services.</td>
</tr>
<tr>
<td>Emergency services Civil Protection</td>
<td>RA; RC1; RC4</td>
<td>- Identify, assess and map territorial hazards; - Advise the government/policymakers on DRR strategies; - Advise on ‘build-back-better’ interventions.</td>
</tr>
<tr>
<td>Role</td>
<td>Stages</td>
<td>Responsibilities</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>---------</td>
<td>---------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| **Firefighting corps**                    | RC2; RC3; RC4 | - Cooperate with heritage authorities in the implementation of disaster preparedness protocols, including training on and evaluation of these;  
- Respond to emergencies/disasters;  
- Advise on ‘build-back-better’ interventions. |
| **Heritage community**                    | RC2; RC3 | - Lobby for heritage DRR implementation;  
- Help funding protection efforts (all DRR phases);  
- Assist in response operations within expert-led teams. |
| **Private sector**                        | All     | - Collaborate in the development of coping capacity- and resilience-building tools;  
- Ensure the transfer of knowledge and its practical implementation in the field. (under the guidance of the public sector) |
| **Media**                                 | RC3     | - Ensure communication channels. |
| **Scientific community/Academia**         | All     | - Research and develop the instruments required in the different DRR phases;  
- Advise on ‘build-back-better’ interventions. |
| (heritage-dedicated) NGOs and volunteers   | RC2; RC3 | - Lobby for heritage DRR implementation;  
- Assist in response operations, including damage survey (experts), stabilization, salvage and triage (within expert-led teams). |
| **Site managers (public or private sector)** | All | - Procure funding for DRR development and implementation at site level;  
- Coordinate intra- and inter-agency development and implementation efforts;  
- Manage site-specific DRR efforts, including the definition of risk criteria and the monitoring and critical evaluation of the implemented programmes;  
- Assist emergency services in disaster contexts. |
| **Inter-governmental institutions**       | European Union | All | - Ensure and fund the implementation of DRR and the Sendai Framework;  
- Ensure and fund the protection of European heritage; |
D1.1: Current practice for management and conservation of Cultural Heritage

- Promote collaboration among member states in the heritage DRR sector;
- Ensure the maintenance and ability of the EU civil protection mechanism to operate in the response and recovery of CH;
- Promote volunteer aid programmes for CH.

Promote collaboration among member states in the heritage DRR sector;
Ensure the maintenance and ability of the EU civil protection mechanism to operate in the response and recovery of CH;
Promote volunteer aid programmes for CH.

ICCROM; ICOMOS; UNESCO; UNISDR

- Lobby for heritage DRR implementation;
- Advise governments in heritage strategies;
- Foster and disseminate research and coping instruments;
- Define and promote training and good practices.

Key for DRR phases:
- RA: Risk Assessment
- RC1: Risk Control phase 1: Prevention and Mitigation
- RC2: Risk Control phase 2: Preparedness
- RC3: Risk Control phase 3: Response
- RC4: Risk Control phase 4: Recovery

*The extent of responsibilities of firefighters in operating on cultural heritage buildings during and in the aftermath of disasters may differ depending on the country and be more or less extensive regulations depending on the country

There are many different experts that may contribute within the scope of heritage DRR, depending not only on the type of process in question, but also on the type of heritage object under consideration. The Table 4 non-exhaustively lists the professions most commonly related to heritage conservation and the kind of roles they may play within the risk assessment and control phases.

Table 4: Possible contributes of different areas of expertise to heritage DRR.

<table>
<thead>
<tr>
<th>Actors – Professionals</th>
<th>DRR phase</th>
<th>Main roles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthropologists and Ethnologists</td>
<td>Risk Assessment</td>
<td>- Collaborate in the risk assessment process, namely assisting in significance assessment and community impact analyses, as well as in risk evaluation.</td>
</tr>
<tr>
<td></td>
<td>Risk Control (all phases)</td>
<td>- Support and advise on policy- and procedure-development.</td>
</tr>
<tr>
<td>Archaeologists and Archivists</td>
<td>Risk Assessment</td>
<td>- Collaborate in the risk assessment process, namely assisting in heritage significance assessment and impact analyses, as well as in risk evaluation.</td>
</tr>
</tbody>
</table>
### D1.1: Current practice for management and conservation of Cultural Heritage

<table>
<thead>
<tr>
<th>Actors – Professionals</th>
<th>DRR phase</th>
<th>Main roles</th>
</tr>
</thead>
</table>
| Risk Control (all phases) | - Contribute to the development and/or design of risk control processes and actions;  
- Ensure the preservation of archaeological records and contexts;  
- Support and advise on policy- and procedure-development;  
- Assist in the implementation of risk control processes, including documentation, monitoring and damage surveys. |
| Architects | Risk Assessment | - Collaborate in the risk assessment process, namely assisting in heritage significance assessment and impact analyses, as well as in risk evaluation. |
| Risk Control (all phases) | - Contribute to the development and/or design of risk control processes and actions;  
- Support and advise on policy- and procedure-development;  
- Assist in the implementation of risk control processes, including training, damage surveying, recovery needs assessment, structural intervention design and recovery actions. |
| Art historians & historians | Risk Assessment | - Collaborate in the risk assessment process, namely assisting in heritage significance assessment and impact analyses, as well as in risk evaluation. |
| Risk Control (all phases) | - Support and advise on policy- and procedure-development. |
| Conservator-restorers | Risk Assessment | - Collaborate in the risk assessment process, namely assisting in heritage significance, exposure and vulnerability assessments and impact analyses, as well as in risk evaluation. |
| Risk Control (all phases) | - Contribute to the development and/or design of risk control processes and actions;  
- Ensure the preservation of heritage significance and good conservation practice;  
- Support and advise on policy- and procedure-development;  
- Assist in the implementation of risk control processes, including training, monitoring, documenting, damage surveying, recovery needs assessment, conservation |
<table>
<thead>
<tr>
<th>Actors – Professionals</th>
<th>DRR phase</th>
<th>Main roles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservation-scientists including: physicists; chemists; material scientists; geoarchaeologists; seismologists; etc.</td>
<td>Risk Assessment</td>
<td>- Collaborate in the risk assessment process, namely by conducting research on hazard, exposure, vulnerability and impacts, as well as in risk evaluation.</td>
</tr>
<tr>
<td></td>
<td>Risk Control (all phases)</td>
<td>- Contribute to the development and/or design of risk control processes and actions; - Assist in the implementation of risk control processes, including early warning system design and support; structural, material and environmental monitoring; damage surveying; recovery needs assessment; and support of conservation, restoration and maintenance interventions.</td>
</tr>
<tr>
<td>Firefighters</td>
<td>Risk Assessment</td>
<td>- Collaborate in the risk assessment process, namely assisting in exposure and vulnerability assessments and impact analyses.</td>
</tr>
<tr>
<td></td>
<td>Risk Control (preparedness and response phases)</td>
<td>- Contribute to the development and/or design of disaster preparedness and response protocols and actions; - Assist in the implementation of disaster preparedness and response actions, including early warning system support, training, ensuring personal safety and disaster containment.</td>
</tr>
<tr>
<td>Structural and/or civil engineers</td>
<td>Risk Assessment</td>
<td>- Collaborate in the risk assessment process, namely assisting in exposure and vulnerability assessments and impact analyses.</td>
</tr>
<tr>
<td></td>
<td>Risk Control (all phases)</td>
<td>- Contribute to the development and/or design of risk control processes and actions; - Assist in the implementation of risk control processes, including early warning system support, structural monitoring, damage surveying, recovery needs assessment, structural intervention design and recovery actions.</td>
</tr>
<tr>
<td>Topographers; Photographers; etc.</td>
<td>RA; RC1; RC4</td>
<td>- Assist documentation processes. - Advise on damage survey and monitoring protocols.</td>
</tr>
</tbody>
</table>

(*) A Conservation scientist, generally coming from the natural sciences, is a “professional scientist whose primary focus is the application of specialized knowledge and skills to support the activities of conservation in accordance with a [conservation] ethical code” (AIC
At last, the Table 5 summarizes the possible involvement of both institutions and professionals across the different DRR phases in the context of cultural heritage. It should be stressed that not all actors are (or need to be) necessarily involved in all the DRR phases; this is an indicative list of potential contributors, whose expertise should be sought according not only with the type of heritage asset in question, but also with the specific issues raised within each step of the process.

**Table 5: Distribution of actors' interventions across heritage DRR phases.**

<table>
<thead>
<tr>
<th>Actors</th>
<th>Risk Assessment</th>
<th>Risk Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Risk Control</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Prev&amp;Mitig.</td>
<td>Preparedness</td>
</tr>
<tr>
<td></td>
<td>Preparedness</td>
<td>Response</td>
</tr>
<tr>
<td></td>
<td>Response</td>
<td>Recovery</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Institutions</th>
<th>Risk Assessment</th>
<th>Risk Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polymakers</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Heritage authorities</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Civil Protection</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Firefighting corps</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Heritage community</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Private sector</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Media</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Scientific community</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>NGOs and volunteers</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Site managers</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>European Union</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Intergovernmental orgs.</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Professionals</th>
<th>Risk Assessment</th>
<th>Risk Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Risk Control</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Prev&amp;Mitig.</td>
<td>Preparedness</td>
</tr>
<tr>
<td></td>
<td>Preparedness</td>
<td>Response</td>
</tr>
<tr>
<td></td>
<td>Response</td>
<td>Recovery</td>
</tr>
</tbody>
</table>
2.2.4 Cultural heritage conservation processes

In its widest sense, conservation corresponds to “The process of managing change to a significant place [or object or site] in its setting in ways that will best sustain its heritage values, while recognising opportunities to reveal or reinforce those values for present and future generations” (English Heritage 2008, 71). ‘Managing change’ to heritage assets involves a very widespread range of processes and actions, from Planning to Conservation-Restoration, from Monitoring to Maintenance.

International guidelines today place heritage significance (i.e., the values of the heritage object) at the core of all conservation decisions. While preserving and/or enhancing heritage significance is the chief aim of any conservation strategy, there are internationally agreed ethical criteria that dictate how these strategies/processes/actions should be implemented; conservation principles are consecrated in the relevant international charters (ICOMOS, n.d.; Australia ICOMOS 2013) and in the UNESCO guidelines (UNESCO 2015). Nowadays, the most widely acknowledged ethical criteria for the conservation of cultural heritage include: compatibility; minimum intervention; reversibility/retreatability/removability; discernible restoration; interdisciplinarity; and sustainability (see the STORM Glossary for definitions). Essentially, all the processes and actions described in the next section should be conducted in a way that respects these criteria, as far as they are applicable.

Table 6 describes the various built heritage conservation procedures and actions in terms of: scale of application; main goals, DRR phases where they may become pertinent; whether or
not they imply direct actions on the material; and which heritage actors are involved in their planning and/or execution.

Table 6 is followed by a second table (Table 7) including only the distribution of heritage conservation actions across the DRR-phase spectrum, aiming at a clearer emphasis of this interconnection.

Table 6: Built Heritage conservation processes.

(Key for the used abbreviations at the end of the table)

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Scale</th>
<th>Definition/Main goals</th>
<th>DRR phases</th>
<th>Dir/Ind. action</th>
<th>Involved actors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservation planning</td>
<td>micro, meso &amp;</td>
<td>“development and coordination of conservation measures and actions” (CEN 2011, 14)</td>
<td>RA; RC1; RC2; RC3; RC4</td>
<td>Indir. CR; CS; SM</td>
<td></td>
</tr>
<tr>
<td></td>
<td>macro</td>
<td>and Documentation: (see below)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Documentation</td>
<td>micro, meso &amp;</td>
<td>“recorded information created, collected, held and maintained for the purpose of present and future conservation and for reference, [e.g.] X-radiographs, drawings, photographs, written reports, [digital] files, photogrammetry, laser scanning, [topographic maps], etc.” (CEN 2011, 15)</td>
<td>RA; RC1; RC2; RC3; RC4</td>
<td>Indir. CR; CS; SM</td>
<td></td>
</tr>
<tr>
<td></td>
<td>macro</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Significance assessment</td>
<td>meso &amp; macro</td>
<td>Identifying, locating, understanding and reporting of the values that make up for the cultural significance of an object/site. Steps for this reporting include:</td>
<td>RA; RC1; RC2; RC3; RC4</td>
<td>Indir. CR; CS; SM; Archit.; Archaeol.; other</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- “Define the [object/site] and its extent;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Investigate the [object/site]: its history, use, associations, fabric;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Assess all values using relevant criteria;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Develop a statement of significance.” (Australia ICOMOS 2013, 12)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition survey and reporting</td>
<td>meso &amp; macro</td>
<td>“inspection to assess condition”, including information reporting (CEN 2011, 14).</td>
<td>RA; RC1; RC3</td>
<td>Indir. CR; CS; SM</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investigation</td>
<td>micro, meso &amp;</td>
<td>“gathering of all information necessary for a conservation decision making process” (CEN 2011, 14).</td>
<td>RA; RC1; RC2; RC3</td>
<td>Dir/Ind. CR; CS; SM; Archit.; Archaeol.;</td>
<td></td>
</tr>
<tr>
<td>Procedure</td>
<td>Scale</td>
<td>Definition/Main goals</td>
<td>DRR phases</td>
<td>Dir/Ind. action</td>
<td>Involved actors</td>
</tr>
<tr>
<td>----------------------------</td>
<td>------------------------</td>
<td>---------------------------------------------------------------------------------------</td>
<td>------------</td>
<td>----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>meso &amp; macro</td>
<td>“process of identifying the present condition of an object and determining the nature and causes of any change. as well as the conclusions drawn” (CEN 2011, RC4 15)</td>
<td>RA; RC1; RC2; RC3; CR; CS; SM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety evaluation</td>
<td>macro (structure)</td>
<td>“subsequent [following diagnosis] judgement on the capacity of the structure to resist specific actions such as loads, earthquakes, etc., and the potential risk involved.” (Croci 2000, 7)</td>
<td>RA; RC1; RC2; RC3; CR; CS; SM; EP; CE</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Monitoring: “Process of measuring, surveying and assessing the material properties of objects and/or factors of the environment over time.” (CEN 2011, 11)

| Regular inspections        | meso & macro           | Periodic surveys destined to verify and accompany the conservation condition of the object over time, which may be general and/or target specific locations or situations. | RA; RC1; CR; CS; SM; SSt. |
| Environmental monitoring   | macro (context)        | Setting up and periodic controlling of sensors destined to measure environmental parameters, which can be correlated with the evolution of the conservation condition and/or may function as warning tools (e.g. weather stations; RH/T sensors, etc.) | RA; RC1; RC2; CR; CS; SM; SSt. |
| Structural monitoring      | macro (structure)      | Setting up and periodic controlling of equipment destined to control changes at structural level (e.g. RC2 potentiometric crack sensors) | RA; RC1; RC2; CR; CS; SM; SSt.; EP |
| Surface/materials monitoring | meso                   | Setting up and periodic controlling of equipment destined to control changes at material and/or surface level (e.g. photo or video cameras) | RA; RC1; RC2; CR; CS; SM; SSt. |

(Material) Conservation (conservation in the strict sense): “Actions applied directly to an object to arrest deterioration and/or to limit damage.” (CEN 2011, 11)
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Scale</th>
<th>Definition/Main goals</th>
<th>DRR phases</th>
<th>Dir/Ind. action</th>
<th>Involved actors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restoration</td>
<td>meso</td>
<td>“Actions applied to a stable or stabilized object aimed at facilitating its appreciation, understanding and/or use, while respecting its significance” (CEN 2011, 11)</td>
<td>(RA); RC1; RC4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleaning</td>
<td>meso (materials / surface)</td>
<td>“Removal of unwanted material from an object.” (CEN 2011, 12) N.B.: “The criteria for something being «unwanted» always have to be stated, e.g. potentially damaging, obscuring detail, un-aesthetic, etc.” (CEN 2011, 12)</td>
<td>RC1; RC4</td>
<td>Dir.</td>
<td>CR; SM; CS</td>
</tr>
<tr>
<td>Consolidation</td>
<td>meso (materials / surface)</td>
<td>“Improvement of internal cohesion or mechanical stability, usually involving the addition of material.” (CEN 2011, 12)</td>
<td>RC1; RC4</td>
<td>Dir.</td>
<td>CR; SM; CS</td>
</tr>
<tr>
<td>Mortar repair</td>
<td>meso (materials / surface)</td>
<td>Includes grouting and repointing treatments: Repointing is aimed at “filling the lacunae [including missing joints] and discontinuities of the stone surface […] to reduce the possibility of adhesion of atmospheric particles and the penetration of water and aggressive solutions.” (Lazzarini and Laurenzi Tabasso 1986, 241) Grouting at material/ subsurface level may be aimed at the reattachment of fragments, the consolidation of elements that lost adhesion (Ferragani et al. 1984) and/or the filling of material voids (RILEM TC 203-RHM 2016).</td>
<td>RC1; RC2; RC3; RC4</td>
<td>Dir.</td>
<td>CR; SM; CS</td>
</tr>
<tr>
<td>Surface protection coatings</td>
<td>meso (materials / surface)</td>
<td>Includes the following product categories: “protective water repellents, emulsions, antigraffiti coatings, salt inhibitors, protective oxalate layers, sacrificial lime coatings, colloidal silica, biocides, and bioremediation treatments” (Doehne and Price 2010, 43-44)</td>
<td>RC1; RC4</td>
<td>Dir.</td>
<td>CR; SM; CS</td>
</tr>
<tr>
<td>Reintegration</td>
<td>meso</td>
<td>“Addition of material in order to</td>
<td>RC4</td>
<td>Dir.</td>
<td>CR; SM;</td>
</tr>
</tbody>
</table>
### D1.1: Current practice for management and conservation of Cultural Heritage

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Scale</th>
<th>Definition/Main goals</th>
<th>DRR phases</th>
<th>Dir/Ind. action</th>
<th>Involved actors</th>
</tr>
</thead>
<tbody>
<tr>
<td>on</td>
<td>(materials / surface)</td>
<td>facilitate the perception and understanding of an object” (CEN 2011, 12)</td>
<td>CS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other stabilisation actions</td>
<td>meso (materials / surface)</td>
<td>Actions destined to halt material loss and/or promote the chemical or physical stability of the object. Includes emergency stabilization actions, e.g. facing.</td>
<td>RC1; RC2; RC3; RC4</td>
<td>Dir.</td>
<td>CR; SM; CS</td>
</tr>
<tr>
<td>Structural conservation interventions: actions destined to stabilize or otherwise prevent or halt deterioration in site elements that have a structural role.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retrofitting macro (structure)</td>
<td>“Reinforcement or upgrading of existing structures to become more resistant and resilient to the damaging effects of hazards.” (UNISDR 2009, 25)</td>
<td>RC1; RC2; RC4</td>
<td>Dir.</td>
<td>CE; CS; SM</td>
<td></td>
</tr>
<tr>
<td>Structural stabilization – permanent</td>
<td>Structural stabilization actions may include grouting; stone replacement; or reinforcing of structural elements. (Structural/Core) grouting in particular corresponds to the “introduction of a binding agent in the form of liquid into masonry or soil” (Ashurst 2006, 26) for fabric consolidation.</td>
<td>RC1; RC2; RC3; RC4</td>
<td>Dir.</td>
<td>CE; CS; SM; EP (RC3)</td>
<td></td>
</tr>
<tr>
<td>Structural stabilization – temporary</td>
<td>Includes temporary shoring/propping for the support of unstable elements; or the application of revetments, e.g. sandbags.</td>
<td>RC2; RC3</td>
<td>Dir.</td>
<td>CE; CS; SM; EP</td>
<td></td>
</tr>
<tr>
<td>Stabilisation of surrounding contexts</td>
<td>Actions destined to mitigate the impact of chemical and/or physical pressures caused by environmental or other context factors.</td>
<td>RC1; RC2; RC4</td>
<td>Indir.</td>
<td>CE; CS; SM; EP</td>
<td></td>
</tr>
<tr>
<td>Rehabilitation macro (structure)</td>
<td>“Interventions on an immovable object in order to recover an inferred earlier functionality, to adapt it to a different function or to standards of comfort, safety and</td>
<td>RC1; RC4</td>
<td>Dir.</td>
<td>Archit.; CE; CS; SM</td>
<td></td>
</tr>
<tr>
<td>Procedure</td>
<td>Scale</td>
<td>Definition/Main goals</td>
<td>DRR phases</td>
<td>Dir/Ind. action</td>
<td>Involved actors</td>
</tr>
<tr>
<td>-----------</td>
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<td>----------------</td>
</tr>
<tr>
<td>Building of macro protective structures</td>
<td>Building of structures destined to shelter and/or otherwise protect objects from given external degradation factors.</td>
<td>RC1; RC2; RC3; RC4</td>
<td>Indir.</td>
<td>Archit.; CE; CS; SM</td>
<td></td>
</tr>
<tr>
<td>(Physical) macro Reconstruction (structure)</td>
<td>“Re-establishment of an object to an inferred earlier form using existing or replacement material”, in a way that respects the significance of the object.</td>
<td>(CEN 2011, 13)</td>
<td>Dir.</td>
<td>CR; Archit.; CE; CS; SM</td>
<td></td>
</tr>
<tr>
<td>Maintenance: “Periodic preventive conservation actions aimed at sustaining an object in an appropriate condition to retain its significance.”</td>
<td>“measures and actions aimed at avoiding or minimizing future damage, deterioration and loss and, consequently, any invasive intervention”</td>
<td>(CEN 2011, 11)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water access control</td>
<td>Implies the regular maintenance of drainage systems; coverings (e.g. roofs); etc.</td>
<td>RC1</td>
<td>Dir/Ind.</td>
<td>SM; SSt.</td>
<td></td>
</tr>
<tr>
<td>Biological control</td>
<td>Regular control of biological colonization, including the growth of higher plants, and other infestations, including those of animal origin, e.g. wasps.</td>
<td>RC1</td>
<td>Dir.</td>
<td>CR; SM; SSt.</td>
<td></td>
</tr>
<tr>
<td>Maintenance cleaning</td>
<td>Periodic removal of unwanted deposits before they accumulate and/or become excessively adhered.</td>
<td>RA; RC1; RC2; RC3; RC4</td>
<td>Dir.</td>
<td>CR; SM; SSt.</td>
<td></td>
</tr>
<tr>
<td>Extraordinary maintenance</td>
<td>Minor stabilization actions, including localized consolidation and/or mortar repairs, found necessary following periodical inspections.</td>
<td>RC1; RC2</td>
<td>Dir/Ind.</td>
<td>CR; SM; SSt.</td>
<td></td>
</tr>
<tr>
<td>Environmental control</td>
<td>“management of one or more factors of the environment [including] temperature, relative humidity, light, pollution, etc.”</td>
<td>(CEN 2011, 13)</td>
<td>Indir.</td>
<td>CR; CS; SM; SSt.</td>
<td></td>
</tr>
</tbody>
</table>
### Abbreviations key:

**DRR stages abbreviations:**
- RA: Risk Assessment
- RC1: Risk Control phase 1: Prevention and Mitigation
- RC2: Risk Control phase 2: Preparedness
- RC3: Risk Control phase 3: Response
- RC4: Risk Control phase 4: Recovery

**Involved actors’ abbreviations:**
- Archaeol: Archaeologists
- Archit: Architects
- AT: Art Historians
- CE: Conservation engineers (structural, civil, etc)
- CR: Conservator-restorers
- CS: Conservation scientists
- EP: Emergency Professionals (Civil Protection and Firefighters)
- SM: Site manager(s)
- SSt: Site Staff

*Please note that Site Managers and Site Staff may have different qualifications, but their reference here implies that they will be trained in a heritage-related area e.g. Archaeologists, Architects, Art Historians, Conservator-restorers, Archivists, etc.*

### Table 7: Distribution of conservation processes across DRR phases.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Risk Assessment</th>
<th>Risk Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>P&amp;Mitigat.</td>
</tr>
<tr>
<td>Conservation planning &amp;</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Documentation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Documentation</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Significance</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>assessment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition survey and</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>reporting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investigation</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Diagnosis</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Safety evaluation</td>
<td>macro (structure)</td>
<td>X</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-------------------</td>
<td>---</td>
</tr>
<tr>
<td>Maintenance planning</td>
<td>micro, meso &amp; macro</td>
<td>X</td>
</tr>
<tr>
<td>Monitoring</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Regular inspections</td>
<td>meso &amp; macro</td>
<td>X</td>
</tr>
<tr>
<td>Environmental monitoring</td>
<td>macro (context)</td>
<td>X</td>
</tr>
<tr>
<td>Structural monitoring</td>
<td>macro (structure)</td>
<td>X</td>
</tr>
<tr>
<td>Surface/ materials monitoring</td>
<td>meso</td>
<td>X</td>
</tr>
<tr>
<td>Conservation &amp; Restoration</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Cleaning</td>
<td>meso (materials/surface)</td>
<td>X</td>
</tr>
<tr>
<td>Consolidation</td>
<td>meso (materials/surface)</td>
<td>X</td>
</tr>
<tr>
<td>Mortar repair</td>
<td>meso (materials/surface)</td>
<td>X</td>
</tr>
<tr>
<td>Surface protection coatings</td>
<td>meso (materials/surface)</td>
<td>X</td>
</tr>
<tr>
<td>Reintegration</td>
<td>meso (materials/surface)</td>
<td>X</td>
</tr>
<tr>
<td>Other stabilization actions</td>
<td>meso (materials/surface)</td>
<td>X</td>
</tr>
<tr>
<td>Structural (conservation) interventions</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Retrofitting</td>
<td>macro (structure)</td>
<td>X</td>
</tr>
</tbody>
</table>
### D1.1: Current practice for management and conservation of Cultural Heritage

<table>
<thead>
<tr>
<th>Structural stabilization – permanent</th>
<th>structural (macro)</th>
<th>X</th>
<th>X</th>
<th>X</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural stabilization – temporary</td>
<td>structural (macro)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Stabilization of surroundings</td>
<td>structural (macro)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Rehabilitation</td>
<td>structural (macro)</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Building of protective structures</td>
<td>structural (macro)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>(Physical) Reconstruction</td>
<td>structural (macro)</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Maintenance &amp; Preventive conservation</td>
<td>m(eso &amp; macro)</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water access control</td>
<td>m(eso &amp; macro)</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biological control</td>
<td>m(eso &amp; macro)</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance cleaning</td>
<td>m(eso (materials/surface))</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extraordinary maintenance</td>
<td>m(eso &amp; macro)</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental control</td>
<td>structural (macro)</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3 Current status of Cultural Heritage management and conservation against natural hazards

3.1 Background

Cultural heritage assets are constantly exposed to natural hazards and, in case of disasters, they could be completely destroyed or severely damaged: their loss impoverishes and diminishes us.

The world's attention to the problems of cultural heritage in relation to the disaster was always connected to the emotional impact consequent to the catastrophe, but often, superseded the first phase, the problem becomes secondary and the damage to CH requires a lot of years to be restored.

Ensuring the safety of people and the well-being of survivors is the top priority when disaster strikes. Clearly, saving and protecting CH became secondary in the scale of priorities.

In EU, many Countries have vast and ancient heritage, but it may be seriously threatened by obliteration in disasters such as earthquakes, floods, storm, warfare, etc. The damage may be extraordinarily expensive to restore, and the technical challenge of doing so may vary from substantial to insuperable. Despite the growing interest in CH safeguard, it is often the “poor relation” in emergency planning; seldom mentioned, rarely treated systematically and with inadequate economic resources (Crue and Clark 2010; Spennemann 1999).

For example, in Italy, a country characterized by an extraordinary and unparalleled heritage, natural disasters have always stirred the conscience and interest had been growing in the study and risk mapping. In particular, some extraordinary events caused necessarily a great mass reaction in favour of salvage and renewed conservation. As example of this assessment, it can be cited the exceptional flood that affected the city of Florence in November, 1966, whose anniversary occurred just last year. This flooding event led to the submersion of thousands of rare and precious ancient manuscripts and books in the National Archives and Library. In that situation, thousands of volunteers from different Italian regions, especially young people, helped in saving the extraordinary book heritage.

Therefore, if we assume the risk of CH loss as a criterion for identifying the operational priorities, the knowledge of its distribution throughout the countries is useful and necessary for the planning of measures for the protection, conservation and land use.

The opportunity to have a mapping of the risk level becomes so a synthetic way to gather this important information imperative for guarantee the life of CH assets. A risk map can be considered a valid mean to plan activities related to CH protection and safeguard. The technology of Geographic Information Systems (GIS) is now the most suited to achieve this goal, because it makes possible the visualization and analysis of natural phenomena (such as geological, earthquakes, floods, etc.) in cartographic form, and it allows to produce an updated map of the loss risk for national cultural heritage.

Moreover, there exists no established universal documentation protocol/system for cultural heritage, so, as part of the development of European-level integrated documentation protocols, a survey of existing documentation protocols will be presented on what was
performed to assess the current state-of-the-art in this field. A recent European project, EU-CHIC project, studied twenty-three information systems from eleven European countries.

Brief indication of Documentation Protocols produced in some EU countries can be listed as follows:

**Greece:** National Archive of Monuments Information System (POLEMON). Ministry of Culture / Directorate of Byzantine and Postbyzantine Monuments: ARCHIMED.

Risk Map of cultural heritage and mapping and description of cultural landscape Ministry of Culture: Technical Reports for museum interventions, extensions, upgrades or new buildings Acropolis Restoration Service (YSMA)

**Portugal:** IHRU and former IGESPAR (five volumes of the Kits)

**Spain:** Ficha de Patrimonio Etnológico en Castilla y Leon; Inventario de Patrimonio Industrial de la Provincia de Valladolid

**Germany:** ADABweb – Allgemeine Denkmaldatenbank

**Belgium:** VIOE – Vlaams Instituut voor het Onroerend Erfgoed; Database of Cultural Heritage in the Brussels Region; Database of the Cultural Heritage in the Walloon Region; Monumentenwacht Vlaanderen; Cities of Bruges and Antwerp: Inspection of the buildings owned by the - heritage and others – aiming at the maintenance of these buildings; Ministry of Education of the Flemish Government: Methodology for the inspection and evaluation of the condition and the maintenance of school buildings.

Data about cultural heritage are collected, managed and presented by many different institutions and associations with various purposes, range of coverage and level of details. International perspective is important in research and development, coordination of activities and standardisation. The international view about safeguarding approaches is interesting in comparison to the current administrative approaches from the national information systems and databases.

A list of some relevant EU projects focused on CH protection and valorisation is shown in Table 8.

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1 EU-CHIC Project website: http://www.eu-chic.eu/
2 Acropolis Restoration Service (YSMA): http://www.ysma.gr
4 ADABweb: http://www.denkmalpflegebw.de/denkmale/datenbanken/adabweb.html
5 VIOE – Vlaams Instituut voor het Onroerend Erfgoed: www.vioe.be
6 Database of Cultural Heritage in the Brussels Region: www.irismonument.be
7 Database of the Cultural Heritage in the Walloon Region: mrw.wallonie.be/dgatlp/ipa/
8 Monumentenwacht Vlaanderen: www.monumentenwacht.be
In Italy, recently the ICCD (Istituto Centrale per il Catalogo e la Documentazione, Central Institute for Cataloguing and Documentation) has launched SIGEC WEB project whose primary objective is to ensure availability of the necessary technological infrastructure to all bodies that operate in the sphere of cultural heritage (http://www.iccd.beniculturali.it/index.php?en/221/sigec-web-project).

Based on the data provided by the delivery “D2.1: State of the art policies on government of Cultural Heritage against natural disasters and climate changes” responsible partner: DGPC (General Directorate for Cultural Heritage) it can be derived that governments have not specific laws requiring the creation of “CH protection plans” against natural disasters.

In Italy and in other European countries, governments have, in some cases, only issued "guidelines" relating to individual CH classes and concerning a limited number of NH, in particularly floods and earthquake. Therefore, it is crucial to understand which are the current practices, usually applied by conservators of cultural heritage, and the relative theoretical base.
In fact, as revealed by an initial investigation made by the Tuscia team, it emerged that the search of a practice for the CH preservation is often linked to the sensibility and risk perception felt by the peripheral protection organisms of the Ministry.

As expected, in the absence of precise legislation setting out the actions to be taken, the protection against natural disasters is being addressed in practice with different ways referring to the nature of CH assets, their construction techniques, materials, and finally to their geographical location.

Basically, the design of a protection plan against natural disaster is implemented by the assigned personnel operating on the base of personal theoretical knowledge, and often using the environmental risk studies developed for other sectors such as economy, industry, landscape conservation, etc.

The first step to design a protection plan against natural disaster is risk perception: if one does not become aware of the potential risk exposure of the CH, one is not able to preserve it.

This simple assumption plays an important role in the challenge for the protection of CH.

The perception that the Tuscia team had during the research of information on current practices, (based on bibliographical studies, interviews, questionnaires, etc.) is that a real awareness of the problem of risk assessment is now well established.

But, this situation often does not correspond to a real planning for the protection against natural disasters, except in some cases of "best practices", which will be discussed later.

To find the causes of this dichotomy is very complex: on one hand, the staff involved in the protection of the CH has usually a high professional profile, on the other hand, this staff has limited financial resources to be invested in research for risk management. The funds allocated by the governments are often barely sufficient to perform ordinary functions.

Another relevant problem is the low rate "connection" between the actors operating in CH assets and institutions/organizations that deal with seismic, environmental monitoring, climate, etc.

Only in a few cases, and at local or regional scale, there is an established network for data monitoring and transmission in real time.

In current practice, for example, a weather alert is issued by the central unit to the peripheral in the imminence of the event if it involves a wide geographical area. It follows that in the absence of real time data, in a CH site it is impossible to promptly intervene for risk mitigation.

From the information gathered by Tuscia team it has been also deduced that in current practice, even if the alert is promptly provided, sometimes a lacking of both plan and means to deal with the impending calamity occur.

In real cases, there is not a unified coordinated plan involving all stakeholders interested in protection of CH. Often planning is developed on a regional basis, or even local, and is linked to the protection of artifacts with great value and importance such as famous archaeological sites, specific relevant collections, important museums, archives, art galleries, etc.
D1.1: Current practice for management and conservation of Cultural Heritage

The perception is that the theory is known by all the actors, (thanks to the outreach work done by European and national bodies), but the implementation of a plan for risk prevention connected to NH, it is often not considered.

Risk perception in CH is rated on a solid theoretical basis (derived from other disciplines) that we will try to shortly summarize here.

It should be stressed that the task on risk assessment and management strategies will be widely developed by WP.5 (Task 5.1 Risk assessment and management methodologies). In the present document only a brief description will be supply about current practices adopted, in case of legislative gap, to define the knowledge instruments used by actors involved in CH safeguard to perceive the risk and to react practically.

Risk management is the identification, assessment, and prioritization of risks followed by the coordinated application of resources to minimize, monitor, and control the impact of unfortunate events (Douglas 2009).

According to the standard ISO 31000 Risk Management – Principles and guidelines on implementation (2007), written by the International Organization for Standardization, “the implementation of risk management will depend on the varying needs of a specific organization, particular objectives, context, structure, products, services, projects, the operational processes and specific practices employed”. Standard ISO 31000 (2007) establishes some principles for managing risk in a way that is more effective, as follows:

- Risk management should create value to the organization: contributes to achievements of objectives, improvement and reputation;
- Risk management should be an integral part of organizational processes;
- Risk management should be part of decision-making;
- Risk management should explicitly address uncertainty;
- Risk management should be systematic and structured;
- Risk management should be based on the best available information;
- Risk management should be tailored: flexible and adaptable to different situations;
- Risk management should take into account human factors;
- Risk management should be transparent and inclusive: involving all stakeholders and right holders;
- Risk management should be dynamic, iterative and responsive to change;
- Risk management should be capable of continual improvement and enhancement (ISO 31000, 2007: 2).

Even though risk management process is well defined and used in several areas such as finances and industry, cultural heritage has approached only partially to risk management. Logically, the existence of an International Standard - ISO constitutes a useful support tool, being the base for the process proposed by ICCROM and UNESCO in their international workshops (ICCROM & UNESCO: Preventive Conservation Of Collections In Storage 2009). However, it is still the challenge of the real application to CH worldwide.

---

9 The work under this task will focus on the analysis and specification of monitoring and decision making services for designing effective management, surveillance, and restoration actions in cases of natural, environmental disaster or climate change in the proximity of an archaeological site.
As emerged from this short premise, risk identification, considered as part of the CH safeguard process, is a very articulate and complex topic. In fact, the identification of risk requires knowledge of a number of processes related to various scientific fields, and therefore it is essential a multidisciplinary approach to the problem.

### 3.2 Current approaches in conservation

The approach to the evaluation of risks for CH may be defined as the correlation between the identified hazards, according to the geographic and environmental specificities of heritage assets, and the detailed analysis of their vulnerability (building materials and building structure conservation state) (Stovel 1998; Accardo et al. 2003; Mazzolani 2010; Kioussi 2013a).

So, in general terms, the risk management of CH clearly involves the field of conservation in all its processes (planning, monitoring, maintenance, prevention and restoration) and the coordination among various staff members and departments responsible for managing the property as well as contact with outside agencies and experts in relevant fields (UNESCO et al. 2010; ICOMOS 2014). In fact, for the future a further integration of the conservation profession into wider emergency planning networks will be imperative to ensure greater resilience, responding to the call for closer collaboration and better integration of communities in disaster risk reduction (Macalister 2015).

In order to achieve this goal it is important to ensure complete survey and recording, and detailed inspection and understanding of CH asset, as well as its structural system and constructional materials and techniques, its evolution and history and its conservation.

Good maintenance is the single most effective means of reducing the amount of potential damage or loss (EN 13306, 2001). Therefore, it is essential that quality maintenance work, undertaken on a periodic basis after regular inspections and employing traditional and compatible techniques and materials, be advised and specified.

Concerning visual inspection and condition survey in CH, the CEN standard 346 (standardized condition survey) has been developed with the main objective of drafting standards which will help conservation professionals in their restoration and conservation work, ensuring at the same time the possibility for European experts to exchange information on test and analyses methods on CH assets. CEN 346 scope is the characterisation of materials, the processes, practice, methodologies and documentation of conservation of tangible cultural heritage to support its preservation, protection and maintenance and to enhance its significance. It includes characterisation of deterioration processes and environmental conditions for cultural heritage and the products and technologies used for the planning and implementation of their conservation, restoration, repair and maintenance. In this regards, the standard NEN 2767 (standardized condition survey and monitoring) has been also developed in the Netherland (NEN 2767, 2006).

Monitoring procedures should be adopted in CH sites in order to evaluate the potential risk factors affecting structures and materials. Risk of decay and damage associated with CH assets can not limited to certain environmental dangers, static/structural, human impact and natural hazards, but is also a function of various other factors such as the conservation state of the materials, the importance and distribution of cultural heritage, the impact factor of the hazards, various socioeconomic parameters etc. (Kioussi et al. 2013a). The deteriorating
D1.1: Current practice for management and conservation of Cultural Heritage

processes in materials and structures may be triggered by external influences or caused because of internal chemical and/or physical time-depending variations of characteristics of material. Therefore risk assessment should be dealt in the direction of revealing the specific active decay mechanism with an integrated study that should consider the type of decay and damage and the decay phenomenon mechanisms (kinetics, thermodynamics, structural) (Moropolou et al. 2012; Kioussi et al. 2011).

A prerequisite for risk identification is the existence of an organised source of reliable, comparable and interoperable data about heritage assets under observation. In this framework the identification and analysis of risks regarding degradation processes for the development of qualitative and quantitative indicators can be supported by integrated documentation (Kioussi et al. 2013a).

Integrated documentation protocols assist proper data collection, classification and presentation, enable understanding and knowledge on the heritage assets, including their history, state of conservation, structural condition, all previous restoration works, risks identification and assessment of its vulnerability by environmental and human impact, monitoring and systematic reporting on alterations taking place during the entire lifetime of assets (Kioussi et al 2013b).

Monitoring is fundamental and imperative practice for risk evaluation and prevention (Boersma 2016; Camuffo 1998; Camuffo Fassina and Havermans 2010; Zehnder 2007). Monitoring can be performed by means of different kind of instrumental solutions whose choice is made according to the parameter that has to be monitored and to the economic requirements.

Advanced diagnostics should be part of the integrated documentation protocols. It can provide the guidelines for revealing the actual degradation processes responsible for the asset’s vulnerability, and also satisfy the necessity for quality control application in building and conservation materials and structures, in order to minimize structural faults, and enhance effectiveness of conservation works (Binda, et al 2000; Pelosi et al. 2013). Different kinds of scientific methods can be applied to investigate the materials of CH and so the possible risks for each of them due to natural hazards. The use of these methods is today a consolidated practice in CH and it allows defining the degradation phenomena and their distribution as function of the potential natural and anthropogenic risks. CH assets may be considered as systems in a dynamic equilibrium with the environment, so the scientific methodologies have the task to monitor the parameters that could affect materials in order to avoid or mitigate surface or structural modifications.

The most used instruments for monitoring the environmental indicators are certainly data logger (Lo Monaco et al. 2012) and sensors (Agbota et al. 2014; Pezzati 2014) that could register continuously different kinds of parameters such as relative humidity (RH), temperature, vibrations, air currents, etc. The European Committee for Standardisation (CEN), Technical Committee for Cultural Heritage (TC346), established different standards concerning temperature and RH for conservation (Alcantara 2004): - EN 15757:2010. “Conservation of cultural property. Specifications for temperature and relative humidity to limit climate-induced mechanical damage in organic hygroscopic materials”;
Moisture content in CH materials is also an important parameter to be monitored and different kinds of procedures and instruments are usually adopted, such as oven-dry weighing, calcium carbide pressure, conductive, capacitive, microwaves, equilibrium relative humidity (Camuffo and Bertolin 2012). Recently, CEN/TC 346 developed a new standard for moisture content in CH materials in immovable assets (EN 16682, 2017). This European Standard is aimed to inform and assist users in the choice and use of the most appropriate method to obtain reliable measurements of the moisture content, or water content, in wood and masonry (including brickwork, stonework, concrete, gypsum, mortars, etc.) in the specific case of the built cultural heritage.

The analysis of the state of conservation relates to all data regarding the diagnosis of the CH decay using visual observations, non-destructive techniques, a large array of analytical techniques, GIS decay mapping, etc., both on structural and decorative parts of the site. Information on the decay forms and mechanisms as well as on the vulnerability diagnosis are also collected and stored to complete assessment of the overall state of preservation. Implementation and analysis of a typical diagnostic study and a structural analysis will reveal the main risks affecting the heritage asset to be subsequently processed in order to result into risk indicators (Kioussi et al. 2013b; ICOMOS 2008).

Considering a possible integrated approach for advanced diagnostics in CH assets, addressed to investigate materials, construction techniques, state of conservation with the aim at supplying a base of data fundamental for risk prevention, a list of protocols can be reported as current practices in CH (Figure 1).
Monitoring and diagnostics are widely used as tools for gathering knowledge of materials, state of preservation, degradation phenomena, and environmental characteristics. In this regards, a lot of papers can be found in different kinds of scientific journals. However, the results of these actions (monitoring and/or diagnostics) are often not used for real risk assessment and prevention (Apollonia et al. 2010). This is also due to the lack of a specific law imposing to the Superintendence or to the stakeholders involved in the management of CH assets to perform monitoring and diagnostics for prevention and risk assessment.

But, in this contribution, some cases of best practices in monitoring, diagnostics and application of solution for mitigating or preventing the risks will be reported (see par. 5.1).

A monitoring program should usually start from visual inspection carried out periodically. A written report must be filled for each inspection to supply the conditions of structures, materials and in general of CH asset. Condition surveys can provide baseline data or a “snapshot” of condition at one point in time, and this data can then be used to effectively allocate resources going forwards.

Following the great work made by Tuscia team for collecting information about current practices in monitoring (interviews and questionnaires by several Superintendencies from different Italian regions and from the European partners of STORM project), it can be derived that visual inspection is usually performed in CH assets and can be considered as a regular procedure in Italy and in other European countries. Generally, visual inspection is performed...
quarterly, half-yearly and also weekly according to the monitored risk and to its potential influence on CH assets.

Visual inspection is recorded by a written report usually accompanied by photographic documentation. Inspection is usually performed by functionaries responsible of the CH asset. These may be architects, archaeologists, art historians, restorers, conservators with the aid and support of technical assistants.

In some cases, also instrumental monitoring is performed. In these cases, the monitoring is carried out both continuously and occasionally. In fact, the use of instruments such as data loggers and sensors for monitoring climatic and microclimatic parameters is sometimes limited to short periods because it has been required to monitor specific problems highlighted during visual inspections such as water infiltration, soluble salts evidence, cracks formation, detachments, and so on.

At last, concerning the prevention linked to monitoring and diagnostics of CH asset, it can be summarized that the following steps are usually performed in the current practices:

- visual inspection accompanied by written reports and photographic documentation, generally performed by institutional officers responsible for the CH assets;
- monitoring of climate and microclimate by different kinds of instrumental systems (data loggers, sensors, climatic stations), generally made by external subjects (universities, research centers, private societies and professionals);
- monitoring of water content and distribution in the structures and materials (gravimetric and psychometric measurements, thermography methods, wireless sensors), usually performed by external subjects (universities, research centers, private societies and professionals);
- monitoring of structures with new generation sensors (Mecocci and Abrado 2014), usually carried out by external subjects (universities, research centers, private societies and professionals);
- diagnostic campaigns aimed at investigating the composition of constituent materials and their state of preservation. Usually, this step is performed on the occasion of restoration activities but is not imposed by regulations and it is made by external subjects (universities, research centers, private societies and professionals);
- application of non-destructive testing for evaluating the structure stability, usually made by external subjects (universities, research centers, private societies and professionals).

Between the processes involved in conservation, maintenance is a well-established activity.

Concerning maintenance and the conceptual links that define it, in-depth studies and experiences made available the necessary grants to conceive maintenance not just as a preventive definition of an abstract model, but as a pragmatic possibility, finding effective answers to the problems of our cultural heritage.
It is more than forty years ago, that Italian Franceschini Commission\(^{10}\) affirmed that the application of intelligent preservation could only start from a careful analysis of the conditions of cultural heritage, considered as inseparable from their context, anticipating the need for a systemic and process-based view of all issues involved (Cecchi 2006; Gasparoli 2012).

Degradation and instability events, which are frequently observed on assets, can spring from the lack of a systematic maintenance that needs to be seen as a priority in the conservation of cultural heritage. As highlighted by Cecchi and Gasparoli (2010), the reasons of special decrees, such as that of Italian Prime Minister Council (May 2009) about the “realization of urgent required interventions for the overtaking situation of great risk about archaeological sites of Rome and Ostia Antica” have to be found, first of all, in the absence of a culture of systematic maintenance, that is the main guarantee of CH conservation. The reasons to promote prevention activities of the deterioration phenomena with programmed controls and maintenance works, instead of more damaging intervention of restoration, in particular on structures exposed to atmospheric and human agents, like archaeological sites, are well-known and widely shared (Cecchi and Gasparoli 2010).

UNESCO also underlines the importance of maintenance in CH assets. In fact, UNESCO recommendations affirm that member states must provide the opportunities for development and education to the staff that will deal with cultural heritage protection, and promote their cooperation with various disciplines (as stated in the 1972 Recommendation Concerning the Protection and in the 2011 Recommendation on the Historic Urban Landscape). It is important that they develop techniques that ensure the long-term protection of cultural heritage authenticity. UNESCO advocates regular maintenance, which is usually cheaper than the major repairs that the member states would have to carry out if they simply left their heritage to decay. Member states must use various measures to protect heritage against external impacts, both natural and anthropic. National and local authorities should allocate funds for maintaining and conserving cultural heritage, as well as promote the development of cultural heritage in a traditional but economical way. UNESCO also supports the inclusion of private investors in development and conservation projects.

In Italy, after the war, Cesare Brandi introduced the concept of "preventive restoration" (Brandi 1977, 53-61), while Giovanni Urbani with his "Pilot Plan for the planned conservation of cultural heritage in Umbria" (Istituto Centrale del Restauro 1976; Zanardi 2000, 105-112) introduced a pioneering vision, taking the concepts already developed by the Franceschini Commission (1964-66). He started from the concept of buildings as complex objects, in relation with the environment. Such vision requires an obvious change of perspective that presupposes to think maintenance as a programmed series of steps planned and activated starting from a general detection of risk factors (Zanardi 2000, 31-35).

The term maintenance, used to indicate consistent and timely activities, is intended as alternative to the restoration applied since the mid-nineteenth century (Ruskin 1849) and in all

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\(^{10}\) Legislation no. 310/1964 instituted an Inquiry Commission for the preservation and valorisation of cultural, archaeological, artistic and landscape heritage. This Commission, known as the Franceschini Commission from the name of its chairman, concluded its work in 1966.
the documents on Restoration. Even in legislation the term generally used is maintenance or scheduled maintenance, starting from the Code of Cultural Heritage and Landscape (D.LGS. n. 42/2004, art. 29): «1. La conservazione del patrimonio culturale è assicurata mediante una coerente, coordinata e programmativa attività di studio, prevenzione, manutenzione e restauro; 2. Per prevenzione si intende il complesso delle attività idonee a limitare le situazioni di rischio connesse al bene culturale nel suo contesto; 3. Per manutenzione si intende il complesso delle attività e degli interventi destinati al controllo delle condizioni del bene culturale e al mantenimento dell’integrità, dell’efficienza funzionale e dell’identità del bene e delle sue parti» [1. The preservation of cultural heritage is ensured through coherent, coordinated and planned activities of study, prevention, maintenance and restoration; 2. Prevention is considered the group of activities which are appropriate to limit risks relating to the cultural heritage in its context; 3. Maintenance is intended as a whole of activities and interventions designed to control the conditions of the cultural property and to maintain its integrity, efficiency and functional identity].

Subsequent legislation, including the most recent one, confirms the terminology significance for maintenance, scheduled maintenance and for maintenance plan: «Il progetto esecutivo deve essere altresì corredato da apposito piano di manutenzione dell’opera e delle sue parti da redigersi nei termini, con le modalità, i contenuti, i tempi e la gradualità stabiliti dal regolamento» [The executive project must also be accompanied by an appropriate maintenance plan for assets and for their parts to be drawn up according to the terms, modalities, contents, timing and established by Regulation] (D.LGS. n. 163/2006 – Code of Public Contracts); «1. Il progetto definitivo, redatto sulla base delle indicazioni del progetto preliminare approvato, studia il bene con riferimento all’intero complesso ed al contesto ambientale in cui è inserito; approfondisce gli apporti disciplinari necessari. Sono documenti del progetto definitivo: m) piano di manutenzione dell’opera e delle sue parti» [1. The final project, prepared on the basis of the indications supplied in the approved preliminary plan, studies the CH with reference to the entire complex and to the environmental context in which it is inserted; it deepens the necessary disciplinary contributions. In the final version of the project the following documents are included: m) maintenance plan of CH asset and of its parts] (D.P.R. 207/2010 – Implementation’s Regulation of D.LGS. 163/2006, art. 243).

It is very difficult to prevent and perform maintenance of cultural heritage sites from being damaged in natural disasters because immovable heritage sites cannot simply be relocated to safer areas. Many historical settlements developed in earthquake-prone areas or along coasts that are threatened by tsunamis. Many were established in landslide-prone areas (Sassa et al. 2005) or in areas threatened by floods. The impacts of natural disasters can be mitigated by reinforcing buildings to protect them against earthquakes, stabilizing unstable slopes to protect them against landslides, and fixing banks, managing watercourses, and building dams to protect areas against floods, but destruction cannot be completely prevented (Migoń 2013, 139–140). One should be aware that “the number and intensity of natural disasters are expected to rise in the course of the climatic changes now being observed on the earth” (Will and Meier 2007, 9).

To this, natural weathering of materials and structures has to be added. Weathering is a natural process that affects cultural heritage over a long period of time. Good examples are the Megalithic Temples of Malta (UNESCO World Heritage Sites) or the Temple of Poseidon near Athens, which were built from limestone, which weathers easily. Salt weathering is also
Current practice for management and conservation of Cultural Heritage

problematic and affects especially the CH assets close to sea. In fact, the wind brings salt from the sea, causing significant weathering of the sandstone buildings.

In spite of this, it is clear that planned preventive maintenance, conceived as a process and implemented according to definite procedures, provides essential elements for conservation and risk prevention and mitigation.

Good practices in CH management, including maintenance, can be found in the literature and are also suggested as high valuable examples easier to understand than good advice (Eppich and Grinda 2015; UNESCO 2012a).

An interesting project, specifically addressed to maintenance, is that illustrated in the Final Report Submitted to Maintain our Heritage by the University of the West of England, Bristol, in 2003 (Maintaining Value project 2003). In this report the it is explained the project Maintain our Heritage (MoH) that, together with a number of project partners won funding under the Department of Trade and Industry’s Partners in Innovation Programme to undertake the first-ever major research programme on the maintenance of historic buildings, entitled Maintaining Value. The research programme was predicated on the idea that systematic maintenance is fundamental to the conservation of historic buildings (“prevention is better than cure”).

Module 1 of the project was devoted to the Best Practice Maintenance Management for Listed Buildings and some case studies, from different European countries are reported as interesting examples of good maintenance procedures in CH.

European Commission, in a recent report (EC 2015), reaffirms the relevance of maintenance in CH assets also in terms of economic impact. Renovation and maintenance represents more than a quarter of the value of Europe's construction industry. It is estimated, for example, that repair and maintenance on historic building stock in England supported 180,000 jobs in 2010. This becomes 500,000 jobs if the indirect effects are included. The property values of residences in historic districts out-perform comparable properties in modern developments. Businesses tend to locate in these areas, as it is easier to attract specialists and expats to live and work in such places. The example of knowledge intensive companies who congregate in culturally rich areas of historic cities is a telling one. These businesses, and others, often seek out historic buildings that can be converted into office space for their headquarters. Cultural heritage thus also enables innovation and enhances the long term competitiveness of the European economy (EC 2015, 7; Ecorys 2012).

Generally, from an operational standpoint, a survey of heritage sites on a territorial scale (Figure 2) and an initial inspection could provide the basis for defining priorities for actions, based on evaluations of the condition and status of each CH asset of historical, artistic and archaeological interest.
The process for the conservation and maintenance of cultural heritage (Gasparoli 2012, 155).

The maintenance process can be divided into routine inspections, scheduled and exceptional interventions specifically designed as function of the asset typology: archaeological sites, museums, outdoor structures, collections, or artefacts stored in confined environments.

The ordinary or programmed inspection is characterized by an approach to the type of CH asset with particular reference to its constituent elements and to the environmental context (confined and unconfined) interacting with the CH.

The visual assessment of CH conditions is therefore based on the assessment of visible or detectable phenomena, and the correlation of these phenomena, understood as responses to certain stresses, to reasonable technical explanations, formulated on the basis of the knowledge on the behaviour of materials, components and structures in CH assets.

Following the great work made by Tuscia team for collecting information about current practices in maintenance (interviews and questionnaires by several Superintendences from different Italian regions and from the European partners of STORM project), it can be that some operations are commonly adopted and so some general lines may be drawn about current maintenance practises.
The visual inspection is considered, in all investigated cases, a basic process for planning maintenance operations. It consists essentially in the observation of the building and its decorative and structural components. The visual inspection is set pointing to the observation and evaluation of the areas or parts (the size could vary depending on the nature of the artifact) considered critical. The result of the inspection allows for defining and planning the activities to be carried out on the CH asset, taking into account the most appropriate modality of maintenance procedures.

The detection of anomalies, not well-defined by human eye observation, requires, where possible, the intervention of technicians and instrumentations able to define the alteration and the possible causes in order to obtain objective information as valid aid for applying the best maintenance practice.

Scheduled Maintenance processes require comprehensive approach in the definition of organizational models, in cognitive and implementation strategies. In a context necessarily multidisciplinary and multidimensional, maintenance can be considered as a discipline characterized by a double task: on the one hand the analytical one, aimed at defining the conditions of CH (conservative status, degradations, etc.) from the other hand to assess the possible risks for assets.

Scheduled maintenance is carried out through a "maintenance plan" that aims to gather and organize technical information, but also to predict, plan and schedule the activities of control and maintenance to be executed according to predefined intervals.

Following the inspection for the detection of faults and degradations, small maintenance works are generally performed in the different sites, if highlighted to be necessary and appropriate for conservative and fruition purposes.

As can be derived by the questionnaires prepared and filled by partners of STORM project, routine maintenance works are usually performed in CH assets both to preserve artefacts and to allow regular fruition.

Routine maintenance of CH located in outdoor environment (mainly archaeological sites and architectural structures) consists of interventions such as mowing, tree/shrubs pruning, removal of stagnant waters, maintenance of paths, controlling of structural elements, consolidating and securing structural parts, and so forth.

Routine maintenance operations are generally performed by private contracting firms engaged according to planned time intervals or to emergency conditions on the base of directives established by the officer responsible of the CH asset.

Major maintenance activities are:

- The monthly removal of deposits in gutters, downspouts, flashings, etc.;
- The half-yearly or annual elimination of abundant humus deposits and weeds by mowing and weeding operations;
- Tree pruning that is mostly done on an annual basis.

During the course of the above activities, the operators have to check the integrity of decorative and structural elements, the absence of solutions of continuity in the critical points of connection between the elements, the adequacy of the slopes towards the conveying systems and the removal of rainwater. If anomalies are observed, extraordinary maintenance
operations should be activated in order to target interventions in correspondence of the detected problems.

Among the routine maintenance activities, it must be included the verification of conditions in funding, both permanent and temporary.

Annually, biennially or rarely sporadically, private contracting firms perform the control of disconnected elements and/or deteriorated parts, the repositioning of dislocated elements, restoring the correct overlap between the elements, the replacement of those severely damaged or missing.

They also usually check the suitability of the protection elements such as covers, sacrifice layers, etc. The operations are carried out under the supervision of a Director of the works and with a technical staff.

Covering structures are expected to carry out not only a protective function – in all cases, primary – but also a supporting function for the fruition of the site by creating a sort of museum in context. However, nowadays, their design and construction present problems that are not easy to solve. Since a covering of this type is a modern structure inserted into an archaeological area, it alters substantially the visual perception of the site and can easily appear extraneous and invasive. Moreover, the functional aspects of these installations, in terms of effective conservation of ancient remains, is not sufficiently taken into account nor is it studied carefully enough during the design phase, where precedence is too often given to the formal creative aspects of the architecture.

Up until a few years ago, the subject of protective coverings on archaeological sites was considered of little interest by archaeologists and architects: the former considered it to be extraneous to their discipline; the latter felt, perhaps, that there was a low level of architectural challenge. In fact, the types of coverings to be seen on archaeological sites range from precarious structures – made with scaffolding tubes and corrugated sheets of various types, installed as provisional works during or immediately after excavation, which finish up by damaging the archaeological remains they are meant to protect – to elaborate constructions where design far outweighs conservation aims. And yet, the problem of covering up remains from the past to preserve them and to protect them from the elements is certainly not new. Some famous examples from the past show how specific structures were built to preserve the memory of places, also enabling people to visit them. Examples include, from the Roman period, Romulus’s hut on the Palatine hill and the Lapis Niger in the Roman Forum, as well as the Church of the Nativity in Bethlehem (Laurenti et al 2013, 141-142).

Overall knowledge of the environmental characteristics of the site and the constituent materials – of which the remains are made – together with the phenomena of their deterioration, constitute indispensable elements in the design of a suitable covering for a particular archaeological context. For some time now, experts have been studying the effects of the physical interaction between the protective structure and the protected archaeological items. Specific studies and experiments have been conducted by ISCR (Istituto Superiore per la Conservazione e il Restauro), in collaboration with other research centres, thanks to special funding. In particular, in 2000-2003, thanks to a partnership with ENEA a research project on protective coverings used on archaeological sites was carried out with some important results: by taking a census of existing coverings, starting with the covering on the Roman villa del
Casale at Piazza Armerina by architect Franco Minissi in 1959 - a project which was supported at the time by Cesare Brandi – basic knowledge on the functionality of protective structures in Italy has been acquired. The general criteria and the main parameters for the design of coverings have been identified, and a digital archive has been inserted on the Geographical Information System of the Risk Map of the Cultural Heritage. No miraculous recipes were discovered, but some guidelines were established, focusing attention on architectural solutions where the geometric conformation and the choice of materials respect the following criteria of minimum interference with pre-existing archaeological features; adequate protection from direct rainfall and other climatic agents; natural illumination; maximum reversibility; efficient system for collecting and draining rainwater; easily adapted to further excavation on the site; absence of greenhouse effect and condensation phenomena thanks to suitable ventilation. The design may include vertical screening on the perimeter sides, in lightweight materials which allow air to pass through, in order to limit the erosive effects of the wind and the circulation of dust and other detritus, and to limit the effects of evaporation on the surfaces of the archaeological remains. Protective coverings are important for the conservation of archaeological remains, not only if they are correctly designed but also if they are properly serviced. Regular maintenance is an essential operation, which must involve all the components of the archaeological area, including heating and air conditioning equipment and the museum’s security systems (Laurenti et al 2013, 142-144).

Among the temporary roofing systems, those related to the operations of temporary reburial can be included. Conservation in situ of archaeological items such as mosaics, plaster works and raw earthworks is problematic since they are more susceptible, because of their material characteristics, to deterioration caused by climatic agents. This fact implies the need to adopt procedures and systems for the temporary reburial.

Such protection systems, which are seasonal or annual and in any case short-term, are used as an instrument of passive conservation and protection. In this field, investigations have been conducted since the 1980s on methods of protection for decorative elements in archaeological contexts. The type of element to be protected, the time span of the re-burial and the presence of other protection systems are the main factors which guide the choice of materials and the type of contact protection.

Studies published over the last thirty years show the use of a wide range of separator materials – such as sheets of polyethylene, wire netting used on worksites, or different types of geo-synthetic materials – applied as protection for mosaic floor conserved in situ, alone or together with inert materials such as sand, *pozzolana*, soil or expanded clay. However, the choice is often dictated by practical considerations (ease of application and removal) with the result that materials and methods of application have often been used that are not really suitable for conservation purposes. Widely used are geo-synthetic materials which were originally developed in the geotechnical engineering field for reinforcing, draining, filtering and protecting structures and other materials.

There are many types of geo-synthetics which differ in the chemical nature of the fibres and their system of aggregation, as well as the thickness of the sheets. Tests were carried out to verify their suitability for conservation in situ bearing in mind the requisites for using these materials to protect archaeological remains, as non-interference with the constituent materials, ease of application, removal and storage; low cost and possibility of reutilisation.
With these aims in mind, the ISCR set up some systems of direct-contact protection at several archaeological sites in Italy and abroad: the Taurine Roman Thermae at Civitavecchia, the Roman Villa at Casignana, the Roman Villa of Faragola at Ascoli Satriano, the Domus dei Coiedii at Castelleone di Suasa, and the site of Tas Silg in Malta. The systems of direct-contact protection were chosen amongst those that were innovative and/or most frequently used in archaeological areas, they were monitored over time in order to observe any changes favoured by the reburial (the microclimate, the biological and chemical values under the reburial system, when possible, were monitored) (Laurenti et al 2013, 145-146).

The tested materials included different geo-textiles (Typar 3337, Reemay 2033, Geodren, Terram 2000, Delta Lite plus, and Goretex 9955N9901). They were used alone, without other elements, or as separators between the archaeological surface and a layer of inert material (expanded clay, gravel, perlite) to protect mosaic floors, located externally or beneath roofing.

Before applying the protection system, the state of conservation was measured, and some conservation actions were undertaken in order to have an objective evaluation of the results after the period of reburial. The most interesting results from the experiments were the following:

- some geo-synthetics (Typar 3337 and Reemay 2033) are rapidly degraded by UV radiation (within the space of a month) and are therefore not suitable for external use unless covered by a layer of inert material;
- some inert materials of the calcareous type (such as globigerina and corallina) are not suitable;
- the increase of humidity in contact with different types of paving surfaces (opus signinum, opus sectile and mosaics with tesserae), is encouraged by geo-synthetics of the felt type when reburied with inert materials;
- the ability of the geo-textile Goretex 9955N9901 to allow the passage of air, used as laminar protection together with barriers against external physical agents (rain, light and atmospheric particles) and to inhibit the growth of biological alterations was verified. On the downside, it has low insulating properties.

Strictly linked to the maintenance may be considered the conservation and restoration topics. The different procedures that are usually involved in conservation and restoration (such as cleaning, consolidation, protection of surfaces, structural interventions, etc.) are performed both as extraordinary and as routine activities. Consolidation of masonry, for example, is a maintenance operation necessary to ensure structural stability to walls and buildings.

The consolidation activities are performed rarely, despite their importance in order to prevent collapse in the event of natural disasters. The motivation lies in the fact that their implementation requires a higher cost than other routine maintenance practices. If expenses for consolidation are not covered in the budget for current year, they are performed rarely or in cases of exceptional events. Consolidation of the walls can be considered as a maintenance procedure adopted for securing these structural parts of the CH assets in order to prevent flaking, fallings, and other damages of structural and non-structural elements. Consolidation is usually performed by professionals specialized in restoration, under supervision of an officer appointed by the superintendence.
The maintenance of collections and artifacts stored in museums is closely related to that established by the rules on conservation and restoration of cultural heritage and in particular the activities related to the monitoring and control of environmental conditions.

The responsibility of caring artifacts stored indoor spaces, is done by qualified and experienced personnel which also provides for the identification of environmental measures and capital equipment necessary to ensure and make the security and integrity of artifacts.

The current practice of mainly of visual inspection with particular reference to the identification of anomalies on the state of conservation of the cultural heritage which cannot be separated from the verification of the instruments used for the control of:

- surface and air temperature
- relative humidity (RH) and mixing ratio (MR), dew point (DP) and dew point spread (DPS)
- atmospheric stability
- direct (and possibly diffuse) solar irradiation falling on the monument surface at different exposures and during the yearly cycle
- micro ventilation at several points near the artifact surface
- dust and pollution deposits
- insect pest

The above mentioned parameters are generally strictly monitored according to programs related to the conservation practices of stored objects in museums or in other indoor spaces. The identification of abnormalities leads to the activation of extraordinary maintenance plans.

Many other controls are envisaged in the contracts for the maintenance facilities outsourced to specialized companies. Some others eventually are covered by means of “orders of service” for staff members at different levels: these controls become part of the ordinary duties for the different employees working in the CH assets.

Each museum, starting from the characteristics of the structure and paying attention to its weakest points, generally perform periodic checks - daily, weekly, monthly, quarterly, semi-annual, annual – necessary for adopting prompt actions to repair, replace, improve, adjust (if new rules dictate), complete plants and facilities.

Extraordinary maintenance is considered as a set of practices and processes to be activated after the identification of critical issues generated by exceptional events related to natural and anthropic hazards. In these cases, the common practice concerns the activation of emergency procedures to face and solve the observed conservation problems.

The last part of this long introductory paragraph will be devoted to show the data obtained from a survey and analysis of current practices, procedures and the state of art about CH protection against ND and climate change. The information has been taken from bibliographical research, in institutional websites, direct interviews to national administrations.
and other governmental entities and also from of the questionnaires specifically produced for the cultural heritage protection actors (T1.1 Questionnaire)\(^{11}\).

From the evaluation of the data gathered by the survey performed as above explained, it emerged that the issue of protection of cultural heritage from natural hazards and disasters has not been properly discussed either in EU legislation nor in national laws, by-laws and other documents, except in few countries.

There are several reasons for this. One is that many well-designed and well-functioning prevention and emergency measures that are effective in saving human lives completely fail to protect cultural heritage assets. Moreover, effective risk management of cultural assets is rare because failure to calculate the true cost of loss and damage, at last inadequate maintenance of old buildings and materials has raised the extent of the damage in other disastrous events, mainly, earthquakes, storms, etc. Natural disasters generate loads which are not sufficiently familiar to engineers, and CH professionals involved.

Maintenance methods are not always appropriately regulated by standards and recommendations, so professionals may not be well informed and educated to plan and implement protective or mitigation measures.

### 3.3 Current practices in relation to the most perceived natural hazards

A correct approach implies that States will support actions against disasters related to cultural heritage in close cooperation with institutions directly involved, police, firefighters, civil protection, etc. But, in general CH legislation does not impose, in EU countries, implementing of measures for the prevention and mitigation of risks associated to natural extreme phenomena or climate change, but in general recommendations are used\(^{12}\).

In the current practices, the main tools upon which the definition and protection concerning the risk for CH assets, on large or regional scale are generally the "Risk Maps" such as "Flood Hazard maps", "Geological hazard maps", "Geophysical risk map", etc., and data from specific project like SHARE “European Seismic Hazard Map”\(^{13}\) and the collaboration

\(^{11}\) The T1.1 section related to this topic will be shown and explained in attached. In this report the institution and the main actors involved in the procedures for CH risk assessment, were deduced on base of the data provided by the delivery D2.1

\(^{12}\) For a comprehensive overview of the legislation see D2.1; in Italy for example there is only a guideline: Legislative Decree 22 January 2004 n. 42 Art. 24. Restoration is considered as an operation of direct intervention on the CH asset through a series of operations aimed at preserving material integrity and recovering of the item itself, at protecting and transmitting its cultural values. In the case of immovable property situated in areas declared to be under seismic risk by current legislation, the restoration includes the intervention for structural improvement.

\(^{13}\) SHARE will deliver measurable progress in all steps leading to a harmonized assessment of seismic hazard - in the definition of engineering requirements, in the collection of input data, in procedures for hazard assessment, and in engineering applications. SHARE will create a unified framework and computational infrastructure for seismic hazard assessment and produce an integrated European probabilistic seismic hazard assessment (PSHA) model and specific scenario based modelling tools. The results will deliver long-lasting structural impact in areas of societal and economic relevance, they will serve as reference for the Eurocode 8 (EC8) application, and will provide homogeneous input for the correct seismic safety assessment for critical industry, such as the energy infrastructures and the re-insurance sector.
with national institutions directly involved in implementing the measures for the prevention and mitigation of risks associated to ND.

As already assessed, the current protection practices are oriented towards the defense against those NH and climate change that actors perceive as most persistent in regional scale.

For example, generally in the countries of the Mediterranean basin (Italy, Greece, Turkey, etc.) earthquake risk is perceived as main problem, while in central and northern Europe countries the actors perceive floods as a more persistent risk.

Case by case, depending on the geographical location of the site, other risk factors of natural and anthropogenic character can be considered.

The following list shows the main natural risk factors that are usually perceived as most persistent in regional or local scale, also worsened by climate change:

- Flood
- Landslide and Soil erosion
- Fire
- Earthquake

This list includes the NHs that are more perceived as a real danger for CH assets. It is necessary to highlight that the risk identification is strongly influenced by the nature and geographical location of the CH and by the typology of asset (archaeological sites, historical buildings, artifacts contained in a museum collection).

3.3.1 Flooding

Flooding is a global phenomenon as recently highlighted by the major catastrophic events in Central and Northern Europe. These catastrophes left hundreds of peoples dead and caused enormous damage leading to high economic losses for the whole community. Europe has to face further flood catastrophes due to the change of climate and due to further building activities in flood-prone regions.

Emergency plans and guidelines, which must take into account not only all categories of cultural heritage assets but also movable heritage, can substantially reduce damage and losses. In recent floods, most of the damage to cultural heritage has been related to movable heritage, which could have been totally saved if proper evacuation plans had been elaborated, if the warning had functioned reliably, and if the objects had been removed to a safe location.

Flood events have the potential to undermine the EU’s drive towards sustainable development and the flood risks are increasing. In response to the severe floods in 2002, the European Commission therefore took the initiative to launch concerted action at Community level to help reduce the severity of flood events and the damage caused by these floods.

management. It proposed that the Member States and the Commission shall work together to develop and implement a co-ordinated flood prevention, protection and mitigation action program.

On 18 January 2006 the Commission adopted its proposal for a Directive of the European Parliament and of the Council on the assessment and management of floods (COM 2006, 15 final, 18.1.2006, http://ec.europa.eu/environment/water/flood_risk/com.htm). The legal instrument is proposed to be ambitious in its scope but not prescriptive in its tools. It intends to translate the approach outlined in the Communication on Flood risk management of July 2004 and the discussions during the stakeholder consultation process into operational actions. First of all a preliminary risk assessment for flooding is necessary and strictly connected the elaboration of a flood risk map. This map serves as base for flood risk management plans to be developed and implemented at river basin/sub-basin level to reduce and manage the flood risk.

Clearly the appropriate level of protection will vary from river basin to river basin and even within each river basin. For example, high levels of protection might be required in the vicinity of major cities, or near sites of particular cultural or historic significance. Within each river basin the Member States will determine the level of protection most appropriate for each locality.

As flood risks may change over time due to climate change and changes in land use, it would be important to regularly review and where necessary update the three elements of the legal instrument.

The international interest for flood risk specifically addressed to CH, is evidenced by numerous initiatives and projects focused on the topic. CHEF Project (Cultural Heritage Protection Against Flooding)14, for example, proposes the integration of multidisciplinary research as scientific support to European policies. This project highlights some strategic points in relation to flooding risks. One of the main objectives concerns the necessity of classifying all movable and immovable CH items and of specifying their vulnerability to flood. A thorough analysis damage processes in relation to different materials is also a relevant objective together with the possibility of applying methods and sensors for non-destructive testing and monitoring of material and structural parameters.

The project deals also with the analysis of preventive and emergency measures, the restoration and repair operations taking into account case studies.

3.3.2 Measures and prevention against flooding

An integrated flood-risk management is essential if the historic environment is to be protected from flood damage, and effective communication between all those involved is therefore vital in securing the appropriate response as well as in providing integrated emergency management as it can be derived from some exemplificative and review case studies (Bubeck et al. 2015; English Heritage 2010; Garvin et al. 2005; Thieken et al. 2016; Will 2008).

14 CHEF : http://www.chef.bam.de
Flood is classified as an unpredictable natural disaster that includes torrential rain, rivers flooding, spring, tides, etc. Flood prevention in relation to CH, moves in two complementary directions: one is analysing a flood’s effect on building materials, and the other is to investigate the effects of flooding on cultural heritage sites using a flood map. Both are beneficial in establishing preventive conservation strategy to decrease flood damage.

Various studies have shown that floods have direct critical effects on cultural heritage structures and materials. Flooding not only damages structures that contact the flowing surface but also sabotages the base and subsoil. Flooding weakens the basic infrastructure of architectural heritage sites, including individual structures, buildings, and artistic objects and components that are attached to the buildings. Floods render these objects vulnerable to various forces and effects and increase building material weathering that destroys the importance and value of cultural heritage sites.

Italy was the first nation to begin investigating the effects of flood on its cultural heritage via flood maps in the 1990s (Bianchi 2010).

The vulnerability of the huge cultural, historic and artistic heritage hosted in Italy against the risk associated with flood waters was definitely brought to the attention of the public opinion and researchers during the Florence’s flood in 1966. Many other flood events among the nearly 7500 surveyed and catalogued by the Italian CNR within the AVI Project concluded in 1996 with the production of a synoptic map of flooded sites (data available at http://avi.gndci.pg.cnr.it) have been threatening the historic and artistic heritage across the Italian territory during the last 100 years However, after the shock following the Florence episode in 1966 and with very few exceptions, little has been done from the Italian government in terms of economic investment and effective and extensive defensive measures to protect cultural heritage against the risk of flood.

Although floods are usually short-term events, it takes a very long time and enormous efforts to deal with the consequences.

Wet materials and structures mostly lose their strength and stiffness characteristics, and they exhibit substantial volumetric changes. In addition to mechanical actions, there are also substantial chemical attacks during and especially after floods. These are mostly due to water pollution and to salt efflorescence during drying processes. It is therefore more difficult to make a general ranking of structures and elements according to their sensitivity to flooding than according their sensitivity to other situations. Generally, many effects occur after a flood, e.g. compacting of infill, which can cause partition walls to fail and floors to buckle as a consequence of the uplift forces. Cracks can appear in vaults due to uneven settlement after the flood, and many other effects can occur.

Taking into account the sensitivity of structures and elements to weather effects, it is possible to categorize structures according to their exposure conditions and the morphological characteristics that influence water retention or the eddies and flows around monuments.

15 The AVI project was commissioned by the Minister of Civil Protection to the National Group for Prevention of Hydrogeologic Hazards to complete an inventory of areas historically affected by landslides and floods in Italy. The results of the AVI project, in spite of the limitations, represent the most comprehensive archiving of mass movement and floods ever prepared in Italy.
In the same way it is possible to categorize structures according to their constitution material. In fact, different materials exhibit different behaviour to water in relation to their chemical-physical characteristics (Sabbioni, Brimblecombe and Cassar 2012).

Preventive and temporary measures are typically divided into two categories: structural and non-structural. Structural measures to protect cultural heritage are sometimes difficult to implement, because they are often visible and disturbing, and in most cases are not cost-effective. As far as non-structural measures are concerned, the application of standards to protect cultural heritage from flood leads to the problem that the measures may compromise the originality, authenticity and aesthetic qualities and values of historic monuments. No European Standard is in practice available for effective protection of cultural heritage against floods, but standardization of some preventive processes and procedures, for example mapping and monitoring, would certainly bring positive results.

In the current practices, the effects of flooding on cultural heritage are generally mitigated by following a precise strategy that includes a series of actions:

1) Regular inspection of structure is needed for all categories of cultural heritage objects threatened by flooding. Special attention on should be paid to the integrity of structures such as dams, in relation to historical water works (ponds and channels) and bridges, especially small bridges made of light materials.

2) The anchoring of light objects and timber parts prone to uplifting and floating away needs to be systematically checked, including the supporting structures. It is also necessary to check the health of trees, which can damage buildings in their vicinity.

3) Regular maintenance is needed for all categories of cultural heritage objects. Lack of regular maintenance causes material decay and loss of the mechanical properties.

4) CH mapping (national scale, such as the Risk Map in Italy, or site scale mapping of movable and immovable CH) to compare with a risk flood map for implement emergency plans and reduce the damage and losses.

5) Necessity of equipment and means of transport on site for evacuating movable heritage, in adequate storage facilities. These equipment and means are not always available immediately.

6) Early warning and information systems are essential elements for flood mitigation measures, and affect all categories of cultural heritage objects. Quick links to meteorological monitoring stations and central weather alert present in the interested area are often available.

7) Preparation of technical measures against floods allows to prevent water flowing into cultural heritage buildings or into the vicinity of these buildings. The measures mostly form part of the integral protection of a settlement, and typically consist of stable walls and dams with moving gates or temporary walls that are easy to install. This category also includes temporary barriers used for sealing door and window openings by means of special shutters or with the use of sandbags.

Measures in this category include surface protection of materials vulnerable to the washing-out effects of water; this measure is also important for stone walls with clay mortars, especially if they are used as retaining walls.

Other measures for decreasing the static or dynamic water pressure load consist in removing any element in order to decrease the surface acting against the water flow.
Floating objects pose a serious threat for artefacts and especially for historical bridges; they may damage all objects in water by impacting them, and they can also accumulate in correspondence of bridges or other obstacles to form like a dam which increases the water pressure and can even elevate the water level.

Some case studies from European contexts will be shortly illustrated in Paragraph 5.1, as good practices in CH safeguard against flooding.

3.3.3 Landslides and soil erosion

Landslides and similar phenomena cause major losses of historic objects and damage to the architectural heritage. They affect large areas and the damage is mostly irreparable (Canuti et al. 2009). A landslide event is usually caused by a combination of factors, the most important of which are:

1. the material properties of the soil/rock massif;
2. geological composition;
3. precipitation and water saturation;
4. slope inclination.

The Italian territory is also particularly prone to natural hazards, in particular many of architectural, monumental and archaeological heritage are exposed to landslide at national scale.

The data on this problem are provided by the Italian Cultural Heritage database (Risk Map, Carta del Rischio, realized by Central Institute for the Conservation and Restoration); the Italian Landslide Inventory (IFFI project) developed by ISPRA (Italian National Institute for Environmental Protection and Research) and the Regions and Self-Governing Provinces of Italy and the flood hazard zones defined by the Italian River Basin Authorities. Italian landslide inventory contains more than 486,000 landslides affecting an area of about 20,800 km², equal to 6.9% of Italian territory. In order to estimate the number and type of cultural heritage at risk some GIS processing have been carried out, overlapping information from the above mentioned databases. The analysis provided the following results: Cultural Heritage exposed to landslide risk were estimated to 5.511 (6.6%) while the ones exposed to flood risk results 9.859 (11.7%) (Iadanza et al. 2011).

Since early 90’s the capability of Synthetic Aperture Radar (SAR) Interferometry technique (Massonet and Feigl 1998) have been exploited to study surface displacement and deformation due to different geo-hazard. In particular, the multi-image Permanent Scatterers SAR Interferometry (PSInSAR) technique (Ferretti, Prati and Rocca 2000, 2001), developed by Politecnico di Milano and licensed exclusively to Tele Rilevamento Europa (TRE), showed its capability to provide information about ground deformations over wide area with millimetric precision, making this technique suitable for both wide and site scale investigations.

The IFFI project and Carta del Rischio (Italian Risk Map) represent two excellences in the field of thematic databases (at national and international level) for the methodology used, the details and completeness of data, and for online mapping services (Figure 3).
Landslides are one of the soil threats considered in the EU Thematic Strategy for Soil Protection and the related Proposal for a Soil Framework Directive. The Strategy calls for actions and means for the protection and sustainable use of soils as a physical platform on which human activities are developed. The proposed Directive requires to identify landslide and other soil threat risk areas in the European Union, set risk reduction targets for those areas and establish measure programs by Member States.

On 13 February 2012 the European Commission published the report “The implementation of the Soil Thematic Strategy and ongoing activities” (COM 2012, 46). The report provides an overview of the actions undertaken by the Commission to implement the four pillars of the Strategy, namely awareness raising, research, integration, and legislation. It also presents current and future challenges to ensure soil protection.

Figure 3 Landslide Index derived from the Italian Landslide Inventory (Spizzichino et al. 2013, 26).
The report includes a preliminary version of the published landslide susceptibility map of the EU and neighboring countries produced by the European Landslide Expert Group coordinated by JRC (Joint Research Centre).

The JRC provides scientific and technical support to the European Commission Services for the implementation of the EU Thematic Strategy for Soil Protection, both through its own work activities and in collaboration with national research organizations, mapping agencies and academia. The main activities and expertise of JRC include harmonization of methods for landslide mapping and zoning in Europe (inventory, susceptibility, hazard and risk) at various scales, development of satellite, airborne and ground-based remote sensing techniques for landslide mapping and long term monitoring, analysis of lessons learnt from management of past landslide disasters, and geospatial database creation and management.

JRC started a series of collaborative activities with external partners within various frameworks linked to landslide management. For example the European Landslide Expert Group was created and coordinated by JRC in order to develop landslide inventories and models for landslide susceptibility assessment and mapping at European and national scales.

JRC is also a member of the International Consortium on Landslides (ICL), an international non-governmental scientific organization supported by UNESCO, UNISDR, and other international organizations, which aims at promoting and coordinating collaborative research and expertise, as well as capacity building on landslide disaster risk reduction.

JRC collaborates with EU Framework Program research projects devoted to landslide risk (e.g. the recent project SAFELAND - Living with landslide risk in Europe: Assessment, effects of global change, and risk management strategies).

Lastly, JRC is involved in the activities of the European Centre on Geomorphological Hazards (CERG), a specialized research network of EUR-OPA Major Hazards Agreement of the Council of Europe. CERG promotes international scientific cooperation and training on prevention of geomorphological and hydro-geological hazards and risks, especially landslides, gravitational flows and floods.

ELSUS1000 (European Landslide Susceptibility Map version 1) shows levels of spatial probability of generic landslide occurrence at continental scale. It covers most of the European Union and several neighboring countries. The map was created by regionalizing the investigated area based on elevation and climatic conditions, followed by spatial multi-criteria evaluation. The location of over 100,000 landslides across Europe, provided by various national organizations or collected by the authors, has been used for model calibration and validation (Günther et al. 2014).

The map has been produced jointly by the Federal Institute for Geosciences and Natural Resources (BGR, Hannover, Germany), the Joint Research Centre (JRC, Ispra, Italy), the Institute of Physics of the Globe (CNRS-EOST, Strasbourg, France), and the Research Institute for Hydrogeological Protection (CNR-IRPI, Perugia, Italy).

An important initiative is the World Landslide Forum (WLF), a triennial mainstream conference aimed at involving scientists, stakeholders, policy makers, and industry to deal

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with the management of landslide risk. The first WLF was organized in 2008 by ICL, United Nations Educational, UNESCO, World Meteorological Organization (WMO), Food and Agriculture Organization (FAO), United Nations International Strategy for Disaster Reduction (UNISDR), and many other international organizations\(^\text{17}\).

The Third World Landslide Forum (WLF3) aimed at further developing the outcomes from the previous editions of the forum editions by providing a global cooperation platform for all types of organizations that could contribute to landslide research, practice, education, and decision making to strengthen strategies for landslide risk reduction. The emphasis of this forum is “Toward a safer geo-environment”\(^\text{18}\).

Other important project is DORIS\(^\text{19}\): an advanced downstream service for the detection, mapping, monitoring and forecasting of ground deformations, at different temporal and spatial scales and in various physiographic and climatic and environments. DORIS integrates traditional and innovative Earth Observation (EO) and ground based (non-EO) data and technologies to improve the understanding of the complex phenomena that result in ground deformations, including landslides and land subsidence, and to foster the ability of Civil Protection Authorities to manage the risks posed by ground deformations.

DORIS has improved the state-of-the-art in the science and technology currently used to detect, map, monitor, and forecast ground deformations. Improvements consist in the innovative exploitation of EO data and technologies. DORIS exploits the unique ESA ERS-1/2 and ENVISAT C-band Synthetic Aperture Radar (SAR) archives to provide unprecedented, very long time-series of ground deformations. DORIS will evaluate new sensors, including ALOS, COSMO-SkyMed and TerraSAR-X. DORIS projects operates in different areas selected in Hungary, Italy, Poland, Spain, and Switzerland.

A wide panorama of projects, devoted to landslide studied, has been reported above. However, prevention activities for landslides are usually performed at a local scale with the aid of different kind of instruments, which will be shortly described in the subsequent pages. These instruments are commonly used in European countries for monitoring landslides and soil erosion processes.

The deformation monitoring with GNSS (Global Navigation Satellite System) measurements is a well-known method which can be employed both for continental scale and local phenomena such as landslides.

A geodetic GNSS receiver is traditionally used in these applications because a high level of accuracy is needed even if but this system is quite expensive.

Nowadays, new technologies make it possible to use small and efficient low-cost single-frequency GNSS receivers, which are able to achieve a centimetrical or higher level of accuracy, in static positioning. Under this point of view, the single-frequency receiver can be less efficient in estimating the ambiguity values of the carrier phase, with respect to geodetic

\(^{17}\) http://www.wlf3.org/

\(^{18}\) The 4th World Landslide Forum will be in May 29 – June 2, 2017, Ljubljana, Slovenia (https://www.wlf4.org/)

\(^{19}\) http://www.doris-project.eu
one. This characteristic is not negligible because, in order to have a positioning with a high level of accuracy, it is necessary to correctly estimate the ambiguity phase.

A ground network of GNSS CORSs (Continuous Operating Reference Stations) dedicated to offer a service for RTK (Real-Time Kinematic) positioning could permit us to bypass some of these limitations.

There is a large number of commercial mass-market GNSS receivers, which are very cheap (<300 US dollars) and light (<50 grams). These sensors are totally different from the first GNSS receivers, which were bulky and expensive. Actually, the new generation of receivers is usually offered as a small card or customized with a dedicated interface.

Low cost and small size are key elements in choosing these single-frequency receivers in order to describe a phenomenon of deformation with a large number of monitoring points and a high number of sensors involved in the field.

Moreover, the better performance derived from the new generation of GPS satellite and the increased number of available GLONASS satellites, led the users to employ the single-frequency receiver in different types of monitoring such as landslides, other natural phenomena and buildings, often combining additional measurements.

The instrumentation usually used for GNSS monitoring usually consist of: single-frequency GNSS receivers kit and default antennas, RTK permanent network connection, Geodetic RTK rover receiver, and a software for single-frequency GNSS receiver control. This software can provide a powerful platform for data evaluation, configuration, testing and real time performance visualization of GNSS receiver data. The software provides a convenient means to configure the GNSS receiver, to save customized configuration settings in the GNSS receiver flash memory and to restore factory settings if needed.

These kinds of receivers, if damaged or un-recoverable (due for example to rock fall, atmospheric event, etc.), can be considered mass-market receivers, or “throwaway instrumentation”, with less economic damage than the use of geodetic receivers.

It is possible to apply other low impact techniques for risk prevention in landslide areas. In order to identify landslide surface and estimate the involved volumes, 3D laser scanner acquisition can be used at different times:

- in the pre-disaster phase, to monitor deviations (also sub centimeter) of landslide risk areas. The control can be done periodically comparing the point clouds acquired at different times with the 3D laser scanner;
- in post disaster phase laser scanning surveying is performed to accurately map of the landslide geometry and estimate the involved volumes.

The collected data allow to extract a Digital Terrain Model (TIN) of the landslide body (after having removed artefacts and sparse vegetation form 3D laser point clouds). It is possible to obtain a model at the beginning of investigations for a detailed description of the area aimed at assessing the landslide area and volume, as well at precisely locating of the potential surrounding area subjected to risk. Reference cross sections for the implementation of slope stability analysis are extrapolated from the two 3D model.

Total Stations are perfectly suited for continuous measurements in monitoring of historic buildings, archaeological sites, geological contexts, landslides, etc.
The Total Station is a surveying instrument that integrates an electronic theodolite with an electronic distance meter (EDM Electronic Distance Measuring or EDME Electronic Distance Measuring Equipment). It is also integrated with microprocessor, electronic data collector and storage system. With the aid of trigonometry, the angles and distances may be used to calculate the actual positions (x, y, and z or north, east and elevation).

Motorized Total Station with automatic collimation precision functions are available on the market. This facility makes them more practical and efficient for repeating the monitoring operations during the time, on a local scale.

The advantages of this system are considerable:

- it always guarantees high accuracy, independent from collimation errors by operator;
- it allows faster measurement times;
- it makes research, engagement and tracking of the reflector in automatic way after the first measure.

The Total Station is recommended for the supervision of landslides and mudslides in areas of cultural interest: the TS must be settled on a stable base (in an area which is not affected by the phenomenon to be monitored), not far from the GCP (Ground Control Point) to be monitored, in order to assess the landslides movements in the three directions.

The study of a landslide usually occurs according to well codified phases that include:

- identification, delimitation and classification of the instability;
- checking its evolution by measuring the superficial and deep movements;
- analysis and evaluation of possible evolutionary scenarios;

The precision required for the measurement of surface displacements related to a disruption is, in most cases, centimetre and, in some cases, also subcentimetric.

The monitoring requires, almost always, the creation of pillars, reliable and durable in time, in correspondence of control points representative of the investigated phenomenon as well as in external points of the investigated area, for the creation of the reference with “datum”.

Similarly, the TS can be used for structural assessment and monitoring of monuments and historic buildings interested in geological and landslide events.

TS can be used for in continuous monitoring, through:

- a motorized Total Station S with automatic precision collimation functions (self-centring system with CCD digital video camera, which allows an accuracy below 1 mm for distances up to 200 m, and an accuracy in the angular extent of not more than 2”);
- a management system consisting of a computer for the control of the station, processing and displaying data and a system for the data transmission;
- reflective targets installed in the monitoring area or placed on the infrastructure to monitor a landslide on fixed GCP. Moreover, additional target should be installed on buildings not involved in the phenomenon aimed at constituting the reference datum for controlling the stability of the TS and for the geo-referencing of the system with respect to points the WGS84 absolute coordinates.
The continuous monitoring system allows to perform measurements with hourly basis, or daily, in order to follow, in near real time, the deformation evolution patterns and save them in a database.

The measuring system on a weekly or monthly basis is usually accomplished using motorized or traditional TS; the procedures are the same as those described above with the only difference in the ability to automatically fit storage and remote transmission.

In these cases the monitoring is repeated at regular intervals by an operator who provides to reposition the TS on its fixed base and to measure the target and of the GPC.

3.3.4 Fire

Fires were more dangerous in settlements in the past than they are nowadays. However, wildfires may become even more disastrous for many cultural heritage sites that are already threatened, and may also threaten other sites that historically—before the onset of climate change—were less prone to fire (Giannakopoulos et al. 2009; Good et al. 2008; Moriondo et al. 2006). In fact, reports of damages caused by wildfires on historical sites are becoming more frequent and alarming.

But the primary concern of the fire authorities is the safe evacuation of the building occupants and the provision of adequate fire-fighting equipment. On the other hand, the conservationists are primarily concerned with maintaining the authenticity of the building itself and are reluctant to see the introduction of preventive measures that have any degree of negative impact on the structure and aesthetics of the building (Emery 2008; Jensen 2006).

In general, national and international fire regulations are primarily concerned with life safety and less concerned with protecting assets (Watts 2008). Fulfilling these life-safety regulations and the associated building codes is, of course, mandatory. However, the number of national regulations and guidelines related to asset protection is steadily rising.

The European technical documents are usually guidance with no legal authority\(^\text{20}\). The content of these documents includes fire performance of historic materials and assemblies,

fire protection measures, such as *Thatched Property Safety Guide*\(^{21}\), the Guidance for fire protection strategies, emergency plan and the configuration and management of fire protection measures to Historic Buildings, and a series of Technical Advice Note (TAN).

More recently, the European Fire Protection Associations decided to produce common guidelines in order to achieve similar interpretation in European countries and to give examples of acceptable solutions, concepts and models. The Confederation of Fire Protection Associations (CFPA) in Europe has the aim to facilitate and support fire protection activities across Europe.

These guidelines are intended for owners, managers, caretakers and other responsible for safety of historical buildings. They should provide knowledge about basic, simple, low-cost actions, which can be done to protect the historic building from fire. They also indicate routes to more advanced ways of protection (CFPA 2013).

Fire was one of the most serious threats for the buildings and sites through the centuries. This threat is omnipresent and causes irreplaceable losses.

Although most of historic buildings have built in periods when very poor, if not at all, Fire Codes and Standards were applied, many of them exist now in their original condition after such a long time. That happened because, on one hand the traditional builders and architects applied several sophisticated fire protection measures based on the state of the art at that time as well on common sense and on the other hand, after major fires and conflagrations the authorities put in force more severe and more developed fire protection legislation.

Although fire safety objectives have been expressed in different ways by various authorities and in different countries, generally there are two main accepted aspects of fire protection for modern buildings: life safety and property protection. For historic buildings it must be added the protection of cultural values either for the buildings or for their contents. It is not possible to achieve an absolute fire safety. In most cases, a proper fire safety design assumes that a limited unwanted fires will occur and means shall be provided to minimize the losses from fire till an acceptable level (Papaioannou 2003).

The building regulations and codes prescribe the minimum fire safety requirements (Jensen 2006).

In planning for fire protection of historic buildings the following main steps should be proceeded by the designers:

- make a risk assessment;
- develop fire safety criteria;
- identify fire hazards;

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- consider building’s arrangement;
- plan a fire protection strategy;
- specify passive fire protection;
- specify active fire protection;
- develop a fire safety management plan (Papaioannou 2003).

Fire measures in historical buildings should be chosen taking into account the peculiarities of the edifice; in fact, for the majority of historic buildings traditional approaches could not be applied due to undesired results about the historical and architectural character of buildings, which is often unacceptable for the conservators (Iringová and Idunk 2016).

Fire protection measures can be divided into passive measures and active measures.

Passive (structural) measures can be generally associated to building's resistance and endurance after a fire has developed, while active measures are aimed at preventing the outbreak and spread of fire. The majority of passive protection measures are related to the building structure, construction methods and materials used. Such measures include the fire compartmentalization of a building, the use of materials to prevent building collapse, fire-resistant construction elements to limit the spread of fire and smoke, the provision of fire-resistant escape routes/exits/staircases/elevators, the selection of materials to reduce the fire load and the selection of materials to prevent the generation of toxic vapours (for more information see: https://www.downloads.siemens.com/download-center/Download.aspx?pos=download&fct=getasset&id1=A6V10859638)

For new museums and art galleries constructions, most of these measures are defined by national or local building codes, especially for larger art centres, which may have complex escape routes. In the case of historical buildings, however, it may often prove difficult to improve effective passive protection without undertaking drastic reconstruction. Any intervention of this nature is generally in contradiction with the requirements of the conservation lobby, who wish to preserve the character and authenticity of the original building as far as possible.

Active protection can be divided into organizational, detection, alarm and evacuation, and extinguishing measures.

From an organizational point of view, during public opening hours the majority of museums and historical buildings will be able to summon professional help relatively quickly in emergency situations.

Organizational measures include:

- staff training (prevention and intervention);
- provision of alarm and emergency plans;
- periodic maintenance and checking of firefighting equipment;
- keeping escape routes accessible and unobstructed;
- enforcement of good housekeeping rules;
- correct storage of flammable materials used for cleaning or restoration work;
- no portable heating equipment permitted;
- no smoking in any part of the building or in the immediate vicinity
Concerning the detection measures, the main tasks of an automated fire protection system are to detect (an incipient stage) fire, sound an acoustic alarm, notify the fire service and activate the pre-programmed control functions. Such a system consists of a control unit with peripheral input devices (such as manual call points and automatic fire detectors), output devices (such as sounders and beacons) and output contacts to control other systems (such as smoke control systems, heating ventilation and air-conditioning systems, elevators, automated extinguishing systems, etc.). To minimize the danger to life and the damage to property, it is important to detect a fire as early as possible.

Alarm and evacuation measures should be activated when a fire breaks out: prompt warning is essential and buildings must be evacuated within minutes to protect people’s lives.

In the case of a historical building, museum, or archaeological site three distinct target groups are addressed:

- visitors for whom a hazardous situation has been detected;
- staff who should coordinate the evacuation;
- the people who should deal with the fire.

In addition to the type of alarm and evacuation system provided, evacuation plans, escape route identification, emergency lighting systems and smoke venting systems (where feasible) are essential to ensure a fast and safe evacuation of all persons.

As concerns the extinguishing measures, the following systems are usually employed:

- the hand-held fire extinguishers situated at strategic points throughout the building allow staff to suppress incipient fires quickly and effectively;
- automatic systems such as sprinklers generally react directly to the heat generated by the fire, releasing water from those sprinkler heads closest to the seat of the fire. The major objective is to prevent fire from spreading to other areas of the building.

As stated above, the awareness of how fires start and how they spread can help to reduce quite significantly the risk linked to them.

The basic fire protection objectives are to try to control all three of these factors:

- reduce the probability of fire by controlling potential ignition sources;
- minimize the potential effect by reducing the “fire fuel”;  
- inhibit fire development by limiting the oxygen supply (for more information see: https://www.downloads.siemens.com/download-center/Download.aspx?pos=download&fct=getasset&id1=A6V10859638).

On the basis of these three simple factors, it can be defined the current practice against fire in historical buildings, library, museum, archaeological site, etc.

Most common causes of fires in historic buildings are arson, electrical faults, open fires, smoking materials, candles, heating equipment, lighting, hot works such as welding, cutting, and similar uses during works of renovation, etc. (Watts 2008).

Regular cleaning, proper storage and disposal of litter, and other rules of good housekeeping are basic actions to prevent fire spread in the room of origin. Fire extinguishers, blankets and other basic equipment are at hand to allow people to extinguish an initial fire (Jensen 2006).
Arson is the most frequent cause of fire in historic buildings, fires can start outdoors and then be transferred into the building (CFPA 2013, 8). To avoid this problem, simple safety measures are adopted in the common practice. These measures prevent waste or flammable objects to be accumulated near the building, on the secondary entrances, exits, windows, and that waste containers to be not stored below a window or in front of doors, especially on escape routes.

The electrical installations in historic buildings are often outdated and can be causes of fire. Therefore, generally, some precautions are taken such as the upgrading of electrical systems with the standards set by law; setting safety distance of spotlights to the combustible materials; checking that electric light fittings are not equipped with overly powerful bulbs; verifying that electric light fittings are stable and are properly fixed; prohibition for staff and users to introduce unauthorized electrical items (for example portable equipment for heating, mini fridge, etc.).

To avoid fire in electrical equipment, it should also be checked that:

- technical space is not used as storage facility;
- cables are intact and not pinched, and areas surrounding heat radiating equipment are clean and clear;
- lids and doors to distribution boxes, controller cabinets and switch bays are closed;
- distribution boxes and other electrical installations are not exposed to humidity;
- electrical heating equipment such as electric radiators, heating units, are not covered or placed in an unsuitable environment.

Defective or overloaded electrical installations can cause overheating or a short circuit that may cause a fire. Early instrumental detection of such defects can be fundamental in saving the building.

In case of old electrical installations thermography survey is carried out to detect hot areas in electrical equipment and circuits (CFPA 2013, 9).

These types of scans are used as routine safety checks to prevent problems that could lead to fire.

An important aspect is related to the so called “hot works”, occurring during renovation and/or maintenance, as this can become a common cause of fire (CFPA 2013, 10). This kind of work could develop heat or cause sparking due to operations such as such cutting, welding, soldering. Fires start when the hot surface comes into contact with combustible material. For this reason hot works should be performed under strict control.

In the same way, in case of restoration, it should be controlled that solvents, acids, and other materials used by restorers, are maintained according to the standards of safety and fire prevention.

Similar preventive measures are contemplated in case of restoration and diagnostics laboratories (with equipment, materials, and flammable chemicals), located in historic buildings, museum, etc.

Generally, fire compartmentation prevents spreading of fire from the origin room to other parts of the building. But in case of historic buildings usually a suitable fire compartmentation is not possible due to the peculiarities of the edifice.
In the case of modern structures, the spread of fire is usually restricted because of the proper distance between the rooms and the fire walls. When speaking of historic buildings, this often cannot be easily achieved.

Fire protection measures like fire detection systems, sprinkler systems and similar are installed to detect a fire in its early stage and to limit its spread. Besides the usual there are additional requirements for fire systems in historic buildings. They should be minimally invasive, sensitively integrated and reversible.

In this regards, some technological solutions have been developed for minimizing the invasive characteristics of fire detectors in historical buildings such those proposed in the project “Minimum Invasive Fire Detection for Protection of Heritage” (Jensen 2006).

Also the employees and visitors can prevent spread of a fire with a fire extinguisher or other suitable manual fire fighting equipment. It is essential to choose fire extinguishers that have sufficient extinguishing effectiveness for the expected fire and not give irreversible damage to the building and its content; portable fire extinguishers are placed in a prominent location and be clearly signposted.

Protection of cultural heritage buildings clearly starts from the protection of human life; for this reason, the responsibility of the evacuation lies on management of the building and the staff are trained to organize the evacuation, help people when needed and to alert fire fighters.

Escape routes in historical buildings often do not match the standards that today are required for fire safety or evacuation procedures. An assessment of capacities and dimensions of elements, such as doors, corridors, staircases, stairs, ramps, etc. is required in safety standard procedures, so in historical buildings, where sometimes it is impossible to reach these standard requirements, other kinds of measures need to be adopted. For example, in extreme cases a restriction of access to visitors should be put in place. Possible measures, often adopted to reduce risks for visitors and for CH, are the reduction of access to limited number of people and only by guided tours, providing additional support for disables.

Fire risk can be associated also to archaeological areas. In fact, a lot of archaeological sites, especially in the Mediterranean region, are covered with vegetation or situated close to forests. Therefore, they are exposed to increased risk of forest fire. Such fires may break out from within the site and spread towards nearby forests and other wooded land, or conversely start in nearby forests and spread to archaeological sites.

Wildfires are one of the main causes of the destruction of cultural monuments in recent years. The increase in seasonal temperatures caused an explosion in the number of self-ignited wildfires in forested areas. Fanned by the dry winds, and fuelled by dry vegetation, some of these fires became disastrous for many cultural heritage sites. Thus, beyond taking precautionary measures to avoid a forest fire, early warning and immediate response to a fire are the only ways to avoid environmental and cultural heritage damages.

In the current practices the actions for protecting archaeological sites are usually the following:

- create fire breaks near/around sites;
- remove potentially combustible objects close to the archaeological assets;
- remove vegetation and shrubs close to the archaeological sites;
- periodically cut weeds, especially in the warmer months, in the site and around its perimeter;
- wrap structures in fire proof materials to protect them from fire;
- for any building within the archaeological site, it should be adopted precautions as described above.

Often fire protection measures, like fire detection systems, sprinkler systems and similar are not installed to detect a fire in archaeological contexts. Fire alarm systems are generally installed only in the buildings.

Security staff employees can prevent spread of a fire with a fire extinguisher or other suitable manual fire fighting equipment. In fact, portable fire extinguishers are placed in a prominent location and clearly signposted. In some cases the site has a fire extinguishing system with water cannons in various points clearly signposted.

Another monitored aspect regards the storage of flammable materials used in temporary works of restoration and renovation. These materials must be stored in compliance with fire regulations, finally the hot work have to be monitored by the same criteria expressed above.

Regarding the archaeological excavations, inside the site, it is made prescription to do not store flammable materials, and to use flame retardant material for temporary cover of archaeological layers.

As a general rule for fire prevention, a fundamental aspect is the timeliness for alarm. In this regard, the FIRESENSE Project\(^22\) (Fire Detection and Management through a Multi-Sensor Network for the Protection of Cultural Heritage Areas from the Risk of Fire and Extreme Weather Conditions, www.firesense.eu) is interesting to note.

FIRESENSE aims to develop an automatic early warning system to remotely monitor areas of archaeological and cultural interest from the risk of fire and extreme weather conditions.

The FIRESENSE system will be based on an integrated approach that uses innovative systems for early warning (Figure 4).

The main aim of FIRESENSE project is to remotely monitor areas of archaeological interest from the risk of fire, and contemporary to provide weather data that can be used for efficient protection and preservation of cultural heritage assets. The project takes advantage of recent advances in multisensory surveillance technologies. The key idea is to place a Wireless Sensor Network (WSN), capable of monitoring temperature, and optical and infrared cameras on the sites. The signals collected from these sensors are transmitted to a monitoring centre, which will employ intelligent computer vision and pattern recognition algorithms as well as data fusion techniques to automatically analyse sensor information. The system will be capable of generating automatic warning signals for local authorities whenever a dangerous situation arises.

\(^{22}\) www.firesense.eu last view 31-01-2017
The approach proposed in the FIRESENSE project could become a current practice in monitoring fire in archaeological sites. According to this approach, multimodal wireless sensors can be deployed at the site, they will acquire periodic measurements from the environment (e.g. ambient temperature, humidity) and provide their readings through the network to the monitoring centre.

In the case of fire detection, the system should create an alert message for the fire fighting management. Moreover, the system should receive data from official weather information services as well as from local meteorological station installed in the site and should create alerts in case of extreme weather conditions.

Detecting the starting position of a fire is only the first step in fire fighting. After detecting a wildfire, the main focus should be the estimation of the propagation direction and speed, in order to help the forest fire management. If the vegetation model and other important
parameters like wind speed, slope, and aspect of the ground surface are available, the propagation of the fire can be estimated. Finally, a Geographic Information System (GIS) could visualize the predicted fire propagation in 3D, providing services for decision and operational support in forest fire suppression.

A lot of projects, without specific reference to cultural heritage assets, can be found in the literature concerning fire and wildfire risk assessment. These projects and studies are addressed to map and develop predictive models to assess and prevent fire risks, especially in the Mediterranean Basin countries, where this kind of risk is particularly serious (EC 2007a; Catry et al. 2009).

3.3.5 Earthquake

Seismic activity threatens thousands of cultural heritage objects. Natural seismicity generates dangerous vibrations and displacements, and man-made seismicity, so called “industrial or technical” seismicity, has also been shown to cause severe damage, mostly to masonry. Technological man-made seismicity can result from quarry blasting, from transportation vibrations and shocks, and from micro-seismicity in mining areas.

Earthquake is understood to be a NH with great relevance and impact on CH in the countries of the Mediterranean basin.

In Italy, for example, a specific Ministerial Directive: “Linee guida per la valutazione e la riduzione del rischio sismico del patrimonio culturale con riferimento alle Norme tecniche per le costruzioni di cui al decreto del Ministero delle Infrastrutture e dei trasporti del 14 gennaio 2008” (Guidelines for the evaluation and reduction of seismic risk of cultural heritage with reference to the technical standards for construction, referred to the Ministry Decree of Infrastructure and Transport, 14 January 2008), highlights this relevance.

The Directive provides guidance for the assessment and mitigation of seismic risk of the protected cultural heritage, with reference to the technical standards for construction. The Directive has been drafted with the intent to specify a path of knowledge, assessment of the level of security against seismic activity, and design of any appropriate intervention addressed to the needs and peculiarities of the cultural heritage. The aim is to formulate, as objectively as possible, the assessment of the safety and conservation of CH. It should be noted that the document refers to the storage, in safe conditions, the some masonry buildings of cultural heritage against seismic action.

To do this is important to have analytical tools that allow the analysis of vulnerability and seismic risk assessment.

The current practices and the analytical tools for the management of CH assets against earthquakes are usually defined starting from the geological contest. In fact, the seismic ground movement is strongly influenced by geological and stratigraphic characteristics and local topography. In the presence of deformable mixed soil and as a function of different stiffness and continuity of the more superficial layers, as well as of the possible topographic irregularities, effects amplification of the seismic movements can be amplified, both in terms of maximum acceleration and in frequency; in these cases it is necessary to make specific analysis of the local seismic response.
In Italy, for example, a preliminary investigation can be carried out, for large areas, using data base of the INGV (Istituto Nazionale di Geofisica e Vulcanologia - National Institute of Geophysics and Volcanology). The main mission of INGV is the monitoring of geophysical phenomena in both the solid and fluid components of the Earth. INGV is devoted to 24-hour countrywide seismic surveillance, real-time volcanic monitoring, early warning and forecast activities. Another possibility is refer to “Geological and geothematic maps” edit by ISPRA (Istituto Superiore per la Protezione e la Ricerca Ambientale – Superior Institute for Protection and Environmental Research). ISPRA acquired the function of State Cartographer's Office, previously hold by the Geological Survey of Italy, as provided by Law 68/1960. The Institute makes new surveys, updates and publishes the Geological Map of Italy at various scales (in the other European countries there are similar institutions with a similar approach in risk mapping for seismic impact).

The geological map is the cartographic representation of the information acquired during a long work on the ground. The process goes from the survey of data to the laboratory analysis and subsequent data processing. The information is then transferred to the corresponding topographic base in order to describe, through the use of conventional symbols, the exact stratigraphic position, age, petrographic characteristics of the investigated geological formations, in connection to the genesis and to the relationship with adjacent rocks.

For an intervention targeted to a single building, the knowledge the type and size of the foundation system, together with the geotechnical characterization of the ground, are necessary elements for the assessment of the seismic action and its effect on the building.

All of the survey and verifications should be preceded by a thorough study of the documentation available for the building, his past and recent history. Thanks to these preliminary studies, it is possible to prepare an investigation plan to determine the shape, size and materials forming the foundation structures. Possible investigations will be preferred through non-destructive testing, such as geophysical and tomographic tests.

Geotechnical investigations should enable the physical-mechanical characterization of the foundation soils, through in situ tests or/laboratory tests, aimed at identifying geotechnical models adapted to local seismic response analysis of soil-structure dynamic interaction.

As said, the perception of seismic risks is particularly relevant in the countries of the Mediterranean basin. A recent work (Silva et al. 2014) reports an overview on projects, both at global and European scale, regarding seismic hazard and assessment of related risk with a specific focus on Portugal. In this work the seismic hazard and risk for Portugal was studied through almost available models, methodologies and datasets. The comparison of the chosen models and the proposed seismic hazard map showed that an important fraction of the buildings is located in zones with high levels of seismic hazard (Silva et al 2014). The main

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23 The geological sheets are on sale at ISPRA, at the Istituto Poligrafico e Zecca dello Stato (Italian Polygraphic Institute) and authorized bookshops. They are also available at ISPRA Library. In addition, flash format geological sheets are available on ISPRA website: Geological Map of Italy at the scale 1:50.000 (Geological Survey of Italy and CARG Project); Geothematic Maps at the scale 1:50.000 (Geological Survey of Italy and CARG Project); Geological map of Italian seas at the scale 1:250.000 (CARG Project); Geological map of Italy at the scale 1:100.000 (complete).
results obtained in the Portugal case results were obtained through the OpenQuake-engine\textsuperscript{24}, the open-source software for seismic risk and hazard assessment developed within the Global Earthquake Model (GEM) initiative.

Another country particularly exposed to seismic risk, and also to floods and landslides, is Turkey where the majority of the population lives in seismically active areas.

The National Disaster Risk Assessment and Analysis Working Group have developed guidelines for assessing the above mentioned hazards following methodologies in line with international standards. In Turkey most studies and projects on hazard and risk assessment are relatively recent and many are still on-going. For example, the Turkey Disaster Risk Management System Project (TAF-RISK) focuses on risk modeling and developing algorithms in relation to earthquakes, floods, landslides\textsuperscript{25}.

The Turkey National Earthquake Strategy and Action Plan 2012-2023 aims to minimise the possible physical, economic, social, environmental and political damage and losses caused by earthquakes and to create living areas that are resistant to and prepared for earthquakes\textsuperscript{26}.

Seismic risk maps are not yet available nationwide due to the lack of data on building and critical infrastructure seismic vulnerability. Risk maps and scenarios are available only for the Metropolitan Municipality of Istanbul.

In general, current practices of detection and reaction against seismic risk can be described as follows:

- **Building identification.** The first step is the correct and complete identification of the building and its location on the territory. This phase also includes a first schematic survey of the building, able to describe the location of elements particularly sensitive to damage. At this stage it must be analyzed the relationship between the building and its surroundings, through the description of the “architectural complex”, isolated or not isolated, and the characterization of the spatial and functional relationships between the building and any nearby objects. The study should provide constructive hierarchy and relationships between the building and the environment; the survey can be effectively conducted through the use of stratigraphic techniques.

- **Functional characterization of the building and its spaces.** The knowledge of the building cannot ignore the historical analysis of the evolution of the building functions, finalized to recognize the uses occurred over time. The result of this analysis leads to even understand the reasons for the structural and geometric changes occurred over time, to motivate any signs or information about disruptions, with the aim of reducing the seismic risk.

- **Historical analysis of the events and actions.** For a correct identification of the state of the building stress it is important to know the construction history, that is, the construction process and the successive changes of the building along the time. Moreover, building’s history can be used as instrument for controlling and verifying

\textsuperscript{24} https://github.com/gem/oq-engine/blob/master/doc/about.md

\textsuperscript{25} https://www.afad.gov.tr/en/

\textsuperscript{26} http://www.deprem.gov.tr/en/Category/udsep-2023
the building's response to the earthquakes occurred in the past. Therefore, events and corresponding effects should be identified with the study of iconographic or historical sources. The knowledge of the construction response to a particular traumatic event can allow identify a qualitative model. The consultation of the numerous existing seismic catalogs and direct retrieval of archives documents related to seismicity of the places and the harm suffered by the buildings, constitutes a basic fundamental reference. The data acquisition of the related damage suffered from the building in previous seismic events is configured as an indispensable method for the identification of vulnerable elements.

- **Architectural and structural survey.** The survey should include both the overall geometry of the building and the construction elements, and furthermore the relationships with other close buildings. The representation of the results of the survey will be exposed through plans, elevations and sections, also with architectural details. As the geometric survey will be used to define the geometry of the model to be employed in the seismic analysis, all necessary information should be verified. It is necessary detect and represent the cracking map, so as to allow to identify the causes and the possible evolution of the structural problems of the building. The lesions will be classified according to their geometry (size, width) and their kinematics (detachment, rotating, sliding, moving out of the plane).

- **Survey of materials and construction techniques.** This survey aims at identifying the constituent materials of the architectural elements of the building, and the construction techniques. It is necessary to know the artifact building phases, and to have a complete knowledge of the construction characteristics of the artifacts in relation to its different historical periods.

This recognition requires the collection of information often not immediately visible (covered by plaster, or from layers of paint, etc.), which may be executed through indirect non-destructive investigation techniques (thermography, ground penetrating radar, etc.) or direct non-invasive or minimally invasive inspections (endoscopies, removal of little portions of plaster, etc.)

Concerning the artifacts in museum or art galleries, some precautions have to be taken, even if the earthquake could not potentially cause damage to the structure of the building. In case of earthquake, in fact, it is possible that the exposed objects fall, slip, or detachment can occur (McKenzie et al. 2007; Saunders 2008).

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27 List of main seismic catalogs for the Italian territory: Catalogo dei terremoti italiani dall'anno 1000 al 1980, Progetto Finalizzato Geodinamica (PFG) del CNR. Gruppo Nazionale per la Difesa dai Terremoti (GNDT), http://emidius.mi.ingv.it/NT/


From some studies of the J. Paul Getty Museum (Lindvall 1984; Agbabian et al. 1990; McKenzie et al. 2007) basic criteria for stability have evolved. For example, the response of a rigid object to earthquake induced forces and motion can be sliding or, if the friction between the object and the supporting plain is high enough, rocking and eventual overturning. Rocking and overturning are based both on the nature of the earthquake and the object’s (or object assembly’s) geometry and mass distribution, additional strength can be provided by introducing supportive mounts that cradle and restrain the object on display.

In the works of Getty, detailed solutions for mounts are reported with specification about dimensions, loads, and materials. As general suggestions, mounts should always be made of stable materials that are non-abrasive, non-corrosive, stable, non-staining, and free of corrosive vapours.

A special attention is paid to the design and planning of interfaces and contact points between objects and mounts.

In conclusion to this paragraph a short mention about climate change should be made as factor increasing the effect of various natural hazards to CH contexts. Extreme weather events and their associated hazards are predicted to become more frequent and damaging under all proposed scenarios of climate change (Hewitson et al. 2014).

The term “climate change” (CC) generally means a change of the sum of the prevailing atmospheric conditions: heat, cold, dryness etc., of a place over a period of time. Such a change causes variations in adverse atmospheric conditions as for example rain, wind, sleet etc., which influence weathering damages substantially. It is possible distinguish between “global”, “regional” and “local” climate changes. However, in the last years, the term “climate change” is understood as a change on global, i.e. on the Earth scale level. Nevertheless, it is reasonable to develop and apply policies, strategies and measures mitigating such a global CC impact on cultural heritage on the three levels mentioned above, too. Human activity is the primary cause of CC at any level.

At global scale, it is a result of deterioration of atmospheric protection layers against cosmic negative agents, first of all against sun radiation causing the so called global warming.

On the regional level, the mass industrial production generates a high air pollution affecting large states and regions. Transport, heating of houses, local industries etc. produce concentrated local or indoor climate changes; the climate change results in physical, chemical, biological, effects on cultural heritage. It causes events with disastrous or catastrophic features, as e.g. high winds, heavy rains and snowfall, floods, landslides and avalanches, and increases a danger of large fires. Physical and chemical effects are significantly associated with threats to material cultural heritage objects, mostly immovable.

At regional and local levels, it is important to promote the creation of vulnerability maps for the region and sub locals regions and provide guidance on the monitoring programmes that might be appropriate for CH sites in the region which might be affected differently by different climate change parameters. Thematic groupings of local sites likely to face similar threats such as archaeological, movable, coastal, mountainous or marine sites, could also be developed (Lefèvre and Sabbioni Eds. 2016).
To identify the greatest global climate change risks and impacts on cultural heritage, the scientific community uses climate parameters such as those published by UNESCO (Figure 5).

In order to mitigate the impact of CC on CH, preventive measures should be adopted and, in case of damages derived from CC effects, reactive approaches are needed.

The best preventive strategy consists in removing the causes of CC. It is obvious that, on global level, such a task lays beyond capacity limits of contemporary profit driven and a heavy consumption oriented society. Nevertheless, preventive measures on lower levels are in hands of local governments or even individual citizens and therefore possible and desirable. Their success is dependent on the scale of problem and it is generally experienced the smaller problem.

In the second case, it is advantageous to know possible mechanisms of degrading or damaging cultural heritage in order to be able to plan adequate and effective preventive measures.

Reactive approach is concentrated on remedial works removing damages or other impacts from the cultural heritage after the action caused by climate change.

Monitoring is a key factor for the sustainability of cultural heritage in the face of climate change. Remote sensing, such as the use of satellite technology, non-destructive techniques, bio-sensing to assess biological damage to materials and the use of simulation tools to predict the impact of climate change on the behaviour of cultural heritage materials, are needed.
### Table 1. Principal climate change risks and impacts on cultural heritage

<table>
<thead>
<tr>
<th>Climate indicator</th>
<th>Climate change risk</th>
<th>Physical, social and cultural impacts on cultural heritage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atmospheric moisture change</td>
<td>Flooding (sea, river)</td>
<td>pH changes to buried archaeological evidence</td>
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<tr>
<td></td>
<td>Intense rainfall</td>
<td>Loss of stratigraphic integrity due to cracking and heaving from moisture</td>
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<tr>
<td></td>
<td>Changes in water table levels</td>
<td>Changes in sediment moisture</td>
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<tr>
<td></td>
<td>Changes in soil chemistry</td>
<td>Data loss preserved in waterlogged / anaerobic / anoxic conditions</td>
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<tr>
<td></td>
<td>Ground water changes</td>
<td>Eutrophication accelerating microbial decomposition of organics</td>
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<tr>
<td></td>
<td>Changes in humidity cycles</td>
<td>Physical changes to porous building materials and finishes due to rising damp</td>
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<tr>
<td></td>
<td>Increase in time of wetness</td>
<td>Damage due to faulty or inadequate water disposal systems; historic rainwater goods not capable of handling heavy rain and often difficult to access, maintain, and adjust</td>
</tr>
<tr>
<td></td>
<td>Sea-salt chlorides</td>
<td>Crystallization and dissolution of salts caused by wetting and drying affecting standing structures, archaeology, wall paintings, frescos and other decorated surfaces</td>
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<td></td>
<td></td>
<td>Erosion of inorganic and organic materials due to floodwaters</td>
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<td></td>
<td></td>
<td>Biological attack of organic materials by insects, moulds, fungi, invasive species such as termites</td>
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<td></td>
<td></td>
<td>Subsoil instability, ground heave and subsidence</td>
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<tr>
<td></td>
<td></td>
<td>Relative humidity cycle/salt causing splitting, cracking, flaking and delaminating of materials and surfaces</td>
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<td></td>
<td></td>
<td>Corrosion of metals</td>
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<tr>
<td></td>
<td></td>
<td>Other combined effects e.g. increase in moisture combined with fertilisers and pesticides</td>
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<tr>
<td>Temperature change</td>
<td>Diurnal, seasonal extreme events (heat waves, snow loading)</td>
<td>Deterioration of facades due to thermal stress</td>
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<td></td>
<td>Changes in freeze-thaw and ice storms, and increase in wet frost</td>
<td>Freeze-thaw frost damage</td>
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<tr>
<td></td>
<td></td>
<td>Damage inside brick, stone, ceramics that has got wet and frozen within material before drying</td>
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<td></td>
<td></td>
<td>Biochemical deterioration</td>
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<tr>
<td></td>
<td></td>
<td>Changes in fitness for purpose of some structures. For example overheating of the interior of buildings can lead to inappropriate alterations in the historic fabric due to the introduction of engineered solutions</td>
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<tr>
<td></td>
<td></td>
<td>Inappropriate adaptation to allow structures to remain in use</td>
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<tr>
<td>Sea-level rises</td>
<td>Coastal flooding</td>
<td>Coastal erosion/loss</td>
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<tr>
<td></td>
<td>Sea-water incursion</td>
<td>Intermittent introduction of large masses of 'foreign' water to the site, which may disturb the metastable equilibrium between artefacts and soil</td>
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<td></td>
<td></td>
<td>Permanent submersion of low-lying areas</td>
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<td></td>
<td></td>
<td>Population migration</td>
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<td></td>
<td></td>
<td>Disruption of communities</td>
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<td></td>
<td></td>
<td>Loss of rituals and breakdown of social interactions</td>
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<tr>
<td>Wind</td>
<td>Wind-driven rain</td>
<td>Penetrative moisture into porous cultural heritage materials</td>
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<td></td>
<td>Wind-transported silt</td>
<td>Static and dynamic loading of historic or archaeological structures</td>
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<td></td>
<td>Wind-driven sand</td>
<td>Structural damage and collapse</td>
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<tr>
<td></td>
<td>Winds, gusts and changes in direction</td>
<td>Deterioration of surfaces due to erosion</td>
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<tr>
<td>Desertification</td>
<td>Drought</td>
<td>Erosion</td>
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<tr>
<td></td>
<td>Heat waves</td>
<td>Salt weathering</td>
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<td></td>
<td>Fall in water table</td>
<td>Impact on health of population</td>
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<td></td>
<td></td>
<td>Abandonment and collapse</td>
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<td></td>
<td></td>
<td>Loss of cultural memory</td>
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<tr>
<td>Climate and pollution acting together</td>
<td>pH precipitation</td>
<td>Stone recession by dissolution of carbonates</td>
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<td></td>
<td>Changes in deposition of pollutants</td>
<td>Blackening of materials</td>
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<tr>
<td></td>
<td></td>
<td>Corrosion of metals</td>
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<tr>
<td></td>
<td></td>
<td>Influence of bio-colonisation</td>
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<tr>
<td>Climate and biological effects</td>
<td>Proliferation of invasive species</td>
<td>Collapse of structural timber and timber finishes</td>
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<tr>
<td></td>
<td>Spread of existing and new species of insects (eg termites)</td>
<td>Reduction in availability of native species for repair and maintenance of buildings</td>
</tr>
<tr>
<td></td>
<td>Increase in mould growth</td>
<td>Changes in the natural heritage values of cultural heritage sites</td>
</tr>
<tr>
<td></td>
<td>Changes to lichen colonies on buildings</td>
<td>Changes in appearance of landscapes</td>
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<tr>
<td></td>
<td>Decline of original plant materials</td>
<td>Changes the livelihood of traditional settlements</td>
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<tr>
<td></td>
<td></td>
<td>Changes in family structures as sources of livelihoods become more dispersed and distant</td>
</tr>
</tbody>
</table>

Figure 5: Table published by UNESCO World Heritage Centre 2007, 25.
3.4 Greek case

3.4.1 Current conservation and management

In Greece there is an official approved list of important artefacts and historical/heritage buildings. The Directorate of National Archive of Monuments (http://nam.culture.gr) compiles a National Digitized list of artefacts (available online at: http://collections.culture.gr).

As support to prevention and conservation activities, different kinds of CH archives exist: photos, cartography, detail mapping, aerial photos (all in paper and digital or digitalized format). Moreover, excavation documents, restoration documents, catalogue cards in paper format and ortho-photography, in digital format, exist. Excavation and restoration documents are in progress of digitalisation. This type of documentation varies among the regional directorates of antiquities and it is formed according to their individual requirements.

Concerning regular maintenance and conservation works, usually the following activities are performed: weeding tree/shrub pruning, wall consolidation and maintenance of paths. All these works are made by Ephorate employees and conservators for the pilot site as well.

Conservation implementation plans are designed according to the individual needs of the monuments at risk and its state of preservation after research on methods and practices (Koygleri 2010).

The conservation and restoration of the minaret of the Gazi Deli Husein Pasha Complex (Giapitzoglou 2008) serves as a valuable example of current practice and co-ordination of different institutes of the Ministry of Culture covering different disciplines including the EFARETH and Directorate for the Restoration of Byzantine and Post-Byzantine Monuments. The minaret was built in 1890/91 and is located in the historic centre. It is a slender tall building, approximately 33m. high and incorporates two balconies on its highest part. Its base is polygonal and supports the round fluted shaft. The masonry of the upper part has been excessively damaged due to the corrosion of the iron holders used between the stone blocks (Figure 6). The risk of collapse was such that in 2004 it was decided to support the entire building with metallic scaffolding (Figure 7).

The restoration of the minaret and the conservation of the stone and metallic parts, begun in 2010. The design of the implementation plan was undertaken by the Directorate for the Restoration of Byzantine and Post-Byzantine Monuments. It was decided to dismantle the most damaged upper part of the building (lower balcony till the roof) in order to avoid further collapse (Figure 8).
Figure 6: the corroded iron parts that connect the original stone masonry.

Figure 7: The minaret after the placement of the scaffolding.

The original location of the stone material was recorded upon dismantling. The stones were conserved and the corroded iron was replaced by stone fittings. New stone parts were used in areas of loss. The new stones and mortar was compatible to the original. New steel fittings were also used. After the re-attachment of the masonry, the original metallic balconies were placed back and the entire building was re-enforced statically.
Figure 8: During the process of the removal of the upper masonry. The condition of the minaret was stabilized successfully (Figure 9).

Figure 9: The minaret after the completion of conservation and restoration project.
Maintenance work relevant to vegetation that covers areas of the fortification of the Fortezza is undertaken in specific time intervals by the EFARETH and the Municipality of Rethymno. The removal and/or clearance of plants and their roots, especially before the period of blossom minimize the risk of mechanical damage on the masonry (Figure 10 and Figure 11). The procedure includes regular cutting of the stems close to the roots during the summer period in order to discourage further plant growth during the forthcoming spring time. Higher plants are also cut before they blossom in order to prevent the pollen spreading and the growing of young plants. The use of biocides and fungicides is strictly forbidden since these products can be harmful to both the user and the material and are considered environmentally hazardous.

Figure 10: The bastion of St. Lucas, west side.
3.4.2 Disaster risk management activities

In terms of risks connected to predictable natural hazards, considerable work has been undertaken in Greece in the field of monitoring environmental pollution and analysing the impact in CH (http://www.ypeka.gr/Default.aspx?tabid=491&language=el-GR). Accordingly, strategies of preventive and implemented conservation were developed and applied in case studies. Risks relative to predictable natural hazards are assessed in general level as well as to individual case studies. There is a general national emergency plan (http://civilprotection.gr/sites/default/gscp_uploads/fek_423b_2003_xenokratis.pdf). At present there isn’t a general GIS Risk map.

The mechanical damaged caused by earthquake on the facade of the Arcadi Monastery, one of the most significant monuments of Greece, posed risks on the physical integrity of the monument. A deep crack was developed at the upper part of the bell-tower passing through the central area of the facade. Wind weathering was also occurring, causing damage on the carved architectural elements (Figure 12).

The conservation implementation plan was developed according to the approved research studies of the EFARETH conservation scientists after experimentation and testing on conservation materials and methods.
The weather stone surface was consolidated with compatible conservation materials and mortars in order to prevent further damage from the action of wind. Relevant to the main crack, this was filled accordingly (Troullinos 2010) (Figure 13 and Figure 14).
3.4.3 Actors involved

In Greece, there is a “Task Force” in which participate local entities of the archaeological service of Ministry of Culture (Ephorates of Antiquities), Civil Protection Departments and Fire Departments (www.fireservice.gr) in collaboration with specialized institutes like Institute of Geodynamics (http://www.gein.noa.gr), National Observatory of Athens, etc.

There are highly qualified persons involved in prevention and management of natural hazards in National Level, working in the Directorates of the Ministries and in Universities and other national institutions. In special projects, like STORM, the Ephorate involves highly qualified persons in temporary phase.

In Greece there are security managers in archaeological sites and museums. Generally, they are the chiefs of the guards, which in collaboration with the archaeologists, architects, civil engineers and under the instructions of the directors of the Ephorates of Antiquities or of specific museums, organize the public safety plans, evacuation plans etc.

In on-going projects there is usually a security manager and responsible for the Health and Safety of the staff and public during the implementation of the project, which is usually an architect or civil engineer.

If a ND affecting the CH occurs in National Level, the situation is handled by the Civil Protection in collaboration with the General Directorate of Antiquities, who give directions to the units in regional level (Ephorates) (http://www.culture.gr/culture/gindex.jsp).
3.5 Italian case

3.5.1 Current conservation and management

In terms of current conservation and management activities, in the Italian case generally, the archives containing photos, documents, maps, etc. are present and stored directly in the site or in the Superintendence central archive.

The different kinds of documents are generally present both in paper and digital/digitalised format.

Paper cartography in different scales (1:500; 1: 200; 1: 100; details in scale 1: 50); prospects and sections covering the whole site is present for the Italian case.

Digital cartography is generally present from the end of the '90s, and today the Superintendencies make or require, to external professionals engaged in documentation activities, only digital cartography, in CAD format. In addition to the cartography, the archives contain historical and recent aerial photos and aerophotogrammetric maps.

In the last years, the Italian Superintendences most commonly are using 3D laser scanning surveys for documenting artefacts, architectural structures and historical buildings.

Monitoring is usually set up in case of specific problems and for limited time.

Maintenance works includes weeding, mowing, tree/shrubs pruning, wall consolidation, removal of stagnant waters and maintenance of paths and protective systems.

Maintenance works are also performed daily, when need. It is carried out usually by external companies under the control of the architect in charge.

Concerning the procedure used in extraordinary maintenance, some examples need to be illustrated to highlight the peculiarity of each intervention in relation to the context.

A) An example of extraordinary maintenance plan is represented by the procedure adopted after the exceptional climatic events that occurred in the months of November and December 2008 in the territory of Rome and province. These events resulted in a serious worsening of the instability phenomena, as well as a rapid progression of structural risks to the entire archaeological heritage of Rome and province.

These events required the development of an extraordinary maintenance plan in the archaeological areas of Rome and Ostia Antica, which imposed the adoption of urgent measures that should be immediately taken with the exercise of powers even in derogation from the normal regulations. For this reason, it was issued the Ministerial Decree n. 3747 in March, 12, 2009 (which followed the Order of the President of the Council n.3774 Ministers of May, 28, 2009, published in the Official Gazette of June, 11, 2009).

The Ministerial Decree ordered the appointment of a special Commissioner-Delegate for overcoming the serious danger for the archaeological assets in Rome and in its province. The Commissioner had the order, based on the available financial resources, to prepare a specific plan of action (Cecchi 2009, 15 and 18; Cecchi 2014), to be submitted to the General Coordination Commission for approval. This plan had to consider:

- Measures for the safety and protection of archaeological sites;
- Extraordinary maintenance and consolidation works to prevent the deterioration of archaeological heritage and to enable the full enjoyment by visitors;
- Initiatives to overcome the emergency situation, with particular reference to the functional safety of the sites, the personnel employed therein and visitors, and environmental restoration.

B) Another example of maintenance plan is that of Pompei (Gasparoli 2012; Gasparoli and Podestà 2011; Gasparoli 2014), where, on the other hand, an innovative approach was developed with respect to the central archaeological area in Rome. Here, the improvement, from a methodological standpoint, lies in the development of a comparative risk evaluation analysis, systemic observations on deteriorating conditions for materials and components, and observations on the static condition of wall structures (including seismic risk), all of which were strictly correlated one to the other, producing a single diagnostic Report (named Diagnostic report sheet, see Gasparoli 2012, 151). Inspection visits in Pompei were conducted jointly by teams of engineers (scientific coordinator: Prof. Stefano Podestà, DICAT, Università di Genova) and architects (scientific coordinator: Prof. Paolo Gasparoli, BEST, Politecnico di Milano). Starting from a shared survey that was structured in two parts: technology risk and structural risk (with the development of a form named Structural risk report sheet, see Gasparoli 2012, 153), and a common codification of technical elements, the inspections were undertaken simultaneously with frequent cross-checks.

C) With regard to seismic risk, in order to collect useful information to monitor the conservation status following an exceptional event such as an earthquake, the Ministry of Culture, according to the Directive of the President of the Council of Ministers, February, 9, 2011 establishes that: "Assessment and reduction of seismic risk of cultural heritage with reference to the technical standards for construction set out in the decree of the Ministry of infrastructure and transport of January, 14, 2008", produced a synoptic form (named Guideline for maintenance report from the Italian Ministry of Cultural Heritage) in which the appointed officer or the technical operator, is obliged to report specific information. In particular, the sheets include general information on the location of the CH asset (section A), the description of the administrative attention to extraordinary maintenance to be performed as a result of the anomalies (section B) and finally the seismic improvement interventions (section C) to address technical data pre and post maintenance. The sheets are a useful tool for gathering information about the intervention of maintenance.

Speaking about extraordinary maintenance work, the bibliographic research provides a wide range of cases of noteworthy interventions.

The prevention of risks also leads to the verification and maintenance of equipment (electric, water, heating/air conditioning, telecommunications, of fire and smoke detection, intrusion detection) inside the structure, but also to check for window and door frames.

In Italy a part of these controls is regulated by the D.M. 569/92 (Norme di sicurezza antincendio per gli edifici storici e artistici destinati a musei, gallerie, esposizioni e mostre - Fire safety regulations for historic and artistic buildings used for museums, galleries, permanent and temporary exhibitions) and by a Decree of the Republic President n. 418 of 30/6/1995 (Norme di sicurezza antincendio per gli edifici di interesse storico-artistico destinati a biblioteche ed archivi - Fire safety regulations for buildings of historic and artistic interest used for libraries and archives).
D) An example is the case of the Lavanderia Borbonica, also called “Palazzotto”, built in the Bourbonist period, which rises on the crater slopes, in the middle of Port Paone inlet, in the island of Nisida (Fumo and Lemetre 1999).

Degradation processes that affected the building were caused by the invasion of vegetation, the mud silting of structures and the loss of functionality of rain water canalising and removal systems.

Restoration and maintenance extraordinary works regarded:
- the decayed covers;
- the separation of the porch from the outside plugging;
- the strengthening of tuff walls with cement mortar or brick bracings and concrete chains;
- the strengthening of foundations.

**Interventions for the removal of vegetation:** The cover terrace was entirely covered by shrubs and brushwood; this made necessary a chemical manual removal of grasses. With regard to vault covers, the intervention on the extrados consisted in the removal of the terra cotta floor, the demolition of blocks, the seam of wounds using stone gallets and cement, the filling with light materials and the realisation of a slab for a better sharing of vertical loads. Also the steel floors and the little vaults, built in the twenties in substitution of the original vaults, required important intervention.

**Strengthening interventions:** The square-plant tower with trapezoidal section till the first floor is heavily degraded because of wide erosion of the sole. The intervention has restored the tuff garnish by using, where possible, the same stones and after the strengthening of the nucleus partly using of cement grouting and partly using stones exceeded from the demolition of the plugging in the porch.

The interventions provided the removal of the floor and of the existing block and the realisation of several works which aimed to the technical and functional improvement of the horizontal structure. As the floor has to bear incidental loads, these one have been established according to law. Analysing the situation of places was necessary to complete the intervention by reclaiming the existing walls in order to guarantee a better co-operation between walls and floor. All the intervention has respected the preservation of the original structures.

After tests, floors were sub dimensioned: the intervention required the realisation of a floor over the existing one, which could take up all the solicitations due to own weights and to incidental and permanent loads. All the existing beams have been brushed and fortified. The removed brickwork floor has been cleaned and reassembled. The interventions didn't increase stresses in the vertical structures; they improved their connections under the action of horizontal loads due to earthquake.

All the inside rooms have been cleaned from rubbles. And nearly all the wall openings have been consolidated.

In the porch, at the middle height between haunches and coussinets, seven steel chains have been inserted and locked with dadoes and check nuts at the extremities of abutment piers.

E) Extraordinary maintenance work were carried out recently also on the Arch of Titus, in Rome, the intervention had to fulfil two objectives: consolidation and cleaning of the
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stonework, especially in the oldest parts, and an assessment of the monument's static condition, both overall and in those points in which crumbling and cracks pointed to possible problems. In particular lesions to a column and in some blocks of travertine added during restoration in the 19th century raised the possibility of damage to the inner core of the stonework (Conforto and D’Agostino 2003).

A detailed assessment of the monument allowed to establish the state of deterioration of the travertine slabs incorporated during Valadier’s intervention. The principal cause was the action of atmospheric agents which corroded the external surface of the stonework and disjointed the various components. This led to infiltration by rainwater, causing the thick metal brackets inserted to fasten the slabs to the original masonry to become rusted. The rusting of the metal brackets was the prime cause of the deterioration of the modern facing. The deep fracture in the base of the column on the side facing the Colosseum was also found to be due to metal elements inside the structure, but this was not investigated more closely for fear of causing further damage.

Inspection of the site showed no sign of deterioration, ruled out any possibility of weakness in the foundations and guaranteed the perfect stability of the monument overall. The disjointedness of the large blocks comprising the intrados can be attributed to the intervention of Valadier.

During reassembling it proved impossible to fit the blocks together again perfectly, so it was decided to close up the interstices, inserting stone voussoirs where necessary, in order to restore the compacting effect of the blocks.

Drawings and paintings and data collected during the survey carried out alongside the conservation work allowed to map every component of the arch and proceed to a series of static tests using both traditional methods and calculus of finite elements. It was established the state of stress under normal conditions, considering the weight of the structure both for the direct bearing and for the whole arch using the traditional method. The calculus of finite elements was carried out on the basis of the following stress conditions: overall weight plus wind, overall weight plus seismic activity.

Cleaning: the surfaces both of the marble and the Travertino have been cleaned with atomized water, in a diversified process, of the more exposed Travertino parts. More tenacious encrustations have been treated, after the Atomized water treatment, with compress of a watery ammonium-carbonate solution kept in suspension with cellulose pulp. Not soluble residuals or calcareous encrustations or not suitable stucco or over edged stucco insisting on the original surface, have been mechanically removed with Vibro-engraver, micro-drills or manual tools.

Consolidation: on the South side of the fractured capital, supported by unsuitable coupling element made in copper; cleaning and consolidation of the object with ethyl-silicate after the disassembly of the unsafe fragments; reassembly of the smaller fragments with Epoxy resin; anchorage to the structure of the three greater fragments with as much pivots in Titanium (cm 12x22). The traditional appearance of the monument was left untouched.

F) Another case of extraordinary intervention on a building damaged by earthquake, can be considered the fragment re-composition in the Upper Basilica of St Francis of Assisi (Il restauro in Italia 2013). In this case, an experimental system for the recovery and re-
assembling of the fragments from the collapsed wall painting was developed and it can be summarized as shown in Table 9.

Work began immediately to save the pieces, sifting through the rubble and recovering more than 300,000 fragments which were carefully catalogued one by one before starting the long work of selection and re-composition.

The task of re-assembling and restoring a work that has been shattered into fragments is one of the most complicated, in this case made even more difficult by the “explosion” of the painted surface into thousands of plaster fragments, many of which were smashed into even smaller pieces by the weight of the bricks that fell together with the fragments from a height of over twenty metres, as well as the total pulverisation of many of the pieces, leaving extensive lacunae in the paintings (Figure 15).

Table 9: Procedure used in the re-composition of the fragmented wall paintings from the Upper Basilica of Assisi

<table>
<thead>
<tr>
<th>Problem</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Determine a criteria for selection and re-assembly</td>
<td>Examination and comparison of painted surface of the fragments. Examination of paint film and the preparatory layers. In the reconstruction were used some of the less damaged original bricks, assembled in a certain number of recovered bricks in a reinforced block in order to create a sort of module</td>
</tr>
<tr>
<td>Recreate the image as closely as possible, trying to find the right position for the many coloured chips</td>
<td>Use of photographs from before the earthquake to reassemble the pieces in the right position. The selected images were enlarged to a 1:1 scale. During this phase, a computer program was used to obtain a flat representation of the curved surfaces by of mathematical comparison with parts of the original decorations which were still in place. In this way a life size map of the collapsed areas was created on which to position the various fragments. The printed images were the basic reference material for the assembly phase, providing a match between the painted fragment and the photographic reproduction.</td>
</tr>
<tr>
<td>Find a method that made it possible to position the pieces definitively on an auxiliary support</td>
<td>Use of a rigid panel that should not change shape or size and be able to support not only the layers of the paint film but also the preparatory plaster layers, so as “not to alter the appearance of the material”. The supporting panels work met the self-same requisites of high dimensional stability, reversibility, reduced thickness and weight, easily shaped to reproduce both flat and also concave surfaces. Once they had been correctly placed in their original positions on the basis of the photographs, the fragments were transferred manually to the auxiliary supports following guidelines derived from the 1:1 photographic prints. The task of positioning the fragments on the carefully shaped surfaces of the panels was achieved using the spolvero technique.</td>
</tr>
</tbody>
</table>
Recreate the images that had been destroyed

The choice was not to retouch the losses in imitation of the surviving paint, but rather to give the fragmented paintings a sense of unity by visually toning down (using neutral grey washes) the losses; a technique which was also similar to that previously employed in the restoration of losses in the paintings which had not collapsed.

Figure 15 (left) Details of fragments of the face of St. Benedict. (right) Detail of panel of St. Benedict after reintegration (From: Il Restauro in Italia 2013)

3.5.2 Disaster risk management activities

A relevant example of current disaster risk management in Italy, can be considered the “Carta del Rischio (1997) del Patrimonio Culturale Italiano” (Risk map of Italian Cultural Heritage) – conceived by the Istituto Superiore per la Conservazione e il Restauro (ISCR, previously named ICR). The Italian Risk Map relies on the concept of preventive restoration developed by Cesare Brandi in 1963, and represents the operational tool to implement the process of preventive maintenance and planned conservation started by G. Urbani since the 1970s (Istituto Centrale del Restauro 1976) in his Piano pilota per la conservazione programmata dei beni culturali dell’Umbria (Pilot Plan for the Planned Conservation of Works of Art in Umbria). Urbani highlighted the need to review ICR activities in order to promote an innovative safeguard system based on the analysis of natural and anthropic risks to which cultural heritage is exposed and on its planned conservation (Ministero per i Beni Culturali ed Ambientali, ICR 1996a; Ministero per i Beni Culturali e Ambientali – ICR 1996b; La Carta del Rischio 1997; Accardo 1997; Accardo and Baldi 1997).

By promoting the projects, Pilot Plan for the Planned Conservation of Works of Art in Umbria (1976) and Protection of monumental heritage from seismic risk (1983), Urbani implemented the first applications of planned conservation and gave rise to a modern interpretation of the work of art in its interrelationship with the territory and the territorial planning processes. The state of preservation and the degree of “vulnerability” of the buildings are simultaneously interpreted as the outcome of the interaction between the artifact, in its material and planning texture, and the environment, in its multiple risk components.
The Italian Law 84/1990 enacted the principle behind the Pilot Plan, promoting the implementation of the “Risk Map” of the national territory under the scientific responsibility of the Istituto Centrale per il Restauro. A first feasibility plan for the final realization of the project was made in 1987 (see Baldi et al. 1987).

The aim was to identify systems and procedures that could allow the programmed maintenance and restoration of cultural heritage (architectural, archaeological, historical and artistic), depending on its state of preservation and the relevant environment aggressiveness. If the risk of cultural heritage loss is assumed as a criterion for the identification of priorities, the knowledge of its distribution throughout the territory is required for developing safeguard, conservation, and urban planning measures. This explains why cartographic representation of the risk level provides a solid planning tool and an immediate visualization of the information relevant for cultural heritage safeguarding. At the same time, a Geographic Information System becomes the best suited information instrument for this purpose.

As a result, between 1992 and 1996, the ICR started implementing the MARIS (MAppa RISchio) system, in order to allow access to planning documents for Public Administration – in particular the Superintendence offices engaged in the safeguard, conservation and maintenance of cultural heritage in their areas of jurisdiction, but also for the local administrations (Regions, Provinces, Municipalities), the dioceses and universities, which contribute to the protection and preservation of the archaeological, architectural, artistic and historical heritage.

The MARIS data sheet model is divided into two sections: one covers property master data, using the ICCD cataloguing standards, and the other covers data on the preservation state. The MARIS GIS was built using ESRI software created for the management of basic cartography and the generation of thematic maps, and Oracle platform for the creation, management and querying of the alphanumerical database. The information processes allowed both to measure the loss risk intensity, which each property is subject to, and to acquire its distribution across Italy by means of thematic cartographic representations that can be always updated.

The “Risk Map” is the most extensive system of alphanumeric and cartographic database that includes data concerning a very large amount of cultural assets distributed across the entire Italian territory, due to the work of property census and cataloguing carried out by ISCR and by locals (Remote Systems, Regions). The experimentation carried out until now through the survey of many artifacts, and the consequent identification of about 200 variables, has allowed to build up a system capable of evaluating, with sufficient accuracy and completeness, the “Vulnerability” index of the cultural heritage under investigation. The system, however, does not still provide a “Risk” index. This is partly compensated for by the use of overlay mapping processes which, by matching computerized maps with thematic content, allow to highlight the relationship between environmental hazard existing on the territory (e.g. due to earthquakes, floods, landslides, etc.) and the risk for exposed monuments.

Despite some functional issues, the “Risk Map” system is the main reference tool in the safeguard of Italian Cultural Heritage. The system consists of an archive capable of processing data and statistics for each of the 8100 Italian municipalities expandable with their provincial, regional and national aggregations.
“Risk Map” includes varied cartography, with the representation of administrative divisions, hydrography, infrastructures and orthophotomaps, among other elements, and record sheets with alphanumeric information, photos and diagrams. Its elaboration took into account three types of dangers to cultural heritage, namely:

- Structural Danger (Seismic; Landslides damage; Floods; Coastal dynamics; Avalanches; Volcanic);
- Environmental – Air Danger (erosion, blackening and physical stress);
- Anthropic Danger (Dynamics linked to demographic density, pressures from tourism, susceptibility to theft).

The “Risk Map” also includes a record for the state of preservation of artifacts and assets and an assessment of their vulnerability, organized by municipalities. “Risk Map” became an important starting base necessary for working on the calculation of “territorial risk”, i.e., the levels of risk in the various municipal territories, according to the verified signs of degradation.

“Risk Map” is available for online consultation, both for registered users and the general public, and allows printing of data. It is, thus, an essential tool for the State, and government institutions, when performing their cultural heritage safeguard functions.

Since 1997 many Regions, in collaboration with the correlated Superintendent, have been outlining their local plans. Lombardia region, for example, published the Risk Map of cultural heritage in Lombardia (“La Carta del rischio del patrimonio culturale in Lombardia”); Emilia-Romagna region realized a risk map for the archaeological heritage; Abruzzo region developed a regional system of risk map; Marche region started the project for Risk Map of Cultural Heritage in Marche (“Carta del Rischio del Patrimonio Culturale delle Marche”, CdR-PCM); also Basilicata, Calabria and Sicily are oriented to follow similar initiatives (Monti and Brumana 2004; Guermandi 2001; http://www.edsiec.it/cultura/reserved/carta_rischio.htm). The GIS of Sicily Region should also be mentioned as system based on the ISCR technical data sheet and aimed at identifying the “vulnerabilities” of each surveyed asset.

The near future development of the “Risk Map” system could be represented by the integration of thematic cartographic data with data provided by satellite remote sensing and drones. Such approach, for instance, is supported by the Cosmo-SkiMed national program, promoted by the Italian Space Agency, and by the European project Copernicus Europe’s eyes on Earth that recently sponsored the Videor project, in order to collect important information on the territory, marine environment, atmosphere, climate change, emergency management, and security thematic areas.

To date, the Geographic Information System of the “Risk Map” turns out to be a tool of territorial government, available both to State and regional bodies, yet its potential is far from being fully understood.

Concerning the specific risks, Italy is one of the countries in the Mediterranean area with the highest seismic risk, due to its particular geographic position at the convergence of the

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African and Eurasian plates. The highest seismicity is concentrated in the central-southern part of the peninsula, along the Apennine ridge (Val di Magra, Mugello, Val Tiberina, Val Nerina, Aquilano, Fucino, Valle del Liri, Beneventano, Irpinia) in Calabria and Sicily and in some northern areas, like Friuli, part of Veneto region and western Liguria. Only Sardinia region is not particularly affected by seismic events.

To reduce the effects of the earthquake, state action has focused on land classification, based on the intensity and frequency of earthquakes of the past, and the application of special rules for construction in the classified seismic areas. These criteria were based on the studies and the latest calculations related to the seismic hazard of the territory. In particular, they were based on the probability of earthquake in a certain time interval (usually 50 years) and took into consideration a certain threshold of intensity or magnitude (Figure 16).

![Figure 16: Map of the seismic risk (from: http://www.protezionecivile.gov.it/resources/cms/images/pericolos_d0.JPG).](http://www.protezionecivile.gov.it/resources/cms/images/pericolos_d0.JPG)

The Geographical Information System of the Risk Map (designed for planning the maintenance and restoration of cultural property) made it possible to extract immediately all the alpha-numeric and cartographic data using its GIS functions by inserting the geographical coordinates of the hazards occurring.
This information can be sent to the Civil Protection agency and become the geographically referenced starting point for the first intervention activities.

The design of first interventions for the safety of CH starts from the damage survey and from the identification of the collapse mechanisms activated from the hazards, carried out by Unit for the identification of significant damages (Italian Directive 12/12/2013). The inspections, carried out by technicians of the Ministry, are planned within the institutional coordination with the Civil Protection organizations and take account of any reported requirements, as well as the conditions of accessibility of places. The inspections are intended to evaluate the damages suffered by the mobile and immovable assets (churches and buildings) of cultural interest, the possible need for temporary works, to avoid more damage to structures and all the movable assets inside the buildings, and thus to establish the first interventions to be done.

The filling in of the damage survey form is therefore the first tool to formulate a hypothesis of project for an intervention aimed to act against the specific hazards that is occurring.

After that is organised a technical meeting for all the expertise who took part in the inspections in order to define the actions of first interventions; during this meeting should be filled the section "Description of first intervention work" on the sheets for the damage inspection (detection of the second phase). The implementation of safety measures are defined, generally, following standard schemes, in respect of architectural compatibility of the building.

In case of damage to the movable CH, they are transferred in temporary warehouses, in order to plan the restoration work, if needed.

The “Operational Unit for temporary warehouses and laboratories for emergency on movable assets” has to guarantee for all movable assets: the inventory and the indexing of assets; the cataloguing (if not previously done); a check of the status of conservation to be registered on the “boards of emergency”; the photographic documentation; the evaluation of operations to be performed and their registration; security interventions, to be registered on the “boards of emergency” with photographic documentation; the attribution of an urgency code; the suitable location in the store; the provision of an information system of the Ministry.

Some entities, as the ISCR in Italy, given their extensive experience on systems for checking and cataloguing works, brought to maturity during the design and creation of the Risk Maps, are commissioned to devise and implement the system for identifying, cataloguing and conducting emergency treatment on the artworks that technicians secured and moved in more suitable places and structures identified for the first recovery.

The aim is to store the items in a way that would make it easy to retrieve them and so that it can be possible to organize a rational program for future treatments.

Can be very useful to compile a brief form for each item with a code number (from 1 to 4) showing the seriousness of the object’s condition and the urgency for restoration.

A summary of the identification data can be prepared on an Excel spread sheet listing the priority code and the item’s temporary location in the storage area. The environmental conditions of the laboratories and the storage area should be monitored using microclimatic control units in order to record temperature and humidity and check the parameters of the materials in storage. All the documentation has to be delivered to the Superintendence.
responsible for the territory in question, to be used as a basis for planning future restoration, and the information are to be added to the database of the Geographical Information System of the Risk Maps mentioned above. The information can be consulted online at the Risk Map website and represents an important platform for our knowledge regarding the condition of the works and their need for medium/long-term actions.

If an emergency of minor intensity occurs each museum or CH building must provide fast and simple written procedures that can be implemented by professionals, without having to resort (but always with the obligation to inform) to the Director or the Safety Officer. Many cases (i.e. a small water infiltration, a change of temperature etc.) can be solved in fact, strictly adhering to simple indications, however, must be noticed and reported, in order to prevent a recurrence of the problem. It is very important, however, to inform the Director or the Safety Officer, so that they can use this important information about the state of the CH assets, structure or installations, in planning a revision and bringing up to standards of the structures involved.

For emergencies of average severity, the procedures are more complex and require the simultaneous implementation of first intervention measures and the use of forces and means able not only to contain the damage, but also to eliminate it completely. So a principle of fire or flooding, impose the attempt of trying to douse the flames or to try to contain the expansion of water but also the need of contact immediately to the Security Officer or the Fire Department. In these cases the information to the Director or the Safety Officer shall immediately follow the request of the emergency services, ensuring their immediate presence (or that of their substitutes), so that the subsequent steps are taken under their direct responsibility.

In cases of major emergencies is essential to activate immediately the emergency plans and so the first intervention procedures, implemented under the direct responsibility of the Director or the Safety Officer. Since often the dividing line between an average emergency and major emergency is thin and it is also possible that the first intervention measures turn out to be insufficient to prevent any emergency to not turn into a more serious damage, the existence of plans general evacuation of the building or of the works must be previously studied and planned (in addition to compliance with the law) in such a way that it can start to be implemented without delay or waiting of those responsible. Forcibly involving a significant number of people (the emergency workers, whatever their definition of the law), it must be empowered to know what to do and to have experienced the procedures to be implemented, that he exercised complete them. Training of emergency workers must be treated carefully and return as an integral part of the emergency plans, using it as a moment of verification and control of their validity and relevance: a contingency plan in fact is not built “around a table”, but it will draw up “on the field”, using as a resource local knowledge and experience of the people.

As concerns the Italian pilot site, from the questionnaire it emerged that each site of the Superintendence and of the National Roman Museum, including the Baths of Diocletian, is provided with an emergency plan in order to deal better with any kind of emergency. Aim of the plan is to safeguard the personnel and the visitors as well as the cultural heritage in place. It identifies the main risks of the monuments and gives operative instructions to be followed in case of different kind of emergencies. Among them are: earthquakes, fires, explosions,
floods. It defines the type of emergencies and actions to be done, as well as the procedures for the evacuation and for the drills to be organised in the area.

According to Mibact circulars and decrees, as well as to D. Lgs. 81/2008 if the event is limited to one site or area, only procedures of the emergency plan have to be activated (see also Decreto del Presidente della Repubblica 30 giugno 1995 n. 418; decreto Mibact 20 Maggio 1992 n. 569; circolare Mibact 8 Ottobre 2004). For the recovery in this case the procedure is the usual one for restorations and interventions in our site, only the faster procedures for urgent works are activated.

In case of emergency, a complete list of artefacts, in relation to the risks, doesn’t exist. Moreover, most of the items in the Museum are marble statues, sarcophagi and inscriptions difficult to be moved in case of emergency. A big part of the archaeological site is used as a storeroom, but the storeroom area has the same security level than the rest of the site. In case of emergency, in the area is a restoration laboratory for first intervention works. Laboratories and offices are included in the emergency plan. The archive of restoration laboratories is stored in the restoration workshop.

3.5.3 Actors involved

In case of an emergency involving the CH, in Italy there are different kinds of procedures to be activated depending on the extension or the territorial relevance of the damages.

Each CH site is provided with an emergency plan in order to deal as best as possible with every kind of emergency. Aim of the plan is to safeguard both personnel and visitors as well as the cultural heritage in place. It identifies the main risks of the monuments and gives operative instructions to be followed for each kind of emergency.

According to Italian MiBACT\textsuperscript{29} circulars and decrees, as well as to D. Lgs. 81/2008 if the event is limited to one site or area, only procedures of the emergency plan have to be activated. For the recovery in this case the procedure is the usual one for restorations and interventions in the site, only the faster procedures for urgent works are activated. The officers responsible of the site (archaeologist/art historian and architect) directly have to contact the fire fighters and take care of the damage assessment and of the conservation works.

\textsuperscript{29} In Italy the authority responsible for management, safeguard, valorisation and conservation of Cultural Heritage is the Ministero dei beni e delle attività culturali e del turismo (MiBACT). MiBACT is organized in 11 different general offices - Direzioni Generali, who are responsible for different areas of the heritage. Regional offices guarantee the coordination of the activities of peripheral ministry structures present in each region, as well as the relations of the ministry with local authorities and other institutions. Soprintendenze are peripheral organs of the MiBACT with the institutional task of protecting, conserving and valorising the cultural and landscape heritage in the territory of competence. This activity is performed according to the Codice dei Beni Culturali e del Paesaggio (Cultural Heritage and Landscape Code, Legislative Decree 42/2004) within the ambit of the cultural heritage belonging to the State, the Regions, public bodies and institutions, as well as non-profit private legal entities. With the recent reformation (different phases between 2014 and 2016) the Soprintendenze were unified and called Soprintendenze Archeologia, Belle Arti e Paesaggio. Some Soprintendenze (e.g. Pompei, and SSCOL, which is a partner of the STORM project), as well as some Museums, are provided of a special financial and organisational autonomy with Ministry decrees.
According to the MiBACT Decree of May, 25, 2012, in case of an event affecting more sites or a vast area, the MiBACT UCCN (Unità di Crisi Coordinamento Nazionale - National Coordination Crisis Unit) has to be contacted by the person in charge of site. The UCCR (Unità di Crisi Coordinamento Regionale - Regional Coordination Crisis Unit) interested in the event is then activated by the MiBACT, in order to coordinate the activities, including damage assessment; safeguard of the damaged buildings and goods (moving and storing in a safe place in case of movable goods). The unities coordinate activities inside the Ministry and with external offices as Civil Protection Units, Fire-fighters, Police, etc.). In case of events of national relevance the activities of the UCCN and UCCR are coordinated by the civil protection.

Operational tools support of the organization identified for emergency management that based on the experience gained and the possible reorganization of the Ministry, can be refined in order to improve the response of the Ministry on the occasion of emergencies. It is essential to point out how, in the context of the more general risk analysis, of the emergencies pertains to "the residual risk management, i.e. that part of the risk which was impossible to reduce. On the other hand the risk analysis itself provides adequate and necessary prevention activities by all those actions aimed at reducing the exposure factors and vulnerability to all foreseeable events, activities, together with the management of emergencies, should constitute the second, indispensable process to operate in a comprehensive way for the preservation of cultural heritage.

If the emergency involves a single settlement is sufficient to activate the structure and procedures encoded by the emergency plans of the structure, set by current regulations or specific instructions for cultural heritage.

If the emergency has a more extended territorial relevance or causes a higher damage level, is needed to implement a specific strategy. In this case, the emergency management should be conceived as a process that develops without discontinuity by the first inspection, up to the phase of reconstruction and restoration of cultural heritage both immovable and movable. This kind of approach generally allows the optimization in the use of available resources, since, by making each stage to the next stage, already planned and programmed, it allows you to verify the effectiveness of what has already been done and to best program the next phase, avoiding interventions “overdimensioned” with high costs. For the realization of this process is necessary to provide a specific organizational structure, where tasks and roles are identified in accordance with univocal and predefined procedures. The Ministry has therefore set up the operational structure for the monitoring and coordination of activities which are necessary to face emergencies arising natural hazards and it also prepared procedures, disciplinary and operational instruments aimed at the management of the various phases of the emergency.

In particular, these procedures include: coordination with the structures external to the Administration, designated to emergency management; coordination between central and peripheral joints of the Ministry; participation of all offices of the Ministry to the emergency management, in order to deal with the maximum effectiveness also the following phases.

It is important to highlight that the emergency management refers to “management of the residual risk”, i.e. that part of the risk impossible to know or reduce.
On the other hand, the risk analysis itself provides adequate and necessary activities for prevention by all those actions aimed at reducing the exposure factors and vulnerability against all foreseeable events.

The operating structure is divided into a “Unity of national coordination UCCN-MiBACT”, which operate with the General Secretariat, and a “Unity of regional coordination UCCR-MiBACT”, which operate in the regional secretariats of the Ministry. During emergency events arising from natural hazards, the following steps are followed.

The UCCN is activated by the general secretary and supports the latter in the following activities:

- Ensure the coordination with national institutions external to the Ministry and in particular with the other components and operating structures of the National Service of Civil Protection which, in case of national emergencies, operate under the coordination of the Department of Civil Protection30;
- Ensure the coordination between the central and peripheral structures of the Ministry;
- Ensure, in collaboration with all interested structures, the implementation of operating procedures, provided for intervention teams, in the operation affecting the cultural heritage (verification of damage, profiling, securing of movable property, recovery and ruins removal, safety measures, removal and relocation of movable property, restoration in situ, etc.);
- Realize monitoring of safety interventions and subsequent static consolidation and restoration projects;
- Identify the information systems and cataloging tools for the management of various activities, from the monitoring of the seismic test to the emergency management up to the restoration and reconstruction phases;
- Identify the procedures for sharing territorial information of general interest with the involved institutions in the planning and management of emergencies.

The unities for regional coordination UCCR-MiBACT are responsible for:

- coordinating the Ministry staff’s activities on the territory;
- guarantee the connection with the departments responsible for emergency interventions through the territorial civil protection coordination centers, if established, or, for events of limited extension or intensity, the direct connection with the relevant territorial structures (Prefectures, National Fire Fighters Corps, Police and Armed Forces, Forest Corps, etc.);
- identify and manage the teams for the analysis of the damages to cultural heritage;
- locate spaces for safeguarding of movable cultural heritage that requires a transfer for its safety;
- ensure the supervisory functions and support during all phases, including those of analysis, safety measures and rebuilding of damaged cultural heritage.

The regional coordination unities UCCR-MiBACT are divided into the following three operating unities:

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30http://ec.europa.eu/echo/files/civil_protection/vademecum/it/2-it-1.html
1. Unity for analysis of significant damage to cultural heritage, with the following tasks: 
   a. management of the Ministry staff engaged in the teams for the analysis of the damages; 
   b. verification, scanning of survey forms; 
   c. storage of paper documents (survey forms, photos, reports, action plans, etc.).

2. Technical coordination unit of the implementation of safety measures (including the movement of heritage) on the architectural, historical, artistic, archaeological, audiovisual, archive and library, with the following tasks: 
   a. coordination of the Ministry staff involved in teams that deal with the implementation of safety measures; 
   b. verification and study of the survey forms for safety interventions; 
   c. paper and digital archiving of technical documents about the safety interventions and the subsequent consolidation and restoration interventions (photos, reports, action plans, etc.).

3. Temporary storage and emergency laboratory unit on movable heritage, with the following tasks: 
   a. management of temporary storage; 
   b. management of the emergency laboratories.

To ensure an effective and coordinated chain of command for emergency management, it imposes a hierarchy of different functions than the ordinary.

1. to allow the effective activity of national coordination, the General Directions, the lead institutions, national and equipped with special autonomy, will have to agree with the General Secretary all initiatives intended to enable in the areas affected by the emergency event;
2. to allow the effective activity of territorial coordination, all institutions of the Ministry, including those, national and with special autonomy, established in the territory affected by the emergency, must refer exclusively to the regional secretariat, territorially responsible both for communications relating to the damage suffered by the cultural heritage for future interventions.

The Regional Secretariat constitutes the structure of the Ministry, connected with the UCCN, works with the departments responsible for emergency interventions through the civil protection coordination centers, if established.

In summary, the chain of command in the event of natural disasters is divided following the two previously described schemes, distinguished only by territorial involvement connected to scale of the catastrophe.

Following the occurrence of an emergency event:

1. The UCCN-MiBACT on disposition of the Secretary-General promptly invites regional secretaries interested in starting, their UCCR-MiBACT
2. The UCCN-MiBACT coordinator will transmit to the Secretary-General the information received from UCCR-MiBACT and the Secretary will constantly inform the Minister and the operating committee of the Civil Protection
3. The UCCR-MiBACT on disposition of regional secretary in his unit coordinator itself, plans and organizes the activities for the analysis of the damages and protection
interventions, safety of movable and immovable heritage, including, for the latter, any recovery, removal, transfer to temporary storages. And also organizes the activities of local authorities, the local police, Fire Fighters Corps, etc.

4. The UCCM-MiBACT on disposition of the prefect who has the role of contacting the MiBACT or others authorities with the role of organize and coordinate the activities.

For buildings the inspections on the second phase are only aimed at damage survey and will be carried out by teams composed of: 1) a technical from MiBACT; 2) an official of the National Fire Fighters Corps; 3) additional professionals of the Superintendence (restorer, historian, archivist, ....), if needed; 4) a structural engineer expert; 5) National Service of Civil Protection when is needed cooperation between different authorities.

For churches inspections on the second phase are aimed at the analysis of the damage and practicability and will be carried out by teams composed of: 1) a technical from MiBACT; 2) an official of the National Fire Fighters Corps; 3) additional professionals from the Ministry (restorer, historian, archivist, ....), if it has been evaluated necessary; 4) National Service of Civil Protection; 5) at least two technicians, registered with the National Technical Unit for the damage survey and assessment of viability after the earthquake emergency post or otherwise proven experience.

These actors make the assessment of the damage by filling in a report provided by the MiBACT.

In the report the following information should be inserted:

1. report for the damage evaluation on cultural heritage in case of natural disasters;
2. sheet for the damage analysis to cultural heritage – churches;
3. sheet for the damage analysis to cultural heritage – buildings;
4. sheet for the damage analysis to property damage cultural-movable heritage;
5. sheet for the transport of removed artefacts;
6. intervention report on movable heritage;
7. emergency report;
8. monitoring report;
9. monitoring report of the main activities related to the damage and the corresponding safety measures.

In the case of events, whose intensity and extension require the activation of the National Coordination level, at the central level, coordination and unitary direction of the emergency activities are insured by the Operating Committee of the Civil Protection, which has the role to establish the actions of the authorities and entities involved in the emergency procedures.

The actions established in the Operating Committee are coordinated with the activation at territorial levels. Regional provincial and local authorities structures of Civil involved in the emergency, at every level of expertise, are integral to the operating committee decision.

31 Legislative Decree 24 February 1992 n. 225, Institution of The National Service of Civil Protection, Art.2 “Gli ambiti di competenza vengono definiti in base alla gravità dell’evento calamitoso e distinti gli eventi fronteggiabili mediante eventi e interventi attuabili dai singoli enti o amministrazioni competenti in via ordinaria”

process itself, in order to define the operational measures to be taken in emergency management. In case of the necessity to set up on site a national coordinating structure for the definition of emergency procedures, the coordination and the management of the structure is secured from the command and control management -Di.Coma.C.-, established by the Department of Civil Protection, which operates in continuity with the actions of the Operations Committee.

The Ministry has the duty of ensuring, in this case, the necessary connection with the Di.Coma.C. through the crisis Regional Coordination Unit (UCCR-MiBACT) of the regions involved in the emergency, activated according to the procedures, in order to coordinate all actions relating to the safeguarding of CH. The Ministry has to send at Di.Coma.C. trained staff that, in connection with the UCCR, participate in the activities of the support function “Census damage and practicability of all attendees of the buildings” provided by Salvage national program for seismic risk but also to the daily coordination meetings of the structure ensuring the connection with the Ministry departments responsible for the management of the emergencies. This fitting is functional for both central and peripheral level, for census activities, relief of the damage and the implementation of safety and eventual removal and relocation of cultural heritage in the area of the event, in the terms provided by applicable laws. The Ministry in particular, ensuring a constant and continuous presence at the Di.Coma.C., provides and updates the framework of the emergency activities carried out or to be programmed relating to cultural heritage, reporting any priority for the purposes of any possible contribution of the other components and operational structures represented at the Di.Coma.C., but also the emergency measures of competence to be adopted.

It is then highlighted by the Department of Civil Protection of the Presidency of the Council of Ministers, the need to strengthen coordination with the MiBACT, through constant cooperation at both central and peripheral level.

In detail, the operations of inspection for damage assessment are carried out in the following way: it is preferable to complete the inspection, acquire a general idea of the actual state on the building and formulate a first hypothesis of judgment. Later, completing all the records is possible to have a final judgment. In some cases it can be useful to make some small tests on masonry mortars or remove portions of plaster in order to examine the progress of the damages and to evaluate their dating and their actual dimension.

**Staff involved**

If the calamity will occur on a large territorial scale the first responders are the National Fire Fighters Corps and Civil Protection, which have a duty to secure the area affected by natural disasters in order to be able to provide, at a later time, to transfer of movable heritage or otherwise, to secure the immovable ones. In this emergency phase archaeologists and art historians have the only function of advice and scientific support in the course of operations, but they do not have the authorization to carry out practical actions, which may be carried out only by National Fire Fighters Corps and Civil Protection, as stipulated by laws.

If the natural disaster strikes a cultural site of small dimensions the behaviour usually put in place is the same as described above for large sized sites. Only the National Fire Fighters Corps and the Civil Protection have the permission to intervene for the activities of promptness and cultural first aid.
The Department of Fire Fighters, Public Rescue and Civil Defence is composed by eight central directorates, eighteen regional offices and one hundred provincial commands, with about eight hundred stations throughout the country. National Fire Fighters Corps is part of the Department that depends on the Ministry of the Interiors. The National Fire Fighters Corps has the duty to assure the urgent technical rescue, even in events in which non-conventional substances are involved and to carry out fire prevention services. It operates all over Italy, except Valle d'Aosta region, Bolzano and Trento provinces, with around 35,000 professional and volunteer units. According to the national law, the National Fire Fighters Corps is the key part of the civil protection system. The Corps also carries out rescue services abroad, within the framework of international agreements on people rescue in case of emergencies.

The National Fire Fighters Corps has its own radio network, which is used in the emergencies services and during disasters, and an independently owned and operated information system, which is also used to improve the management of rescue operations in civil protection activities.

The National Fire Fighters Corps, initially fragmented in various municipal units, was established as such by the Royal Decree of 27 February 1939, later converted into Law 1570 of December 27, 1941, and had initially the duty "to protect the personal safety and the salvation of things, by preventing and extinguishing fires and the provision of technical services in general, including those related to air defence."

Following to the development of the country these tasks become more and more complex and various, until the Legislative Decree no. 139 dated March 8, 2006 stated that: "National Fire Corps, is a civil structure of the state, anchored in the Ministry of the Interior, fire fighting, rescue and public civil defence Department, by which the Ministry of the Interior guarantee emergency services and public fire prevention throughout the national territory; moreover, it shall carry out other activities assigned to the Corps by national laws and regulations, as provided in this decree."

Every day, every night, Fire Fighters are ready to intervene to rescue people, to safeguard assets, to protect the environment. The rapid response, expertise and experience gained from previous activities of civil protection are essential for the relief of people affected by natural disasters or major disaster.

The National Fire Fighters Corps, in order to protect the personal safety and integrity of goods, provides technical rescue and assistance, which requires technical skills even for highly specialized equipment and adequate resources, and performs technical studies and experimental tests in specific field. Included among the technical operations of public assistance of the National Corps are:

1. technical rescue during fires, uncontrolled releases of energy, sudden or threatening structural collapse, landslide, floods or other public calamity;
2. technical work against risks from the use of nuclear substances and the use of chemical, biological and radiological threats.

National Fire Fighters Corps work as a basic component of the National Service of Civil Protection and assures, within its technical expertise, management of emergency technical operations in accordance with the degree of coordination required by the current legislation.
The National Fire Fighters Corps, as part of its institutional capacity in the field of civil defence:

- faces the risks arising from non-conventional crimes committed in any acts against persons or property, with the use of nuclear, chemical, biological and radiological material;
- contributes to the preparation of fire fighting units for the armed forces;
- contributes to the preparation of national and regional civil defence;
- provides services and training to the units responsible for the protection of the civil population, included activities carried out in case of war;
- participates with its representatives, to the collegial bodies responsible for civil defence.

In terms of extinguishing forest fires, the central and peripheral structures of the National Fire Fighters Corps provide urgent technical assistance to the direct jurisdiction of the people and safeguard the integrity of the goods. In case of a prior agreement, the National Fire Fighters Corps makes also available to the regions resources, equipment and personnel necessary to perform active fight against forest fires.

Fire protection services are entrusted to the exclusive jurisdiction of the Ministry of the Interior, which exercises its activities through the National Fire Fighters Corps. Fire protection is the overriding public interest function intended to achieve the safety of human lives, the protection of properties and environments through the promotion, study, preparation, testing of measurements, standards, devices and modes of action aiming to prevent or limit the occurrence of a fire and its consequences. According to uniform criteria applied in all national territory, fire protection services are conveyed in all areas characterized by high risk of fire and, because of its interdisciplinary importance, also in those working areas to that use hazardous goods, energy, ionizing radiation, and in yards.

In Italy the superintendent has to deal with quite often a scarcity of economic resources devoted to the preservation and protection of cultural heritage, therefore, even in the event of an emergency, the funds allocated to aid are rather low. The interventions are therefore shoring made by National Fire Fighters Corps, preparatory for the National Civil Protection interventions.

If a disaster affects a site or an artefact with historical-artistic interest in the site, the personnel working on the site communicates to the officer in charge of the structure or of the territory where it is located the heritage. The MiBACT officer shall promptly notify the event to the Superintendent and, simultaneously, if necessary, alert the National Fire Fighters Corps, National Civil Protection, and Local Police Authorities.

An official who has responsibility in the area reach the site in order to coordinate the operations of first intervention and damage limitation. At this stage of assessment are involved the architect of the Technical Office of the Superintendent, and the technical staff present in the structure.

After this first inspection, a report is compiled, which also includes a photo report and an initial estimate of damages, in order to communicate the damage extent and to communicate
to the Superintendent. In this phase are taken the first containment measures for the damage and then are directly involved the National Fire Fighters Corps or other stakeholders in order to stabilize the extent of damage.

The Superintendent organizes a technical meeting for the evaluation of the preparedness. In this council there are:
- The Superintendent
- The MiBACT Officer
- The architect of the Technical Office
- The Archaeologist/Art-historian
- The restorer
- The structural engineer

In this council are established the measures for: safety measures, economical evaluation of the damage and cultural first aid.

3.6 Portuguese case

3.6.1 Current conservation and management

In terms of preventive measures, in Portugal does not exist a list of the artefacts or artworks, highly exposed to risks, and their state of conservation. The only list available to be used by DGPC museums and foreseen in the Security Plans regards the goods to evacuate from the buildings in case of an emergency, that only include the indication of the movable good, it’s location, the person responsible for its evacuation and the place to accommodate. DGPC also maintains updated databases for the inventory of immovable and movable heritage, that include an overall description of the state of conservation of the CH.

The most employed typology od archives in Portugal are: photos, cartography detail mapping, excavation documents, restorations reports, all these in both paper and digital or digitalized format. Moreover, catalogue cards are usually present in CH archives.

Speaking about ordinary maintenance works of CH in Portugal, tree/shrub pruning, coverage settlement and maintenance of the paths are normally performed by private companies and DGPC staff (only in the case of paths maintenance).

3.6.2 Disaster risk management activities

Concerning this topic the Law of Museums – n° 47/2004 of August 19th - makes it obligatory the existence of a security plan that enables hazard prevention and neutralization, through different resources that guarantee prevention, physical protection, surveillance, detection and alarm.

In Portugal there is also a legal document for fire protection and safety in buildings - DL n. 220/2008 of November 12th – that foresees the drafting of a plan containing prevention and self-protection measures, that has to include risk categories identification. Although this law recognizes cultural heritage preservation (article 4), in practice its application consists in reducing the probability of fire occurrence; in ensuring fire circumscription and avoidance of
fire spreading; in facilitating salvage and evacuation of occupants at risk; and in enabling the reliable and effective intervention of the means of assistance.

There is also compliance with safety in terms of structural integrity and stability of all type of buildings in case of earthquakes by following specific rules (DL n. 235/1983 of May 31st) and applicable Eurocodes in all interventions carried on by public and private authorities, in this case, through obligatory authorization and competent supervision.

In compliance with the above mentioned legislation, DGPC draws up and implements security plans, as well as self-protection measures for all its assigned Museums, Palaces and Monuments. These plans develop the procedures to be implemented in emergency situations caused by natural hazards, like fires, earthquakes, floods and lightning strikes, including actions and prevention/preparedness measures, like monitoring and inspection of technical equipment, training against fires and raising awareness activities. The overall procedures are based on the measures for fire hazards protection in buildings, established on the current legislation (DL n. 220/2008). This plans also contain people evacuation procedures and a general list of CH goods to evacuate.

DGPC’s Security Plans were not elaborated in the scope of a process of risk analysis which would take into consideration the consequences in terms of loss of value, authenticity and integrity of cultural goods (immovable and movable).

In Portugal there is not a Risk Map. Although, in the late 90’s, the former General Directorate for Buildings and National Monuments (DGEMN) developed a Heritage at Risk Survey, which consist of a methodology to record and assess the state of conservation of historic buildings. This information was to be updated in a module specially designed, in the National Architectural Information System (SIPA), contributing for the establishment of decision-making priorities and resources, however has never been updated (Carvalho 2001).

3.6.3 Actors involved

In Portugal, classified and under classification immovable and archaeological heritage is registered in national information systems33 developed and managed by DGPC; this technical and administrative data is considered fundamental for the analysis of safeguard procedures, namely in what relates to decision making in the areas of urban development, land management and environmental impact assessment project conception and execution. Data includes descriptive information on about 32 000 buildings and sites, with reference to state of conservation and geographical location, among other aspects. Teams from DGPC and regional directorates of culture inspect and supervise interventions held on cultural heritage, even though regular monitoring is hampered by the vast number of monuments and sites and the lack of available resources.

At the level of movable heritage, DGPC manages an online collective catalogue for 34 museums, allowing access to information on the more than 100,000 cultural assets and national collections treasures kept in those museums34.

At the present, Portugal does not have a fully developed risk map, despite works developed by the extinct Directorate General for National Buildings and Monuments towards the creation of a Portuguese Architectural Heritage Risk Survey aiming to map the state of conservation of cultural assets and expected risks, in order to calculate conservation costs in advance, and define priorities when allocating public resources35.

In the case of an imminent or present accident or calamity in mainland Portugal, the National Emergency Plan for Civil Protection (PNEPC), a support instrument to civil protection operations, is in place, in order to guide the technical and operational coordination of the Integrated System of Protection and Rescue Operations (SIOPS). The Plan identifies the governing and executive bodies, the civil protection agents, and the support organisms and entities, as well as their respective functions within the framework of their legal competences and available resources for operating in the Emergency and Recovery phases. Cultural heritage protection is vaguely featured in the objectives of the National Plan, the municipality’s civil protection services being responsible for the development and implementation of specific measures adapted to each territory, to available resources, and to the nature of assets. The lack of a national policy for the cultural heritage disaster risk management, namely the lack of regulations defining concrete procedures, translates into heterogeneous preventive and response measures, to be carried out by distinct actors.

**The Government operating structure**

In Portugal, Civil Protection is the activity carried-out by the State, Autonomous Regions and Local Authorities, by citizens and by all public and private entities, with the aim of preventing risks that causes calamities or disasters, to attenuate its effects and to protect and help people and property in danger, whenever those situations occur36.

The national Civil Protection system was instituted by the Law on Civil Protection (Law no. 27/2006 of 3 July37, recast by Organic Law no. 1/2011 of 30 November and Law no. 80/2015 of 3 August38), and the Integrated System for Safety and Protection Operations (SIOPS).

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The national responsibility for the civil protection policies lies with the Prime Minister (or the Ministry of the Interior), and at autonomous regions the presidents of the Azores and Madeira islands.

Actions will be developed, at distinct levels, via the policy directive and coordination structures, the institutional coordination structures, and the command and operational structures, the latest being responsible for the management of all civil protection and rescue operations held in the aftermath of a catastrophe or serious accident, as well as for the mobilization of all necessary resources.

The National Civil Protection Commission (CNPC), the District Civil Protection Commissions (CDPC) and the Municipal Civil Protection Commissions (CMPC) supervise and coordinate the civil protection policies:

- CNPC – (Artº 36 da lei de bases) assesses the general basis for the organizing and functioning of bodies and services, and supports the decisions of the Government and the Prime Minister in the matters of Civil Protection. Functions as an interministerial and consultive body (Ordinance no. 302/2008, of 18 April).
- CDPC – (Artº 38 da lei de bases) follows, at district level, the implementation of civil protection policies by the public entities.
- CMPC – (Artº 40 da lei de bases) assure the articulation between all municipal entities and institutions involved in protection, rescue, emergency and assistance operations, in the sequence of a disaster.

The institutional coordination is assured, at national and district level, by the Operative Coordination Centres (CCO), responsible for the management of rescue operations conducted by each force or service.

At the executive level, the application of the civil protection policies is competence of several technical and administrative bodies: the National Authority for Civil Protection (ANPC), the Azores’ Civil Protection and Firefighting Regional Service (SRPCBA), the Madeira Civil Protection Regional Service (SRPC, IP – RAM), and the Civil Protection Municipal Services (SMPC). Smaller administrative unit, the parish councils, also have responsibilities of promoting actions of civil protection (ULPC).

Fire-fighters Brigades (CB) are included in the SIOPS, as civil protection actors that ensures the implementation of the necessary safe and rescue actions, as well as support of recovery, alongside with the remaining intervenient.


The following table (Table 10) describes the response operations for the emergency and recovery phases of each body that may contribute to cultural heritage protection:

### Table 10: Response operations for the emergency and recovery phases.

<table>
<thead>
<tr>
<th>Body</th>
<th>Response phase</th>
<th>Recovery phase</th>
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| ANPC | - To ensure the functioning of the command, control, communications and information unit;  
- To activate response resources and to mobilize reinforcement and support means and resources;  
- To ensure the coordination of public or private services responsible for intervention or rescue and protection operations, in order to guarantee the safety of populations and the safeguard of heritage (cultural assets of high value) and the environment;  
- To coordinate the action of Situation Recognition and Evaluation Teams (ERAS) and Technical Evaluation Teams (EAT),  
- To issue announcements and warnings to populations, entities and institutions, including the media;  
- To guarantee international assistance at the operational level. | |
| SMPC | - To provide for all means, resources and personnel required to the civil protection and rescue response;  
- To evacuate and transport people, goods and animals;  
- To ensure the dissemination of warnings to populations;  
- To ensure the signalling of roadblocks, either as precautionary measures or caused by serious accidents or catastrophes, as well as all alternatives;  
- To plan logistic support to victims and rescue teams in emergency contexts;  
- To assess, organize and manage | - To provide means, resources and personnel for the civil protection response;  
- To unblock roads, remove debris and clean conduits and water lines along municipal routes and paths;  
- To promote the evaluation of damage and of the needs of affected populations;  
- To evaluate and quantify personal and material damage;  
- To assist in defining intervention priorities, and supervise works of repair and reconstruction of damaged structures and equipments;  
- To promote the reestablishment of essential services with the |
### ULPC
- To reinforce all forces involved with local human resources;
- To cooperate with municipalities regarding the dissemination of warnings to populations;
- To collaborate in the signalling of damaged roads and municipal routes, in the cleaning of gutters, conduits and water lines, in the clearance of roads, and in demolitions and debris removal, in each respective geographic area;
- To promote, in close cooperation with municipalities, the creation of self-defence teams in each population cluster, endowing them with resources for intervention and guarantying their training, so that they can operate safely;
- To manage immediate emergency acting volunteering systems of damage evaluation, with particular emphasis on injuries to persons

### CB
- The fire prevention and fighting;
- The development of actions of fire fighting and search, rescue and transportation of people, animals

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<th>Responsible Entities</th>
<th>ULPC</th>
<th>CB</th>
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<td>- To provide (according to the extent possible) the means requested by the Rescue Operation Centre (COS);</td>
<td>- To reinforce all forces involved with local human resources;</td>
<td>- To provide logistic support to the population and task forces;</td>
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<td>- To support evacuation operations;</td>
<td>- To cooperate with municipalities regarding the dissemination of warnings to populations;</td>
<td>- To collaborate in actions destined to inform and raise public</td>
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<tr>
<td>- To support population warning operations;</td>
<td>- To collaborate in the signalling of damaged roads and municipal routes, in the cleaning of gutters, conduits and water lines, in the clearance of roads, and in demolitions and debris removal, in each respective geographic area;</td>
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<tr>
<td>- To continuously assess the situation in affected areas, and transmit all information to the Plan Director.</td>
<td>- To promote, in close cooperation with municipalities, the creation of self-defence teams in each population cluster, endowing them with resources for intervention and guarantying their training, so that they can operate safely;</td>
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<tr>
<td>- To organize the return of displaced people, animals and goods.</td>
<td>- To manage immediate emergency acting volunteering systems of damage evaluation, with particular emphasis on injuries to persons</td>
<td>- To collaborate in actions destined to inform and raise public</td>
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and goods;
- To participate in the emergency evacuation phase, in each respective geographic area;
- To support task forces in the Theatres of Operations relating to ground reconnaissance and orientation;
- To cooperate in the installation of Control Stations;
- To cooperate in the unblocking of roads and emergency routes;
- To assist populations in the event of fires, floods, landslides, and accidents in general;
- To assist people in distress at sea and promote sea search and rescue operations;
- To assist and transport the injured and the sick, and to provide pre-hospital care, in the scope of the Integrated System of Medical Emergency;
- To participate in other civil protection activities, in the scope of assigned specific functions;
- To participate in other actions and activities to which adequate training has been provided, whenever such activities meet their particular propose and that of the respective tutelage;
- Providing other services, in accordance with internal regulations and other relevant legislation.

<table>
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<th>and goods;</th>
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<td>- To participate in the emergency evacuation phase, in each respective geographic area;</td>
<td>- To participate in the rehabilitation of infrastructures;</td>
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<tr>
<td>- To support task forces in the Theatres of Operations relating to ground reconnaissance and orientation;</td>
<td>- To collaborate in the unblocking of roads and emergency routes;</td>
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<tr>
<td>- To cooperate in the installation of Control Stations;</td>
<td>- To assist in the return of affected populations to normal life;</td>
</tr>
<tr>
<td>- To cooperate in the unblocking of roads and emergency routes;</td>
<td>- To participate in other civil protection activities, in the scope of assigned specific functions;</td>
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<tr>
<td>- To assist populations in the event of fires, floods, landslides, and accidents in general;</td>
<td>- To participate in other actions and activities to which adequate training has been provided, whenever such activities meet their particular propose and that of the respective tutelage;</td>
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<tr>
<td>- To assist people in distress at sea and promote sea search and rescue operations;</td>
<td>- Providing other services, in accordance with internal regulations and other relevant legislation.</td>
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The main programs, strategies or national plans, such as the National Spatial Policy Programme (to 2026), the Portuguese National Strategy for the Adaptation to Climate Change (to 2020), the Portuguese National Plan for prevention and Protection of Forest against fires and the National Water Plan, coordinate with PNEPC in what relates to their respective preventive contents to the distinct areas.
Regarding the safeguard of cultural assets (movable and immovable), the way of acting in case of an emergency is to be outlined in internal emergency plans elaborated by each organism or institution, whether public or private, and executed, in what relates to fire protection, under the national legislation. In all emergency situations, collaboration of these entities or institutions with fire departments and civil protection services is indispensable.

Municipalities, through their cultural heritage management and civil protection services, are responsible for ensuring all necessary preventive measures, including the updating of information on local serious accidents and catastrophes, their contexts, adopted measures and conclusions regarding their success or failure, and for updating inventories of cultural property to evacuate, as well as for cooperating with fire departments and other entities in the management of prevention, emergency and recovery phases.

_Actors interventions in case of a calamity_

PNEPC is activated in the case of an imminent or present accident or calamity, when expected or verified consequences are of such severity and dimension as to demand the triggering of supplementary public and/or private means. The plan aims to ensure the collaboration of all intervening entities and to guarantee the quick, efficient and coordinated mobilization of all means and resources available in mainland Portugal, as well as other means of reinforcement considered necessary for answering the emergency.

Institutional coordination of PNEPC is managed by the National Coordination Centre (CCON), headed by the president of ANPC. CCON guarantees, at national level, the coordination of technical information during civil protection and rescue operations. CCON team is informed, within no more than 30 minutes after the occurrence of a serious accident or calamity, of their eventual call.

While PNEPC is in action, a national command centre (PCNac) is established and made responsible for the monitoring, follow-up and managing of all civil protection and rescue operations in national territory. PCNac is constituted and installed in its own infrastructures, with dedicated channels of communication, in a place defined according to the location and territorial scope of the accident or catastrophe. PCNac head in charge is the ANPC national operational commander, or its legal substitute.

In districts affected by the serious accident or calamity determining the Plan activation, the constitution of a District Command Post (PCDis) guarantees the exclusive management of all means available in the area, and of all supplementary national resources, when needed. PCDIs reports, in a permanent basis, to PCNac, having similar objectives, even if restricted to district level. They must also ensure the coordination with Municipal Command Posts (PCMun).

In municipalities affected by the serious accident or calamity determining the Plan activation, the constitution of a sole PCMun guarantees the exclusive management of all means available in the municipality, and of all supplementary district resources, when needed. PCMun are constituted with support from SMPC, and report, in a permanent basis, to their respective

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PCDis. PCMun head in charge is the municipal operational commander, or a substitute appointed by the city mayor.

In order to guarantee the functionality of the Plan, biannual drill exercises are foreseen.

Once the reestablishment of normal life for populations in areas affected by a serious accident or calamity is assured, the deactivation of PNEPC must be declared by CNPC.

The publicizing of activation and deactivation of PNEPC will be made via the national media (cf. Part IV, Section III, chapter 2) and ANPC internet page (www.prociv.pt)\textsuperscript{43}.

Activation and chain of command

Following a calamity of nation proportions, PNEPC is activated by decision of CNPC, under the Civil Protection Basic Law, or by means of a Governmental declaration of calamity.

The emergency procedures are activated by the security manager of the site (when exists a emergency or Security Plan); the Mayor (at municipal level), ANPC (at district or national level), under the authority of the prime Minister or Ministry of the Interior. ANPC ensure the planning, coordination and execution of civil protection policies, namely on prevention and reaction to disasters, protection and rescue of populations, and the superintendence of the activity of fire-fighters. Following a natural calamity of national proportions the PNEPC is activated according the decision of CNPC, as stated by the Framework law for Civil protection, or after the declaration of calamity situation by the Government.

At the municipal level, the Municipal Civil Protection Commissions supervise and coordinate all the civil protection actions, but the responsibilities and implementation of procedures are under the authority of the Mayor, who promotes the development of emergency plans. This takes especially into account the security of people and goods.

Regarding CH, the Municipal heritage technicians are responsible for the procedures in the response phase, which varies within the different municipalities, and the activities related to recovery (stabilization and restoration). In none of the plans consulted by DGPC, confirmed by information of the National Authority of Civil Protection (ANPC), specific procedures exist for CH protection. The only action to be implemented indicates that in the aftermath the public authorities (DGPC) should be contacted, to cooperate, supervise and monitor the recovery actions. Although not described in the emergency plans, DGPC will impose the conditions for the works of damage evaluation and the implementation of measures of stabilization and restoration of cultural heritage to be conducted. The necessary works will be carried out by a multidisciplinary team composed by private professionals.

Involved actors in case of emergency localized in a restricted area of the site

For this part was consulted the internal security plan for sites managed by DGPC and the T1.1 - Questionnaire for current practice for management and conservation of Cultural Heritage.

The Law of Museums – nº 47/2004 of August 19th - makes it obligatory the existence of a security plan that enables hazard prevention and neutralization, through different resources that guarantee prevention, physical protection, surveillance, detection and alarm.

In Portugal there is also a legal document for fire protection and safety in buildings - DL n. 220/2008 of November 12th – that foresees the drafting of a plan containing prevention and self-protection measures, which has to include risk categories identification. Although this law recognizes cultural heritage preservation (article 4), in practice its application consists in reducing the probability of fire occurrence; in ensuring fire circumscription and avoidance of fire spreading; in facilitating salvage and evacuation of occupants at risk; and in enabling the reliable and effective intervention of the means of assistance.

There is also compliance with safety in terms of structural integrity and stability of all type of buildings in case of earthquakes by following specific rules (DL n.º 235/1983 of May 31st) and applicable Eurocodes in all interventions carried on by public and private authorities, in this case, through obligatory authorization and competent supervision.

Following the above mentioned legislation, DGPC draws up and implements security plans, as well as self-protection measures for all its assigned Museums, Palaces and Monuments, that are submitted to the approval of the National Authority for Civil protection, as mandatory by law. These plans develop the procedures to be implemented in emergency situations caused by natural hazards, like fires, earthquakes, floods and lightning strikes, including actions and prevention/preparedness measures, like monitoring and inspection of technical equipment, training against fires and raising awareness activities. The overall procedures are based on the measures for fire hazards protection in buildings, established on the current legislation (DL n.º220/2008). This plans also contain people evacuation procedures and a general list of CH goods to evacuate.

DGPC’s Security Plans were not elaborated in the scope of a process of risk analysis which would take into consideration the consequences in terms of loss of value, authenticity and integrity of cultural goods (immovable and movable).

In the case of an emergency in DGPC CH, the following procedures are taken:

- Hazard is detected by a sensor (example a fire sensor) or by a person, which triggers the alarm.
- If the security manager confirms and recognizes the emergency, the security plan is then activated.
- The first steps are to call the fire-fighters and activate the intervention team, composed by some staff with training that starts the procedures to contain fire, if possible, and guide staff and visitors to the evacuation exits.

The security manager of the site, that normally are the Directors of the Museums, that have several qualifications (Architects, Archaeologist, Art Historians, Conservators- Restorers) and experience in cultural heritage management, have the responsibility to coordinate all the activities between archaeologists, art-historians, restorers or others and offer all the assistance available to the fire fighters commander who, during the emergency procedures, is the person legally responsible for all operations. This happens in the emergency response phase. None actions are defined in the other phases (risk assessment, prevention/mitigation, preparedness, recovery).

The only list available to be used by DGPC museums and foreseen in the Security Plans, regards the goods to evacuate from the buildings in case of an emergency, that only include
the indication of the movable good, its location, the person responsible for its evacuation and the place to accommodate.

In the DGPC sites, some of them have alternative rooms to accommodate CH assets during an emergency evacuation (for instance a flood or fire), but none have a storage space previously identified with the full conditions required. The staff may be able to evacuate some movable goods that are specified in the list of the Security Plan (mentioned above), nonetheless, there aren’t established procedures or means to prepare evacuation of CH.

For the recovery phase the works should be promoted by the manager of the sites and DGPC will supervise all the necessary works, to be executed by a team of qualified professionals, including architects, engineers, conservator-restorers, archaeologists, historians, etc. Since there are no written procedures or guidelines to define a recovery planning task force, this is left to the discretion of the person in charge, with the advice of DGPC.

3.7 Turkish case

3.7.1 Current conservation and management

Code entitled “Protection of Cultural and Natural Assets” (No. 2863) came into force by year 1983. The Ministry of Culture and Tourism has the authority to decide and assign tasking on protection in the Preservation of Cultural and Natural Assets according to Law No. 2863 which is still in force. According to the Article 10 of the relevant code: “Taking the necessary precautions to ensure the protection of immovable cultural and natural property, regardless of their ownership or administration, or to have the necessary measures taken by public institutions and organizations, municipalities and governorships, the responsibility belong to the Ministry of Culture and Tourism.

Within this scope:

- In situations where urgent intervention is required for the registered immovable cultural assets, partial interventions are made through simple repairs, strengthening and consolidation following the approval of Preservation Board.
- In areas where extensive restoration work is to be carried out, primarily surveying and restitution studies are realised for the registered immovable cultural assets, restoration projects are prepared and presented to the Preservation Regional Boards; Work is being carried out using internationally recognized restoration techniques, under the supervision of Ministry of Culture and Tourism, following the approval of the project.

Scientific Committees, consisting of academicians who are specialists in their field, are established with the aim of directing, contributing and coordinating the project and repair work regarding conservation of registered urban and archaeological sites and registered cultural assets that are deemed appropriate by the Ministry, in the light of scientific methods.

The Convention for the Protection of the World Cultural and Natural Heritage, adopted at the UNESCO General Conference in 1972, highlighted natural disasters threatening cultural and natural heritage. The World Heritage Committee, established in line with the convention, has begun to identify world heritage sites at risk and publish relevant information regarding these sites.
In 1983 Turkey became a party to the Convention on the Protection of the World Cultural and Natural Heritage adopted by UNESCO in 1972.

In the World Heritage List composed according to the World Cultural and Natural Heritage Convention, and ruled by the World Heritage Committee (WHC), there are 1052 heritage sites declared as World Heritage Sites. 814 of them are cultural, 203 are natural and 35 are mixed (natural and cultural) heritage. Turkey has 16 heritage sites, 14 of which are cultural and 2 are mixed.

Site Management Directorates are established for the effective protection and management of World Heritage Sites. Studies are being carried out in the World Heritage Sites in accordance with the regulation entitled “Regulation on the Procedures and Principles for the Establishment, Duties and Determination of the Administrative Areas of the Site Management and Monumental Asset Board “through the guidance of the Advisory Board, the Coordination and Supervision Board and the Supervision Unit, which are established to make suggestions on the management plan studies and to evaluate the implementation.

In addition, studies regarding the protection of cultural assets are also conducted with the involvement of UNESCO, ICCROM, ICOMOS, ICOM and other organizations. These studies contribute to the development of the notion of preservation/protection in Turkey.

Due to its tectonic and geological structure, topography and meteorological features, Turkey is under disaster risk for a variety of natural hazards such as flood, drought, landslide, avalanche, forest fires, storms and earthquakes. Turkey is most affected by earthquakes, landslides, floods, and avalanche.

In this context, it is significant to be prepared in order to protect cultural assets against disaster risk and to take necessary precautions. Structural strengthening studies are also being considered within the scope of restorations carried out in order to protect the structural integrity of the assets and to strengthen the structures against possible disaster risks.

In terms of disaster and emergency preparedness AFAD and the Ministry of Culture and Tourism are carrying out joint studies and when necessary, the retrofitting activities are carried out by including them within the scope of the projects and applications and with the appropriations of Ministry of Culture and Tourism.

In terms of conservation activities in Turkish cases, current practices in museums and archaeological sites are reported in case studies section (cases nrs. 21 and 22).

From the questionnaire, filled in by the Turkish partner, it can be derived that in current practices, conservation and management activities include the phase of documentation. For the case of Ephesus, there is an archive which contains up-to-date information on conservation status of cultural assets within the Museum Directorate, their original material characteristics, and previous restoration or consolidation studies. Moreover, in the Museum, an archive containing photos, documents, maps, etc. regarding the archaeological site is present. The documents in the archive include: photos, detail mapping, excavation documents, restoration documents and catalogue cards both in paper and digitalised format. Furthermore, cartography and volume are present. The area has conservation development plans (1/1000, 1/5000), base maps (1/1000, 1/5000) and topographical map. They have been updated in 2011.
Concerning monitoring, in order to verify the artefacts preservation and static description of the buildings, in Ephesus there is no structural health monitoring system. However, the entire area is monitored with security cameras controlled by Museum Directorate.

In terms of inspection to evaluate the state of preservations in artefacts and structures, this work is made once a year. A catalogue of construction techniques of the site structures and artefacts is available in the site.

Maintenance operations in the Ephesus site include: weeding, mowing, tree/shrub pruning, wall consolidation, removal of stagnant waters, maintenance of paths and protective systems.

The maintenance works are permanently made because permanent staff members are engaged in the site for this specific operation. These personnel can carry out maintenance work continuously.

The authorized personnel of the Directorate of Ephesus Museum supervise the maintenance work carried out by the Regional Preservation Board and the Directorate of Surveying and Monuments.

In situations where urgent intervention is required for the registered immovable cultural assets, partial interventions are made through simple repairs, strengthening and consolidation.

In areas where extensive restoration work is to be carried out, primarily surveying and restitution studies are realised for the registered immovable cultural assets, restoration projects are prepared and presented to the Preservation Regional Boards; Work is being carried out using internationally recognized restoration techniques, following the approval of the project.

### 3.7.2 Disaster risk management activities

*Efforts Specific to Cultural Heritage*

Disaster risk management involves both risk reduction implementations and disaster and emergency planning. Information on regulatory dimension and strategic planning is explained in Deliverable 2.1. Besides planning and regulations, there are several efforts in Turkey on risk reduction. Below are some significant examples.

For World Heritage Sites such as Ancient City of Ephesus (ACE), there is an appointed Site Management Authority subsidiary to the Ministry of Culture and Tourism. The Site Management Plan is developed for several sites and studies are underway for other World Heritage Sites. The plans integrate a component on risk management and planning. Site Management Plan for Ephesus, as an example, defines risk management actions such as: defining all relevant risks to the site; preparing a risk scenario and crisis management structure; constituting a specialized team trained for the archaeological sites; physical preparedness measures such as establishing water reservoirs and pumping stations and organizing signs for evacuation routes; performing exercises; and measuring and reporting emergency intervention capacities (see [http://whc.unesco.org/uploads/nominations/1018rev.pdf](http://whc.unesco.org/uploads/nominations/1018rev.pdf)).

Following a loan agreement signed in 2005 between Republic of Turkey and The World Bank, Istanbul Seismic Risk Mitigation and Emergency, Preparedness Project was initiated.
Within this project the preparation of the inventory of cultural heritage buildings; the seismic risk assessment for selected cultural heritage buildings and preparing retrofitting project designs were aimed to be performed (İ.P.K.B., n.d.). Within the scope of this project, inventory and seismic risk evaluations of buildings under the protection of Ministry of Culture and Tourism in Istanbul were performed and transferred into a GIS database; three significant structures (Istanbul Archaeological Museum, Hagia Irene, and Mecidiye Kiosk) earthquake resistance were assessed and alternative retrofitting designs were prepared.

Turkish Scientific Committee of ICOMOS’ International Committee on Risk Preparedness (ICORP) came into operation with a mission to conduct activities regarding risk reduction, preparedness, response and recovery efforts on protection and management of cultural heritage in natural and anthropogenic disasters. Within its fields of activity, ICORP Turkey has performed and continues to: develop and give trainings; contribute to raising awareness and sharing knowledge through publications, exhibitions; and provide consultancy services on related studies.

Moreover, studies to develop a guideline for managing earthquake risk of historical structures are being conducted as a multidisciplinary project under auspices of Directorate General of Foundations, Ministry of Culture and Tourism and Istanbul Project Coordination Unit with contribution from ICOMOS Turkey.

Efforts on Disaster Risk Management

Recently, disaster risk management for both national scale (Turkey) and regional scale (Izmir) has been evaluated in the several projects and studies. These regional studies are briefly summarized in the following paragraphs:

National scale (Turkey):

Several studies on earthquake risk assessment for Turkey have been conducted and most of them were published (Demircioglu 2010; Demircioglu et al. 2012; Özcebe et.al. 2014). Özcebe et.al. provided some important outcomes of a probabilistic seismic risk analysis for Turkey. The results of this comprehensive assessment are crucial to understand how the risk is distributed across Turkey and thus how this risk can be effectively managed. In their study, the required seismic sources for the probabilistic seismic hazard assessment used herein were obtained through the European FP7 Project SHARE (Seismic Hazard Harmonization in Europe) and were used together with a set of ground motion prediction equations applicable to Turkey (Figure 17). SHARE Hazard model, there were three seismic models to assess the occurrence of earthquake activity: a classic Area Source Model. More information can be found on the project website: http://www.share-eu.org/ and on the portal: http://www.efehr.org.
Seismic hazard analysis in general

In addition to the comprehensive seismic hazard analysis, the 2000 Building Census Survey carried out by Turkish Statistical Institute (TUIK) including buildings classification at the province-level used as an exposure data. Considering the TUIK database, the Turkish building stock is mainly composed of low- to mid-rise reinforced concrete infilled frames and unreinforced masonry structures. The vulnerability functions derived by Erberik (2008) which is a combination with a damage-to-loss model modified from DEE-KOERI (2003) and Bal et al. (2007) has been used. As a result, the mean hazard map in terms of peak ground acceleration for a probability of exceedance of 10% in 50 years was calculated.

The latest one was prepared for DASK (Compulsory Earthquake Insurance Pool) with the cooperation of Turkish Earthquake Foundation and Bogazici University. In this study, the seismic source regionalization and the resulting peak ground acceleration, spectral acceleration at short and long period for a 475 years return period proposed by the UDAP project have been used. UDAP project supported by AFAD (Disaster and Emergency Management Authority of Turkey) under Project Code UDAP-Ç: 1316-13, has been conducted for the country scale assessment of the seismic hazard by probabilistic methods (Şeşetyan et al. 2016; Demircioglu et al. 2016). The main scope of the UDAP –Ç: 1316 was the update of the seismic design code (Figure 18). The need aroused for an updated seismic hazard map, incorporating recent data and state-of-the-art methodologies and providing ground motion parameters required for the construction of the design spectra stipulated by the new Turkish Earthquake Design Code.
Compulsory Earthquake Insurance Pool – Turkey

With the aim of the mitigation to the potential consequences of earthquakes, the Compulsory Earthquake Insurance Pool (DASK), which is a non-profit institution with the status of a public corporation and was created to provide compulsory earthquake insurance, has been formed by the State in collaboration with the private sector. It consists of a crucial insurance application relevant to the possible financial consequences of these events. The management is comprised of public, university and private sector representatives. The main purposes of the DASK can be summarized as: 1) To provide insurance coverage for all dwellings, within the scope of its mandate, against earthquakes in return for a premium 2) To ensure risk sharing within the country and also to distribute the financial liabilities caused by earthquakes on to international reassurance markets through insurance; 3) To mitigate the possible financial burden of earthquake-related consequences on the government; 4) To use the insurance system as a means for the construction of reliable structures.

Regional scale (Izmir)

RADIUS (Risk Assessment Tools for Diagnosis of Urban Areas against Seismic Disasters) Project (www.geohaz.org/contents/publication/RADIUS_RiskAssessment.pdf; http://www.geohaz.org/contents/publications/RADIUS_comparativestudy.pdf; http://www.undp.org/bcpr/disred/documents/miscellanous/yokohamastrategy.pdf), has been launched by the secretariat of the International Decade for Natural Disaster Reduction (IDNDR 1990-2000), United Nations, and Geneva with financial assistance from the Governmental of Japan. The main objectives of the project were to develop earthquake damage scenarios and action plans in selected pilot sites, to develop practical tools for seismic risk management, which could be applied to any earthquake-prone city in the world, and to promote information exchange for seismic risk mitigation at city level. It also aimed to promote worldwide activities for reduction of seismic disasters in urban areas, particularly in

Figure 18 Mean seismic hazard map in PGA (g) for a probability of exceedance of 2% in 50 years (2475 years return period) for Turkey (http://tsttdi.th.afad.gov.tr/, UDAP –Ç: 1316, Şeşetyan et.al. 2016).
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developing countries. Nine pilot sites Addis Ababa (Ethiopia), Antofagasta (Chile), Bandung (Indonesia), Guayaquil (Ecuador), Skopje, Tashkent (Uzbekistan, Tijuana (Mexico), Zigong (China), and also Izmir (Turkey) were selected to implement the methodology proposed by RADIUS project.

In Izmir case study, the earthquake mitigation activities were initiated by the Directorate of Izmir Metropolitan Municipality. A local steering committee including two co-chairmen from municipality, one from the chamber of civil engineering, and the other from Dokuz Eylul University Geology Engineering Department, was constituted within Metropolitan Municipality to the responsibility for the implementation of the case study. They were responsible for all the activities of the case study, including authorization of expenditure of the United Nations grant and preparation of periodical reports to the IDNDR secretariat. Under the steering committee, four working groups consisting of 1) Risk assessment group 2) Building and infrastructure assessment group 3) Social and economic condition assessment group 4) Rescue works relief activities and rehabilitation group, were constitute to apply the case study efficiently.

The project process can be defined as 1) Data collection 2) Risk assessment 3) Damage estimation 4) Earthquake scenario text 5) An action plan proposal 6) Dissemination to related government organization. The agreement signed with IDNDR secretariat required to start on 01.02.1998 and resulted on 31.07.1999. The final report transmitted to United Nations IDNDR secretariat and presented in Tijuana Symposium that was held on 11-14 October 1999 in Mexico.

Metropolitan Municipality of Izmir has signed a protocol with Bogazici University to execute the RADIUS Project. Accordingly, Bogazici University has prepared the Earthquake Master Plan of Izmir (URL 7) that was also forming the RADIUS Project’s data collection phase. Earthquake Master Plan of Izmir, and contents, proposals of RADIUS Project has been introduced to risk Assessment Process for Izmir.

One of the most recent hazard map prepared in the UDAP-Ç, -13-16 project for a 2475 years return period, for Izmir and vicinity (AFAD) is shown in Figure 19.

The main ingredients of risk assessment are earthquake hazard, vulnerability assessment and exposure defining as a building inventory. In this case, all components were defined as following items:

Earthquake Hazard. The earthquake scenario with Ms 6.5 on Izmir Fault source have been selected as a similar characterized of 8th of November in 2013 at 17.25 (Izmir Earthquake Master Plan, 02/10/2005 http://www.izmirbld.gov.tr/izmirdeprem/izmirrapor.htm).

Vulnerability Assessment. Considering all the buildings in the borders of Metropolitan Municipality, an immense building inventory based on their structural properties, construction date, project and construction quality and functional properties were prepared in order to use vulnerability assessment as input file.

Damage Estimation. Using the HAZUS, ATC-25 and GIS methods, the possible damage estimation of infrastructures and lifeline systems in Izmir such as highways and bridges, railroads, airports, marine facilities, subway system, telecommunication systems, electrical transmission and distribution Systems, sanitary water and waste water systems, dams, and also building contents, were carried out considering with the Izmir scenario earthquake.
Risk assessment for Izmir case

The results obtained from the investigations were presented in master plan (Izmir Earthquake Master Plan, 02/10/2005 http://www.izmirbld.gov.tr/izmirdeprem/izmirrapor.htm). National activities about risk reduction have been searched focusing on Istanbul and Izmir. Istanbul Earthquake Master Plan (Istanbul Earthquake Master Plan, 26/09/2005, http://www.ibb.gov.tr/tr-TR/Kurumsal/YonetimSemasi/Baskan/GenelSekreter/ImarGenelSekreterYardimcisi/Planlama veImarDaireBsk/ZeminveDepremIncelemeMud/DepremMiniSite/Calismalarimiz/MasterPlan) is presented briefly considering as a guide for Izmir case. After that, Izmir RADIUS Project comprising Izmir Earthquake Master Plan was examined.

The risk levels for R/C and Masonry buildings in Izmir are shown in Figure 20 and Figure 21. A risk management study is required for the historical structure by considering a site specific study for the Ephesus site. First step for such a study is the calculation of hazard maps for the area.
The risk maps, developed for Istanbul and Izmir, are based on building and infrastructure data. However, no study is available for the risk assessment and management of historical
structures located in the region. In this study a site specific earthquake hazard study is to be developed for Ephesus site and the risk assessment and management for historical structures is to be defined.

From the questionnaire collected for Ephesus, the risks in the area have been partially analysed and evacuation plans are being prepared for potential risks. Investigations and evaluations on other risks are under development, in fact, in Turkey a risk map doesn’t exist but at present GIS are under elaboration in order to compare archaeological maps with cartographic layers linked to natural hazards. For the specific case of Ephesus, at present, there is a civil defence unit, a fire fighting unit and a health unit at the Museum Directorate. In addition to the permanent staff, there are two water tanks ready for 24 hours, as well as 24-hour specialized health care teams and ambulances. In any emergency that may occur in the field, site can be fully intervened within 5 minutes.

In addition, for emergency situations, Selçuk Municipality is being worked in coordination and all the facilities of the municipality are utilized.

In case of an emergency, all operations which will take place in the field will be carried out by the Directorate of Museum and Selçuk Municipality. Coordination centres are established for emergencies and all communication and decision mechanisms are controlled from these centres. In case of severe emergency, AFAD units carry out the operations together with the crisis management desk in the governorship (see next paragraph for more details).

Ephesus Museum Directorate has temporary storage areas for safeguarding movable heritage in case of disaster. These spaces are located within the site.

Moreover, the specific spaces for first intervention and restoration are located in the vicinity of the archaeological area and they are suitable for all operations required.

### 3.7.3 Actors involved

As stated in D 2.1\(^{44}\), in Turkey, The Ministry of Culture and Tourism stands as the main authority on taking the necessary measures for the conservation and restoration of all cultural heritage; also executes and supervises the works performed by the other governmental institutions and municipalities (Code 2863, Article 10);

- The conservation and restoration of the cultural heritage under the guidance of Turkish Grand National Assembly is done by the authority itself. The Ministry of Culture and Tourism provides technical support (palaces, pavilions and several museums)

- The conservation and restoration of the cultural heritage under the guidance of Ministry of Defense, is done by the authority itself depending on the protocol to be held between The Ministry of Culture and Tourism and Ministry of Defense.(besides several museums, is responsible of the area close to the borders)

- The immovable heritages owned by the foundations under the guidance of Directorate General of Foundations, or the cultural assets owned by natural or legal persons is conserved and restored by Directorate General of Foundations, by getting the approval of

\(^{44}\) For law aspects see D2.1, p. 68.
regional Preservation Boards under the Ministry of Culture and Tourism. (such as mosques, caravanserai, baths)

- Besides, by the permission of Ministry of Culture and Tourism, conservation offices (KUDEB) under the guidance of Metropolitan Municipalities and Governorships is established to implement and supervise the works performed on the cultural heritages and heritage sites (supervision of construction works, conservation development plans).

Turkey changed the disaster management structure in 2009, the new organization is established under Prime Ministry and called Disaster and Emergency Management Presidency (AFAD, see Peer Review Turkey 2015 Programme for peer reviews in the framework of EU cooperation on civil protection and disaster risk management)\(^45\).

AFAD was established in May 2009 by Law No 5902 (on the organisation of AFAD, this law covers the taking of necessary measures for efficient country-wide execution of services relating to disasters, emergencies and civil defence, making preparations prior to the occurrence of incidents, mitigating the damage sustained, providing coordination among institutions and organisations that manage the responses to incidents and recovery works to be performed afterwards, and creating and implementing policies on these matters) on the basis of lessons learned from the 1999 İzmit earthquake, which indicated a need to facilitate cooperation with ‘solution partners’ and ministries. This involved the merger of General Directorates in the Ministry of Interior, the Ministry of Public Works and the Prime Minister’s Office. At national level, Turkey’s policy and legal DRM (Disaster Risk Management) framework and its implementation are characterized by AFAD’s role as coordinator, facilitating cooperation between ‘solution partners’ in governmental bodies, scientists, NGOs, private business and local communities.

The Disaster and Emergency High Council meets at least twice a year to approve DRM plans, programmes and reports. It is chaired by the Deputy Prime Minister, consists of 13 ministers and also prepares an overall national DRR strategy. In addition to the High Council (for overall strategic decision-making), AFAD also reports to the inter-ministerial Disaster and Emergency Coordination Council. The national legislative framework relating to DRR and disaster management is considered comprehensive. The many laws relating to disaster management include a law on AFAD’s organization and functions, a law on measures and assistance as regards disasters affecting the life of the general public, a civil defense act, a law on land development, a law on catastrophe insurance, restructuring areas at risk and the execution of services relating to damage and disruption caused by natural disasters, a national defense act, expropriation, soil protection and land utilization.

AFAD is responsible for organizing the National Platform for Disaster Risk Reduction. The Platform is a multi-stakeholder forum that is active at European level. It has a relatively large membership from governmental and semi-governmental bodies. In addition to ministries, scientific and academic institutions, NGOs, the private sector and national financial institutions are also involved. The National Platform for Disaster Risk Reduction was established by Cabinet Decision No 2011/1320 of 17 January 2011 (Official Gazette No

Current practice for management and conservation of Cultural Heritage

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27844, 12 February 2011), which also set out its structure. Plans for a new structure were adopted in 2015, but still need to be implemented.

In Turkey, the ‘local’ level comprises provincial, district and municipal actors. AFAD is directly present at provincial level via its 81 disaster and emergency directorates, which are responsible for managing local emergency action, including engineering activities, SAR operations and coordination between institutions. AFAD also has 11 regional SAR (Search And Rescue) brigades and 23 regional logistics warehouses distributed across the country.

Guidance (e.g. on plans and risk assessments) is passed down from national level to regional/county level. Emergency and contingency plans are prepared centrally, taking account of suggestions from the municipalities under the control of provinces. There are local preparedness and response plans, but these do not identify targets and indicators.

Laws No 5393 (3 July 2005) and No 5216 (23 July 2004) require municipalities and metropolitan municipalities to develop disaster and emergency plans, which must contain DRR (Disaster Risk Reduction) elements. Municipalities must demolish buildings that are exposed to high disaster risks and are also responsible for suitable urban transformation.

Istanbul has a sophisticated Disaster Coordination Centre (AKOM), an emergency control room established in 2000 where local authorities and the mayor gather in the event of a disaster. AKOM cooperates closely with AFAD’s Istanbul Provincial Directorate and the two bodies are considered examples of good practice.

As compared with the national and provincial levels, the district and municipality levels seem to lack a balanced system of subsidiarity and proportional autonomy in terms of DRR decision-making and budget, although municipalities are responsible for demolishing buildings at risk and for urban transformation within their territories. Fire brigades are also a local responsibility.

Turkey is vulnerable to three main types of natural disaster: earthquakes, floods and landslides. The majority of the population (70 %) live in seismically active areas and earthquakes have caused two-thirds of total disaster losses over the last century, with 16 % due to landslides and 15 % due to floods. With most of the country exposed to these natural hazards, prevention and risk reduction are extremely important. The approach to risk assessment is currently hazard-specific, with no overarching multi-hazard assessment.

The National Disaster Risk Assessment and Analysis Working Group developed guidelines for assessing the following hazards: rock falls, avalanches, landslides and floods (under development). The methodologies are in line with international standards. There is cooperation between sectors and between levels of government (primarily national and regional/county level). In some cases (seismic hazard), the hazard assessment and maps need to be improved, in others (landslides and floods) the limitation is the lack of data at national level.

Risk assessments are carried out at provincial or county level and are limited by the scarcity of quantitative data on the vulnerability of elements at risk (buildings, key infrastructure, roads).

Most studies and projects on hazard and risk assessment are relatively recent and many are still on-going. For example, the Turkey Disaster Risk Management System Project focuses on
risk modelling and developing algorithms in relation to earthquakes, floods, landslides and large-scale industrial accidents. Turkey Disaster Risk Management System Project started in 2014 and still has to be implemented. This project gathers all electronic and printed material relating to disaster losses in Turkey. It is updated, well organized in terms of GIS and includes:

- five datasets on active faults (1:25 000 scale);
- an instrumental earthquake catalogue (12 674 earthquakes of magnitudes over 4.0 between 1900 and 2012);
- historical earthquake catalogue (1 236 events with intensity of V and over from 2000 BC to 1900 AD);
- moment tensor catalogue;
- information on crustal thickness.

Responsibility for flood prevention lies both at national (AFAD, Ministry of Forestry and Water Affairs) and local level (municipalities). Turkey is adopting the provisions of Directive 2007/60/EC on the assessment and management of flood risks. Implementation has begun in two of its 25 hydrological basins (the Yeşilırmak and Antalya river basins). Flood-risk assessments, including risk maps for these two basins, were due to be completed by June 2016. The mapping involves coordination with various ministries (e.g. Ministry of Environment and Urbanization, Ministry of Forestry and Water Affairs, Ministry of Public Works and Settlement, Ministry of Development).

The National Seismic Observation Network development (USAG) project, which was started by AFAD in 2004, has led to the setting-up of 780 stations, including 550 accelerometric stations measuring seismic hazard (strong ground motion) around the clock. Infrastructure systems and software are continuously renewed in order to improve the network.

The probabilistic seismic hazard map, which constitutes the basis for the official seismic zoning map and application of the seismic building code, dates back to 1993 and needs to be updated. To this end, there is an important ongoing project.

The National Earthquake Strategy and Action Plan 2012-20236 aims to minimize the possible physical, economic, social, environmental and political damage and losses caused by earthquakes and to create living areas that are resistant to and prepared for earthquakes. It has three specific goals:

- learning about earthquakes;
- earthquake-safe settlement and construction;
- coping with the consequences of earthquakes.

It sets out seven objectives and 87 actions, the majority of which remain to be implemented.

Seismic risk maps are not yet available nationwide due to the lack of data on building and critical infrastructure seismic vulnerability. Risk maps and scenarios are available only for the Metropolitan Municipalities of Istanbul and Izmir.

Turkey’s National Disaster Response Plan, the result of a two-year study conducted particularly in the light of the 2011 Van earthquake, was adopted in January 2014. Turkey’s National Disaster Response Plan is flexible, modular and adaptable to all types and scales of disaster. It clarifies the planning and coordination of public institutions and NGOs in the
event of a local/national disaster to minimize the loss of life and property by efficient resource management. As Turkey’s National Disaster Response Plan was adopted quite recently, it will need to be tested through training and exercises.

Response and recovery activities are divided between the national and the regional level. The national level consists of AFAD, eight ministries and key solution partners such as TRC, while the local level is made up of governorships, AFAD’s 81 provincial directorates and the eight ministries local agencies.

There are 28 national service groups, covering all the main sectors of disaster response and grouped in four types of service: operation, information, logistics and maintenance, and finance and administration. These service groups coordinate and organize at ministry level to ensure the sustainability of interrupted services in disaster and emergency situations. All service groups should work in coordination with AFAD, with a ministry assigned as major associate.

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### 3.8 United Kingdom case

#### 3.8.1 Current conservation and management

In terms of preventative measures, Historic England have the Heritage at Risk programme which protects and manages the cultural heritage at risk in England. It is the most compressive list of heritage at risk that exists in England. The programme raises awareness of the state of cultural heritage site in England. The latest register was compiled in 2016, the results of which are used to give guidance and advice to local government, land owners and developers. Concerning the CH archives typology, in UK all kinds of available ones are in digital or digitalised formats (photos, cartography, detail mapping, excavation documents, restoration documents and aerial photos).

All the maintenance activities, as required in the questionnaires (weeding, mowing, tree/shrubs pruning, wall consolidation, coverage settlement, removal of stagnant waters, and maintenance of paths), will be carried out on an individual case by case basis. The UK government departments will only provide guidelines for CH protection and upkeep, and will therefore leave the cost and planning of upkeep to individual site owners. Local government may involve themselves with issues of sites not conforming to regulations – and thus may demand upkeep of CH – with the threat of compulsory purchase if the asset is becoming endangered.

#### 3.8.2 Disaster risk management activities

In the UK protection of CH sites is split for each of the constituent nations. In England it is Historic England, in Wales it is Cadw, in Scotland it is Historic Environment Scotland, and in Northern Ireland it is the Northern Ireland Environment Agency. Recent work in England, by Historic England is the protection and prevention of flooding impacts on CH. This gives
landowners, local government and other stakeholders’ guidance in preparedness, in terms of prevention, for flood events and subsequent inspection, conservation and repair measures. This includes both coastal and riverine flooding. More information and reports can be found at:


Wales’ Cadw have conducted work on preparing Wales’ historic environment to the challenges that is faces from climate change. This involves best practice guidelines for land owners, developers and local government, and looks into challenges including: Extreme weather, flooding, coastal erosion, rising sea levels and migration of pests and diseases. A report on this can be found at:


In terms of planning – in the United Kingdom Cultural Heritage assets are under less regulation than continental Europe. Much of the disaster planning, therefore, is carried out and planned by the individual site owners and stakeholders for each CH asset. Thus, there is no overriding emergency plan for all CH in the UK. Even the above examples are only guidelines which managers and owners may choose to implement or not.

Historical England’s heritage at risk list can be downloaded as shapefiles for use within a GIS, free of charge. Shapefiles can be downloaded for: listed buildings, protected wreck sites, parks and gardens, world heritage sites and more.

https://historicengland.org.uk/listing/the-list/data-downloads/

In terms of CH management of natural hazards for the risk assessment, in organisations like Historic England, Cadw etc., many of the individuals who work for and on behalf of them will be highly qualified. In terms of individual sites, site owners and stakeholders may not at all be qualified, especially when CH is under the control of local trusts for example.

3.8.3 Actors involved

In the UK there is no organisation responsible for disaster management for cultural heritage. Recently studies have assessed the impact of climate change, notably coastal erosion and flooding, on CH (Croft 2013).

In general, guidelines for the protection against natural disaster may be in place from local councils and other bodies, but it is up to site owners how and if to implement them. It is responsibility of the owners of the assets and trusts in charge of CH assets to respond to Natural Disasters, and there is not a real chain of command to be activated.

Recently, there have been suggestions of involving the British emergency services with CH management. For example, Greater Manchester Fire and Rescue Service have recently outlined plans to collect information on historic buildings in the Greater Manchester region. They hope that this information will be used to protect listed buildings in the event of a fire.
Similarly, guidance has been published by the London fire brigade on how to control damage and protect important artefacts in case of fire. This hopes to provide information for site owners and stakeholders about how to react in an emergency – however the information is only for guidance and may or may not be used\textsuperscript{46}.

In case of ND affecting the CH, the chain of command in the UK doesn’t rise very high for the response of CH sites to NDs. It will be down to the owners and trusts in charge of CH assets how they respond to NDs.

Museums and Trusts responsible for multiple locations, CH assets and artefacts may have regional and even national responses to hazards, but this will be a case by case, since there is not a real procedure or plan of actions to be followed. In case of calamity site owners would activate their own emergency procedures. This could include involving the emergency services for ordering evacuation etc.

After the damage Site owners usually assess damage with the help of experts including: architects, archaeologists, and emergency services. These will follow guidelines set out by historic England- who may also assess the damage along with local government.

In terms of planning the damage reimbursement and funding, the site owner would have suitable insurance to cover the cost of damage to their CH assets.

Should the result of a disaster force the CH asset onto the heritage at risk register- Historic England may allocate funding to ensure that the asset can be repaired and removed from the register. Local government may also provide grants to help site owners fix damage in the aftermath of a disaster.

3.9 Other cases

3.9.1 Austrian case: risk management and actors involved

In Austria, combating, eliminating or mitigating the effects of imminent disasters or disasters that already occurred (disaster relief, preparedness) falls mainly within the responsibility of the Federal provinces. The disaster relief acts of the Federal provinces, which primarily define the declaration of a disaster and the command and control structure in the municipalities, districts and Federal provinces form the legal basis\textsuperscript{47}.

When crises and disasters occur, an increased coordination is required. This is ensured by the National Crisis Management and National Disaster Management (in German: Staatliches Krisen- und Katastrophenschutzmanagement, SKKM). The SKKM enables efficient disaster management in Austria and abroad based on cooperation between all competent authorities and rescue organizations at federal and provincial level (see note 48). The Federal ministries, Federal provinces, rescue organizations and the media are represented in the SKKM Coordination Committee (established by the Ministerial Council Decision of 20 January 2004) chaired by the Director General for Public Security. In case of major threats, the committee is responsible for the coordination and consultation regarding the necessary

\textsuperscript{46}http://www.london-fire.gov.uk/Documents/GN_80.pdf

measures at the Federal and Provincial levels. The committee is not only active as coordinating body in case of disasters but also in basic planning (see note 48). The administration of the SKKM is established within the Federal Ministry of the Interior (MOI), and the current policy is provided by the SKKM Strategy 2020\(^48\).

In addition to being responsible for the SKKM, the MOI is responsible for the coordination of Crisis Response, International Disaster Relief and Civil Protection. Thus, in Austria one single authority at the Federal level is responsible for the coordination of trans-regional and international disasters, enabling a quicker and better response in crisis situations\(^49\). More specifically the Department II/13, Operations, Crisis and Disaster Coordination, within the MOI is responsible for:

- the coordination of National Crisis and Disaster Management and Civil Protection (Unit II/13/a)
- International Crisis and Disaster Affairs (Unit II/13/b)
- Civil Protection Training (Unit II/13/d)

The Department II/13 avails itself of the Federal Alarm Center (FAC) at the Operations and Coordination Center of the MOI. It is the central office for the combined warning and alarm system of the Federal Republic and the provinces, and serves as permanent monitoring center of the radiation early warning system\(^50\). In addition, it is the contact point for international requests for assistance in cases of disaster\(^51\). It is connected with the provincial alarm centers (LWZ), with responsible authorities at the federal and provincial levels, with the emergency and rescue organizations such as the Fire Brigade, Red Cross, Mountain Rescue Service, and with the contact points of the neighboring countries, the European Union, the NATO Partnership for Peace, and the United Nations (see note 51).

If a natural or technological disaster occurs within Austria or abroad, all information arrives at the FAC. The relevant authorities are alerted without delay; moreover, as information platform, it supports the coordination of all actions required for an effective response to the crisis or disaster. The LWZ are permanent offices specialized in disaster management at the provincial level. Their task is to warn and alert the public in the event of a disaster. In case of major disasters, they coordinate the emergency and relief services in their respective provinces. The LWZ are connected to the regional headquarters of the emergency and rescue organizations as well as the regional contact points of the neighboring countries (see note 51).

Also in Austria the disaster prevention refers to all measures that significantly mitigate the likelihood and the consequences of a disaster. These measures are comprehensive and therefore difficult to define. Numerous legal provisions in Federal and provincial acts foresee security measures and standards as well as regulations to prevent disasters. In addition, there


are comprehensive standards at the international level (ISO), the European level (CEN) and the national level (ÖNORM); these range from traffic safety via industrial safety procedures to international cooperation in these fields.\(^{52}\)

Furthermore, within the scope of the SKKM, the MOI has established a first national risk analysis. The central element of this risk analysis is a preliminary risk matrix (see note 53).

A specific model of risk mapping was implemented by the Ministry of Agriculture, Forestry, Environment and Water Management and the Association of Insurance Companies of Austria as a nationwide risk zoning system for natural disasters, focusing on floods (see note 53). In fact on the Floods Directive (FD) implementation (2007/60/EC) is mandatory to consider flood risk against human health, the environment, economic activity and CH. There is a cyclic implementation of the FD (6 years) with 3 steps of implementation (http://wisa.bmlfuw.gv.at):

1) preliminary flood risk assessment / identification of areas with potential significant flood risk
2) elaboration of flood hazard maps and flood risk maps
3) elaboration of flood risk management plans.

All decisions to be made for implementing the FD are discussed in a decision committee consisting of approx. 80 delegates of relevant ministries, provincial administrations, stakeholders, etc. Nearly all of them are graduates in the fields of water management, law, spatial planning, nature conservation, biology, geology, etc.

In term of disaster preparedness, both governmental authorities and rescue organizations (emergency relief services) are involved. The provincial disaster relief acts and regulations lay down the operational preparedness measures of the authorities. The main preparedness measures focus on command, control structures, respective management and coordination tasks. These include training, exercises, development of disaster management plans on municipality, district and provincial level as well as technical equipment and staffing of the command and control structures. Furthermore, warning and alerting of the population is covered by these acts and regulations. The authorities provide basic financial resources for rescue organizations and the necessary legislative framework.\(^{53}\)

The disaster management authorities have the following responsibilities (see note 54):

- the development of disaster management plans (including special contingency plans)
- the development of external emergency plans by the disaster management authorities (district administration authorities) for hazardous facilities (Seveso directive)
- setting up command and control structures to support the head of operation
- setting up and maintaining facilities for the general public alert: provincial alarm centres (LWZ) have been set up in the Federal Provinces, and the FAC has been established at the MOI
- training of disaster management personnel


exercises: a separate directive on exercises in the area of radiation protection has been developed

Weather has a significant influence on disaster preparedness. Meteorological warnings are available through the Central Institute for Meteorology and Geodynamics (in German: Zentralanstalt für Meteorologie und Geodynamik, ZAMG). Extreme weather events are available on the Meteoalarm website for most of the European countries. In addition, Austria has a nationwide warning and alerting system and a radiation early warning system (see note 54).

In the response phase, the competent authorities (usually the authorities on district level) are responsible for the command and control measures. Typically, the disaster operation starts with an emergency call, an alarm, and a rescue and/or firefighting operation (local rescue services, local fire and police authorities). With the official declaration of a disaster by the responsible authorities (and in some provinces with the announcement), command and control passes over to these authorities. According to the disaster relief acts, the competences of the command and control structures are applied in a subsidiary way.54

4 Salient best practices for Cultural Heritage Management and Conservation

4.1 Short illustration of salient case studies of best practice for CH Management and Conservation

4.1.1 Case study 1 – Pompei project

An important case study related to monitoring of assets for risk prevention is constituted by the archaeological site of Pompei (Wollner 2013). Archaeological areas of Pompei, Herculaneum and Torre Annunziata were included in UNESCO world Heritage list. The decision of including the areas in the list was made considering that the impressive remains of the towns of Pompei and Herculaneum and their associated villas, buried by the eruption of Vesuvius in AD 79, provide a complete and vivid picture of society and daily life at a specific moment in the past that is without parallel anywhere in the world (UNESCO 2012b). In Pompei, thanks to a collaboration with Finmeccanica, a continuous interferometric monitoring via satellite is performed in order to check the development of micro-collapses in correspondence of the embankment close to the excavated areas (personal communication of Arch. Bruno De Nigris during a survey in the site in July 2016, Figure 22). Historical collapses were also investigated in order to find a correlation between them and the rainfall.

In fact, the amount of water from rainfall is a critical factor affecting the site. It has been estimated that 100-150 mm of rainfall can cause micro-collapse.

To monitor the environmental parameters, a multifunction station has been installed in the site of Pompei. The station measures temperature, RH%, wind and rain and it is possible to check the values by mobile phone so that, in case of emergency, to immediately intervene.

Clearly, an agreement with fire fighters has been created in order to guarantee a rapid intervention in case of emergency. The idea is to create a crisis team which could establish emergency procedures in case of risks and disasters.
Wireless sensors were also installed in chosen walls in order to monitor the movements. A devoted modem receives all data from station and sensors and in case of risk activates alarms according to alert thresholds. Concerning constituent materials used in the site, a diagnostic campaign has been started in order to investigate the conservation state and also to deepen the knowledge of the different kinds of stones used in Pompei: volcanic tuffs, some calcareous rock. In particular, Italian CNR (Florence) started a campaign of investigation by non-invasive multispectral system with the aim at evaluating the general state of conservation of the surfaces and so at supplying information for a possible intervention plan.

Until today some spot investigations were also performed in specific areas of the site and they were addressed especially to the mortars and wall paintings (Castriota et al. 2008; Miriello et al. 2010; Piovesan, 2008).

4.1.2 Case study 2 – The MUSA project

Italian case studies, in which monitoring was applied, are for example the project MUSA specifically developed in Emilia Romagna region. MUSA Project was promoted by the Istituto beni culturali della Regione Emilia-Romagna - IBACN a Regional governmental body acting in the field of cultural heritage - and was developed in partnership with the Italian National Research Council (CNR) and IBACN of Bologna since 2002. MUSA project has created a regional network that exploits Internet and wireless communication technology to monitor buildings containing works of art using a remote-controlled system, in conformity to recent standards for preservation (De Nuntiis et al. 2007).

The network (Figure 23) offers to museum curators and technical staff practical tools of tackling preservation of the cultural heritage through automatic measuring of physical parameters at museums. All parameters monitored are transmitted from the remotes sites to a
central archive (database) providing analyses and forecasts on the trend of environmental conditions.

The sensors positions were opportunely chosen in collaboration with the museum curators, on the basis of some important criteria as special value of the artworks, sensibility of material conserved and instability of microclimate, according to the standards and to the Italian rules (G.U. n. 244, 2001).

Figure 23: The Museums of the MUSA network (from: http://ibc.regione.emilia-romagna.it/istituto/progetti/progetti-1/musa)

4.1.3 Case study 3 – The Monumentenwatch project

The Monument Watch project is an integral approach for the preventive conservation of the cultural heritage developed in Belgium (Flemish Region, http://www.monumentenwacht.be/en).

Monument Watch Flanders is an initiative of the King Baudouin Foundation, the Foundation for the Conservation of Monuments and Landscapes and the Flemish Association of Provinces. It was set up in September 1991. This project is based on a work of regular condition surveys in architectural contexts. It is well-organized in terms of structure and finance (see brochure available at the web site of the project).

4.1.4 Case study 4 – The Temperierung system

In the oratory of the church of Saint Stephen at Lentate sul Seveso (province of Milan) a new system (Temperierung, a warm water pipe running at the bottom of a masonry along the interior perimeter of the church) was developed and applied in order to limit the rising damp that caused high values of relative humidity and water in the walls (Del Curto et al. 2010). The investigation campaign in the oratory was performed before the installation of the Temperierung for one year by means of infrared thermography, gravimetric tests, psychometrics and data logger measurements. After the restoration work on the oratory and
its wall paintings with the life scenes of Saint Stephen, a new campaign was undertaken in order to evaluate the effect of Temperierung installation. The new investigation was carried out for one year. The results demonstrated that the effects of Temperierung are very limited and act over long time of application, so avoiding rapid changes and stresses on wall paintings and structures. The effect of high RH% values and rising dump have been so mitigated and clearly reduced.

4.1.5 Case study 5 – The Colle del Duomo museum

Another example of monitoring, diagnostics and application of cost effective solution is the Museum of Colle del Duomo in Viterbo, part of the famous monumental complex of Papal Palace where the famous conclave took place (the first and longest of the history of conclaves) which concluded with the election of the Pope Gregorio X in 1271. Viterbo was the Papal see for 24 years, from 1257 to 1281.

Thanks to the collaboration between the Society Archeoares, responsible of the Museum management and University of Tuscia, a continuous plan of monitoring and diagnostics is performed in the different expositive rooms containing several kinds of objects and materials.

The monitoring was a relevant action which demonstrated the necessity to limit the effect of light, especially on textiles, papier-mâché and wooden artefacts.

The solution for mitigating the effect of solar radiation, especially during summer, was the use of special glass to the windows (Figure 24) for reducing the UV component, particularly dangerous for objects made of organic materials.

Figure 24: Museum of Colle del Duomo, Viterbo (Italy). The room of Sacred Paraments.
4.1.6 Case study 6 – Energy efficiency in cultural heritage buildings as a result of EU projects Climate for culture and SMooHS and early warning system for room climate measuring

This contribution is based on the possibility in making the most of the characteristics of building itself, hosting collections, as system to maintain good microclimate conditions for conservation (Kaeferhaus 2014).

Sometimes, in fact, museum standards establish too strong limits for RH% and temperature and, as a consequence, these recommendations often provoke too much machinery in museums and depots with the result of contradictory output. Huge air conditioning systems, big energy bills and measuring results with short term peaks endanger the artifacts.

Consequences may be that in the future we cannot any longer afford our museums or depots, especially when energy is getting more and more expensive, not mentioning the totally unsolved situation of what might happen in those strongly air conditioned museums when there is a failure in energy supply. On the other hand, there are several museums, with none or a minimum of building conditioning, where very delicate artifacts are well-preserved.

In this approach, the thermal stability is proposed to be reached through a series of indications:

- Integrated planning
- Intelligent use of big masses of the building to reach thermo stability
- Improvement of the thermal quality of the building, if possible
- Ensure air tightness and create buffer rooms
- Using best possible, intelligent shading systems to minimize external loads
- Reducing internal loads (light, machinery) to 15W/m² maximum
- Heating exclusively by radiation with warm walls to avoid mould; convective heat transports dust
- Simple controlled ventilation with minimum air exchange rate to 0.5, if possible
- Humidification, if possible, decentralized
- Simple technologies for building services and control systems.

This approach was applied to different kinds of CH assets, in particular:

- The Art Gallery in the Academy of Fine Arts, Vienna
- The church of Saint Colombano in Bologna
- Stift Klosterneuburg, in Vienna, is unique for its rich early medieval art as the “altar of Verdun” (a very rich enamel work of 1180) and the painted wooden wings from the same
- The underground depot of the Monastery of Einsiedeln (500m²), Switzerland, containing numerous and precious books.
- The Museum of Fine Art in Vienna.

The SMOOHS project (Smart Monitoring of Historic Structures) aimed at finding the best possible new measuring devices (“smart-mote” as a wireless data logger developed by University of Stuttgart), to show on site in different case studies the application of new devices and examples of energy saving.
At last, an attempt of developing an early warning alarm system (climate alarm) was tested. This method was based on a previous microclimate monitoring, for at least 2-3 years, because the climate alarm needs former data to analysis congruity with the present climate data.

In such a case the system gives an alarm before damages to artifacts could happen.

Naturally, agreed limits of room temperature and relative humidity could be defined before.

4.1.7 Case study 7 – A GIS application in the city of Ferrara (Italy)

Another interesting case of monitoring, associated to planned maintenance, is the project on the use GIS applications in the architectural field in particular referred to the historical city of Ferrara (Fabbri, Rocchi and Zuppiroli 2014). Drafting a conservation plan requires the management of several multi-disciplinary data (i.e. thematic database) that, only if properly integrated, will allow stating correct assessments. On the contrary, an inefficient management of data complexity may produce an inappropriate plan. The availability of computer tools able to collect and organize large amounts of information undoubtedly facilitates the management of the procedures provided for the conservation plan.

Consequently, in this scenario, it is crucial to use GIS technology, which combines the databases management with geometrical and spatial referencing. The Geographic Information Systems, initially developed in urban and territorial research fields, find effective application even in a strictly architectural scope, not only on conservation plans, but also on the management, up to the detail scale, of architectural elevations. The system enables the management of a geolational model in which there is a direct topological relationship between the stored data and the restoration project: the entities of graphical model (points, lines and polygons) are associated to data structures with the definition of topological relations (adjacent, closeness, overlap, inclusion, etc.).

In this example, the capabilities of GIS in architectural restoration were tested, deepening the historic buildings of the Municipal Cemetery of Ferrara (Fabbri, Rocchi and Zuppiroli 2014, 161).

Many information, as follow, are managed and related together on an updated geometrical model:

- Building features (techniques, materials, finishes);
- Historical documentation (archival documents, maps, historical iconography);
- Structural problems, with the possibility to identify the severity of the lesions and the possible evolution of the phenomenon;
- Conservation and restoration works carried out in the past, with the possibility to link, for homogeneous areas, the specific procedures performed;
- Samples, preliminary tests and diagnostic analysis, noting the location and allowing an easy visualization and comparison;
- Deterioration and alteration, with the possibility of analyzing the spatial overlap and the quantification of the presence of several set of problems.
4.1.8 Case study 8: The National Archives (UK) approach to assess risks to the collection and correct monitoring plan

Between 2005 and 2007, the National Archives in UK carried out an extensive preservation risk assessment of its collection of original government documents (Bülow 2010). Results have highlighted the effectiveness of policies and practices already in place. However, the assessment also provided evidence of current weaknesses, and helped prioritize necessary work to improve further the management of the collection. The National Archives took some actions to improve issues such as environmental conditions within storage areas, mitigating risk of physical damage to documents from handling, policies on the use of archival microfilm masters, and to reduce damage and loss of original records by substitution copying.

In particular, the correct monitoring of environmental conditions demonstrated a fundamental item in conservation process. Concerning the specific topic on environmental monitoring, the National Archives verified that the control equipment installed in 1976, and upgraded sometimes over the years, has become inefficient also due to the increasingly warm summer temperatures. Moreover, changes in the staff involved occurred so that it resulted in disjointed efforts to maintain and control the storage environment within the repositories. Due to the problems found by the Collection Care, starting from 2007, the monitoring program was performed systematically in the storage environment via telemetric equipment, and irregularities are reported to the Estates and Facilities Department. In addition, an interdisciplinary group consisting of staff from Estates, Collection Care, Repositories and maintenance engineers was reinstated to help monitor and control the environment. Most importantly, the National Archives let a new contract to a single company, which is contractually bound to deliver specified environmental conditions. The measures taken by Collection Care, were effective in improving the environmental control (Bülow 2010).

4.1.9 Case study 9: The case of Tarquinia (Italy) Etruscan Necropolis

The necropolis of Tarquinia, also known as Monterozzi, contains 6,000 graves cut in the rock. It is famous for its 200 painted tombs, the earliest of which date from the 7th century BC (UNESCO, http://whc.unesco.org/en/decisions/126).

The Tarquinia Necropolis has been described as “the first chapter in the history of great Italian painting” for its exceptional painted tombs adorned with scenes of human life: huntsmen, fishermen, musicians, dancers, jugglers and athletes.

Housed in the fifteenth-century Palazzo Vitelleschi, the National Archaeological Museum of Tarquinia, hosts an absolutely unparalleled collection, whose pieces include the majestic, evocative Winged Horses.

One of the main problems in conservation of these extraordinary paintings is certainly the microclimate in the tombs and in particular to the changes in conditions caused by opening for public access.

A recent publication reconstructs the conservation history of the painted Etruscan tombs of Tarquinia on basis of archival research, visual examination and oral history (Cecchini 2012). The complex conservation history of this famous site begins in the first half of the 19th century when most of the tombs were discovered and the first interventions were carried out.
The book describes the most recent and advanced methods of preventive conservation to protect the wall paintings from the outside climate and the measures and provisions adapted by the administrative authorities to reconcile conservation and public use of the site (Figure 25). A part of the book focuses on the current intervention methods to protect the wall paintings and that give provide hope for the sustainability of the incredibly important heritage. The appendix contains an important study on the characterization of the painting technology focusing on the presence of different clay-based preparatory layers.
In this context, it is interesting to consider also the project developed by ENEA (National Agency for New Technologies, Energy and Sustainable Economic Development) aimed at developing hi-tech technologies for the great Etruscan painting (https://www.researchitaly.it/en/success-stories/cultural-heritage-from-enea-hi-tech-technologies-for-the-great-etruscan-painting/).

The famous Tomb of the Blue Demons in the Necropolis of Monterozzi in Tuscia will host the first outdoor/open laboratory for technological innovation established by the Agreement between ENEA and Around Culture.

The project, which aims to test a pilot model of a laboratory open to technological innovation applied to cultural heritage, includes Tombs 6222 and 5203 and the Querciola Tomb in Tarquinia, an expression of the great wall painting of Etruria, the most important “art gallery” of pre-Roman Italy.

Along with ENEA, the initiative for the creation of an outdoor/open laboratory applied to cultural heritage involves the Lazio Region, the Superintendency for Archaeology, Fine Arts and Landscape for the Metropolitan area of Rome, the Province of Viterbo and Southern Etruria, Associazione Amici delle Tombe dipinte di Tarquinia (http://www.amicitombeditarquinia.eu/), public institutions, local authorities, technical and cultural operators, scholars, researchers and private companies. The initiative is part of the COBRA project, funded by the Lazio Region, for the development and dissemination of methods, technologies and advanced tools for the conservation of cultural heritage based on the application of radiation and enabling technologies.

“With this project the sites Tarquinia become an unprecedented outdoor/open laboratory for monitoring and application campaigns of the wide range of laser technologies implemented by ENEA in the context of the COBRA project also in terms of cultural dissemination and training of new professionals and new scientific and technological figures”, explained Roberta Fantoni, ENEA, responsible for the COBRA project (http://cobra.enea.it/).

Started in 2015, the COBRA project will end in December 2017. It aims at the diffusion and transfer to small and medium enterprises, operating in the field of cultural heritage, of ENEA skills and advanced diagnostic and analysis tools aimed at the qualification of materials and the identification of innovative treatment for the protection and preservation of cultural heritage (http://cobra.enea.it/).

At last, in the case of painted tombs of Tarquinia, it is interesting the management aspect that involves the important role of a no-profit Association named Amici Tombe Dipinte di Tarquinia (Friends of Painted Tombs of Tarquinia). As declared in the web site of the Association (http://www.amicitombeditarquinia.eu/index.php/component/content/article/7-notizie/25-eng): “The solution to the problem of the protection and the improvement of the artistic heritage is an institutional duty that the nation carries out through the Soprintendenza, but at the same time citizens are mandates and beneficiaries of its tutelage. Therefore, you must be pleased when citizens, and lovers of beauty convene to carry out a task concerning the integration and support for the protection and improvement of such heritage” (Ruggero Martines, “Le tombe dipinte di Tarquinia (the painted tombs of Tarquinia) a non-profit association”, extract from the Quotidiano arte.it – May 28, 2013.).
The Association was founded in accordance with the “Soprintendenza of The Southern Etruria's Archaeological Heritage” (a regional office connected to the Ministry of Cultural Heritage and Activities) to promote the preservation and improvement of the UNESCO archaeological site of the “Painted tombs of Tarquinia”.

The Association intends to:

- promote the safeguard, tutelage, improvement and the study of the painted tombs in Tarquinia by searching for funds and involving Authorities, Institutions, Universities and private citizens that have the same common interest;
- place the associates' specific professional competence and expertise for Authorities, and Institutions and cooperate for the attainment of the goals of improvement and tutelage of the heritage;
- divulge for cultural and scientific purposes the cognitive heritage of post-mortem documentation of the painted tombs in Tarquinia;
- use the Data-bank, previously deposited at the “Soprintendenza” by Dr. Adele Cecchini concerning the technique of execution and the conditions of the tombs that are currently accessible by specifically updating the “case sheets” of every individual tomb when necessary;
- promote, along with the “Soprintendenza of The Southern Etruria's Archaeological Heritage” research programs and exclusive technological trial testing and technical assistance for associates or whoever makes a request, providing them with the appropriate technical documentation for eventual measures to be taken concerning the safeguard and tutelage and make available products and technology that they deem necessary through terms and conditions established by the Administrative Authority;
- invent, design and combine to bring about the dissemination and research on the state of conservation and the operational techniques of the Tombs of Tarquinia in order to effectively contribute to their tutelage, maintenance, preservation, restoration and improvement;
- support the ethical research on the main scientific techniques together with other professional Associations;
- create brands which guarantee and distinguish the products, the technologies and eventually machines or instruments used in the conservation and restoration of hypogea environments;
- contribute in promoting knowledge of recovering the archaeological heritage of Tarquinia, through a careful action in locating, selecting and classifying the tombs according to the previous experiences in archaeological research and collaborating with other institutions, associations and organizations.

The case of Tarquinia is particularly relevant because cover completely an example of current practice in management of a CH archeological context from monitoring to maintenance, knowledge, dissemination, etc. with the fundamental role of non-institutional association. Due to the relevance of the site and to the interesting approach used in management and conservation, an interview with the restorer Adele Cecchini, also responsible of the Association Amici Tombe Dipinte di Tarquinia, is reported.
Interview to Adele Cecchini (January, 2017)

During the researches it was possible, for Tuscia team, to interview some expertise and restorers, who worked directly on the Italian CH. Adele Cecchini, a restorers working on Tarquinia’s necropolis, spoke to the team about her experience, giving a description of the problem she had to face, and explaining some proposal for damage mitigations or maintenance work.

The most dangerous NH for hypogeum sites are floods, since contact with water can seriously damage the plaster that ends to "melt" becoming a sort of slurry impossible to retrieve. Solve, or at least mitigate, the flood damages would be possible by making the drains, that can prevent or reduce water infiltrations in tombs; drains, however, require constant maintenance.

Moreover, if there is a flood the walls of the tombs could collapse. In Tarquinia (in the area of the cliff) there were some collapses; a boulder from the dromos of one of the tombs collapsed because the mud has seeped into the rock causing the sliding of the rock; at the moment in this dromos is used a support, in order to prevent other damages.

It is very important, therefore, to restore not only the graves, but also the dromos and maybe cover it with mortars that resemble the macco same, this would also allow better readability.

It is also important to pay particular attention to the problems of static nature of the soil, and thus the risk of experiencing landslides. The gradients of the terrain have to be "right" to prevent damage.

Even trees can be a significant problem, not only for the possibility of damaging the environment with their roots, but also because, if they are constantly pruned cannot grow too and- in case of strong winds - falling damaging environments (in Tarquinia, in March 2015 strong winds uprooted several trees).

Tombs of Tarquinia. interventions:

- Tomb of the Inscriptions: is located in a very steep and therefore the access is rather complicated, in recent years have not been carried out interventions to address this issue; this tomb, one of the most important discovered in the Nineteenth century, was attacked by plant roots in the area, which must be removed; in the past it has posted on the grave using the cement, which happens to be much more hard plaster, and therefore end up stressing the latter causing it to fall. In this tomb there are cracks on the plaster and cement used for interventions; on the paintings it encounters strong presence of insects, centipedes and bacteria (white).

- Tomb of the Bronze Gate: past interventions were made using cement; recently hydraulic mortars developed specifically for Tarquinia were used for interventions. In a first period Torraca mortars were used, with the addition of macco, but also these mortars presented some endurance issues, also hydraulic lime had the same problem. Bonaccini has therefore realized the Leden, excellent mortar for the situation of Tarquinia which is still used for the interventions of consolidation of the plasters.

For surface consolidation work are used nano-lime, Calosil and Nanorestore. The acrylic emulsions were found to be unsuitable since they make the water-repellent surfaces.
- **Tomb of the Juggler**: the roof, which was made of cement, would have been very difficult to remove, removal could also cause extensive damage to the tomb; for this reason, it was chosen to intervene by covering the cement with mortar and macco, in order to reduce the possibility of condensation. The intervention was effective.

- **Tomb Sculpture**: inside are eliminated all the roots, the entrance of the tomb - which was painted - has not yet been released by the roots.

- **Jars of Paintings Tomb**: it was necessary to remove the roots; the surface of the walls (and therefore also the painted areas) are literally attached to the roots, so it was chosen to use the cyclo-dodecane by which the surfaces were blocked and then raised in order to remove the roots without damaging the paintings, after that it was possible to proceed to the surface repositioning.

In order to preserve a hypogeum site, it is critical that it remains closed while maintaining constant temperature (18 °) and humidity (even 100%). In Tarquinia transparent doors were installed at the entrance of the tombs.

The hot air inlet may damage the painted hypogea, since it causes condensation on the surface. The cold air is instead less dangerous, since it causes only a quicker evaporation. If the temperature drops below zero the water that constitutes the macco likely to freeze, but, usually, the frost affects only the surface regions and does not arrive in depth.

Adele Cecchini and Luigi Campanella studied macco in relation to the painted surfaces; the studies showed that surely close their environments is very important, but equally important would insulate the ground above, since even the seasonal cycle can result in degradation of the sites. In addition to drainage channels would be effective to use insulating sheaths or, also, of turfs made with selected plants and free of taproots roots.

The turf could become at this point a protection for environments, in case of excessively hot temperatures would be enough to water the turf to maintain constant the temperature of the soil. Is therefore important to protect and perform maintenance on the ground through actions of weeding, elimination of insects and snails (especially snails without shells), protection from microbiological attack (rare but severe, eg a tomb has been the' attack of pink bacteria that caused significant damage).

To prevent bacterial attack is very useful to be able to have the floor completely clean environments. At the moment, in Tarquinia, only three graves have clean floors.

The snails in Tarquinia are a significant problem, a few years ago as a result of heavy rains have arrived in Tarquinia many snails, inside the tombs; eliminate them is rather complicated and the most functional method seems to pick them manually from the surfaces; bait for snails do not help indeed coming to worsen the situation: they are in fact made from verdigris thus being blue, the snail - unlike the mice - do not die immediately, but after eating the bait produces blue droppings which can damage the paintings. The association “Amici delle Tombe Dipinte” (see case study 8 in par. 9.1) proposed to plant in some areas of the necropolis sage and rosemary, plants that could push away the snails.

Another problem encountered in Tarquinia was that of termites: these are quite difficult to eliminate, in the event an infestation. The termites create galleries of the ground with one inlet port and one output; the land can be easily removed being careful not to "scratch off" too much avoiding to damage the paintings. In the case of infestation occurred in Tarquinia,
caused by the abandonment of timber in the area, has intervened digging up to the point where it is identified the termite nest and then the restorers proceeded filling the same with a lot ant poison. To prevent infestations of termites is sufficient to keep the affected area clean and pay attention to this timber.

4.1.10 Case study 10: The case of Domus Aurea (Rome)

Another important case concerning integrated plan of monitoring, conservation, management of CH assets is that of Domus Aurea project aimed at rehabilitating the monumental complex.

The general project “Light in the Domus Aurea”, by the Architect Enrico Del Fiacco, had the main focus on lighting aimed at ensuring the right quality of light and minimal thermal impact.

The permeability to light of Domus Aurea was one of its fundamental features.

In fact, the structure was conceived with a marked east-west orientation, ensuring maximum exposure to the south and thus guaranteeing the greatest possible amount of natural light.

The problems of decay present on the lower right-hand part of the vault are obvious and were caused by two concomitant problems: the first was the LED lighting on this side, effective but also a source of heat that slowly led to an extensive growth of efflorescence. The second, which did not cause major destruction purely because there was a rapid intervention, was a sudden and massive percolation of rainwater from the layers of earth.

These issues are just some of the problems that conditioned the guidelines to be followed in developing the lighting project for the Domus (Figure 26).

The topographical and archaeological recordings by Di Heinz-Jürgen Beste, Gabriele Monastero and Valentina Iannone, report on the work made by the German Archaeological Institute in Rome (DAI), in collaboration with the Soprintendenza Speciale per i Beni Archeologici di Roma (SSBAR), from 2010 (Figure 27). The Institute has created a topographical map covering the underground rooms of the Domus Aurea and the overlying level of Trajan’s Baths now forming part of the park on the Oppian Hill.

![Figure 26 The current visitors’ route and some of the most representative rooms – Soprintendenza, from: http://archeoroma.beniculturali.it/cantieredomusaurea/en/2016/10/la-domus-aurea-e-la-luce/#more-3570.](image-url)
All the detailed archaeological recordings for the Domus Aurea worksite are carried out within this reference framework. The recording project aims to create a graphic support of assistance in all the conservation interventions.

Figure 27 A phase of recording work in Room 34 - Archivio SSBAR (from: http://archeoroma.beniculturali.it/cantieredomusaurea/en/).

Testing the effects of an ancient and a modern roof on the replacement of the plant cover of the Domus Aurea, by Sandro Massa is another relevant part of the project and it is related to the environmental conditions and possible risks for the monument. As the author writes: “a material may decay for a variety of reasons: normally we consider those that derive from environmental interactions, to which we should add events that are limited in time but of high energy that may be far more dangerous for the maintenance of heritage”.

In the case of Domus Aurea, the load-bearing structures have become more fragile over time and are therefore no longer able to support the maximum load for which they were designed.

The enormous quantity of earth that over the centuries has accumulated on top of the vaults of the Domus endangers the load-bearing structures due to its excessive weight; after heavy rains, this may increase by as much as 30% if the water is not rapidly discharged. For security reasons it is therefore necessary to remove some of the earth above the structures. However, whilst from a structural point of view this would ensure greater security, the same cannot be said for thermo-hygrometric stability. So, for conservation purposes, it was tried to keep thermo-hygrometric conditions as close as possible to those of the present by stabilizing them.
To do this, some solutions were tested and at last the better one was to place, above the vault, two different types of plastic modules with wedge-shaped protuberances. They were filled with expanded clay. One module had holes for the passage of water while the other did not.

On the ground surface, two types of vegetation were planted, perpendicular to the arrangement of the two modules so that to see the effect of both systems (Figure 28).

![Image](https://example.com/image.jpg)


All the parameters, both on the ground and inside the structure, and on the inner surface of the vault were clearly recorded. Finally, an automatic irrigation system was set up. The results, after elaboration and evaluation, showed that in calculating heat exchanges it is important to consider the convection taking place on the underlying vault in addition to the heat conduction above.

Irrigation, as well as ensuring plant growth, also guarantees a reduction in the heat flow penetrating into the structure as an effect of evaporation.

### 4.1.11 Case study 11 – Historical buildings in English heritage

The case study of Historical building in English heritage discusses the problems of flooding in buildings of historical contents (Historic England 2015). In this case, floodwater can enter a building through: masonry and mortar joints; cracks in external walls; vents and airbricks around windows and doors; door thresholds; etc.

Protection works must be applied with sensitivity to a historic building and in general CH assets so that they do not damage the special interest or integrity of them. In particular, the aim must be to retain and respect the existing structure and materials. Appropriate flooding-adaptation measures, particularly for resistance, must be tailored to specific properties (English Heritage 2010, 11).

A flood-protection survey combined with a flood-risk assessment to establish what is the appropriate form of protection is a necessary step for establishing the correct measures to be adopted. Flood-resistance measures need to be considered in relation to the type of flood risk – regularity, duration, speed, cause and source.
Good effective maintenance is a key part of flood resistance in older properties. Basic maintenance such as keeping masonry pointing in good order and sealing gaps around pipes that penetrate the external wall can certainly help.

Sometimes, the use of temporary barriers can be a solution needed for reducing the possible damages of flooding. Both fixed and temporary barriers can be installed. The most used temporary barriers are covers for airbricks and sandbags. Airbricks and vents should be sealed only during flood conditions and then removed to aid drainage and drying out and later to provide permanent ventilation. Sandbags have the disadvantage of being heavy to use and can be substituted by commercial alternatives made of ultra-lightweight expandable materials.

Permanent barriers against flooding are also proposed in the document of English Heritage. These permanent barriers are walls, gates and additional drainage ditches to site perimeters that could prevent water reaching the buildings. Such barriers need to be carefully designed as they can have a significant impact on the appearance, character and performance of the building.

For properties vulnerable to repeated flooding it is advisable to limit the potential damage and cost and the amount of time the property is uninhabitable. Modifications can be carried out to services, interior fixtures and fittings to limit damage and enable the building to be made habitable again as soon as possible after a flood. In the document proposed as case study for flooding management, also an emergency flood plan and kit is proposed, in case of flooding episode (see English Heritage 2010, 16, Figure 29).

![Emergency Planning Chart](image)

**Figure 29** Emergency planning proposed in case of flooding, from English Heritage 2010, 16.
In the document proposed by English Heritage, some further recommendations are supplied in relation to the occurrence of flooding.

In this section of the document a list of indications is supplied for the readers, with detailed instructions such as, for example, to check Environment Agency flood-warning codes; to take removable valuable and valued possessions upstairs or to a safe place; to make safe/turn off gas/electric/water supplies when floodwater is about to enter home; to wash hands thoroughly if you come into contact with floodwater. Use anti-bacterial hand gel as the water supply may be contaminated; etc.

Detailed instructions are supplied also when returning to the building, for example: “is it safe? – there may be hidden dangers and slippery surfaces in the floodwater; check that the electricity has been turned off at the mains before standing in any floodwater; make lists and notes of damaged items/areas to hand to the loss adjuster or claims adviser; and so on” (see English Heritage 2010, 19).

A further (chapter 4) of the document is devoted to the measures and operations suggested after the flooding event has occurred in order to minimize the effects of flood damage in old buildings. After having verified the damages with insurers, it will be possible to start with the initial operations of drying, decontamination and cleaning. A health-and-safety risk assessment needs to be carried out before decontamination and cleaning can start.

Once the property has been cleaned and decontaminated and some initial drying has taken place then a more detailed assessment and recording of damage can be made and what repair work is required. This step could be required by insurers, for insured property, but it is important to obtain assessment and recording of damage from specialists in historic-building repair.

In the situation of possible structural damages, it will be necessary to engage architects, building surveyors and structural engineers with experience in the conservation and repair of structurally damaged historic buildings.

A further step after flooding events concerns reconnecting services. Before doing this step it will be necessary to consult the local utility companies. Systems should be inspected and certified by an appropriately qualified electrician before use. Gas supplies, pipe-work and meters need to be inspected, cleaned, dried and tested before re-use.

A conspicuous part of chapter 5 is addressed to the drying issues after flooding. This part is particularly relevant and should be carried out without attempting to dry old buildings out too quickly, as this could cause a great deal of damage. Thin timber elements, including floors, doors and panelling, may warp, twist or split; salts may migrate through old stone and plasterwork, causing blistering, powdering and exfoliation; many painted surfaces will peel and flake. The remedial work can become more damaging than the flood itself.

It is essential that the relative humidity is monitored and recorded both in and outside the building so that the rate of evaporation can be assessed and thus the speed of water removal estimated. Slow and gentle drying can take several months, but it is better than destroying irreplaceable historic fabric by acting in haste. Professional help and equipment will be needed.
D1.1: Current practice for management and conservation of Cultural Heritage

As explained in the document drying time and the regime depends on a number of factors:

- time of year (outside weather conditions)
- building-fabric components and coverings
- porosity and permeability of the materials
- flood duration
- type of flooring
- water table
- ambient relative humidity.

Both natural and assisted ventilation can be applied for drying process.

Assisted ventilation can be performed through fans, background heating and dehumidification.

In all cases, it is important to monitor and check the drying process, taking regular moisture measurement readings. It is essential that the relative humidity and temperature are monitored and recorded both in and outside the building in order to know and assess the rate of evaporation and therefore the speed of water removal.

The last part of the chapter is addressed to evaluate how flooding affects materials of buildings according to their compositions and characteristics. These materials include stone, solid brick-and-mortar walls, timber frames, wattle-and-daub panels, timber boarding and panelling, earthen walls and floors, lime-plaster walls and ceilings and many decorative finishes.

Each material reacts in a different manner according to its composition and physical properties. For example, organic materials such as timbers swell and distort when wet and suffer fungal and insect infestations if left damp for too long. If dried too quickly and at temperatures that are too high, organic materials can shrink and split, or twist if they are restrained in panels. Inorganic porous materials do not generally suffer directly from biological attack. Significant damage can occur when inherent salt and water (frost) crystals carried through the substrate are released through inappropriate drying or very cold conditions.

To conclude, the case study of English heritage concerning flooding and historical buildings, can be considered a good practice of prevention, monitoring, maintenance in CH assets.

In fact, all steps of the natural event are taken into consideration: from risk assessment to the building to the mitigation measures and at last to post-event recovery and long-term evaluation of assets.

**4.1.12 Case study 12: Burford Church, Oxfordshire**

This case study is an example of good practice related to post-flooding intervention on CH (Historical England 2015, 30).

Burford church is considered Grade I listed church. It was flooded to a depth of about 450mm in the summer of 2007, when the adjacent River Windrush broke its banks after torrential rainfall.
The floodwater deposited a layer of sandy silt over the floors and lower part of the walls. This water affected many of the floor-mounted contents, such as antique furniture, pews, kneelers, altar cloths and bookcases.

The first exercise was to remove all the contents that were at risk to a safe, secure and dry area of the church and to compile an inventory. Fabric items were dry cleaned and furniture was allowed to dry naturally. Once the floodwater had receded vacuum cleaners and soft-bristled brushes were used to gently remove the silt deposits. A neutral detergent-and-water solution was used to gently clean the floor and walls. The same areas were then rinsed with clean water, dried with cloths and then allowed to air dry before being sprayed with a sanitizing mist to kill any remaining bacteria.

Natural ventilation was maximized by the use of large fans strategically positioned within the church (Figure 30).

The fans were set up so that they drew dry air into the building while at the same time blowing wet air out. Relative humidity measurements were taken at regular intervals.

The choir stalls, which were built on oak plinths with voids beneath, were opened up to allow air circulation and to allow access to the void for cleaning. The boards were numbered to ease identification for replacement. High-velocity fans were then used to dry the void and stone flooring.

No dehumidification or heating was used to dry the building and the church was certified dry less than seven weeks after the floodwaters had receded (Historical England 2015, 30).

4.1.13 Case study 13 – Integrating Technical Flood Protection and Heritage Conservation Planning for Grimma, Saxony

Another case study proposed as good practice in flooding protection is that of Grimma in Saxony, a region interested, in August 2002, by unprecedented amounts of rainfall that within a few hours turned small creeks into terrifying torrents and calm rivers into devastating masses of muddy water (Will 2008). The city of Grimma was one of the worst affected of the many places flooded in Saxony.
An initial, technically oriented proposal for Grimma was the construction of a monolithic concrete wall stretching 1200 m and rising about 3 m. This proposal was promptly rejected by both the city council and the permit authority. The citizens saw themselves confronted with the prospect of being blocked off from the Mulde river by the monolithic wall. As a consequence, a different solution should be found taking into account some pre-requisites: flood protection in historic urban areas must be seen as part of a complex planning process and needs to be integrated with other related activities, such as town planning and urban design, historic preservation, environmental protection and design, local economy and infrastructure, recreation, and tourism.

Taking these concepts in mind, a team of architects and landscape architects from the Technical University (TU) in Dresden was called in for consultation to help meet these objectives.

In order to devise flood control structures that would meet the hydraulic requirements without destroying the cultural, spatial and landscape values of the Grimma riverside, alternatives to the initial plan had to be developed. To this end comprehensive analyses were made to describe and visualize topographical, spatial, environmental, aesthetic and functional qualities of the city and its relationship to the river.

Evaluation of these findings led to the formulation of four main strategies for the design of the flood control structures:

1. **Location**: pushing the alignment beyond the river banks as far as possible;
2. **Height**: reducing the maximum height of the structure;
3. **Typology**: differentiating the structure according to the specifics of various sites by articulating or emphasizing either their architectural/urban or landscape character;
4. **Surface/texture**: visually adjusting the structure to its historical surroundings.

As a consequence of this strategy, some alternative design proposals were developed and exposed to professionals and public scrutiny several times in order to either reject or refine them and eventually to reach the general agreement regarding solutions tailored to the special needs of Grimma. A proposed solution was the creation of a structure merging into the architectural fabric and thus nearly disappears from sight (Figure 31).
4.1.14 Case study 14 – Standards for the repair of buildings following flooding

Another case study related to flooding management is that published as result of CIRIA Research Project 676 “Standards for the repair of buildings following flooding” (Garvin et al. 2005).

This book reports procedures for flood sources evaluation, for taking safety measures, for decontamination and drying, for post-flood survey and reduction of impacts of future floods and at last a series of standards for repair.

The book provides detailed specifications for the repair of buildings following flooding.

The standard of repair is defined as follows: the standard of repair is the extent to which repair work is carried out and the extent of measures undertaken so that damage from future
flooding is minimized. The standards of repair are determined through risk assessment. The flood resilience or flood resistance measures in the standard of repair can include dry-proofing and wet-proofing of the property.

Three standards of repair are defined in this book and relate to the level of risk determined, as defined in the chapter 3 of the book. They are summarized as follows.

- Standard of Repair Level A. The risk assessment shows that there is little or no risk of a future flood. It is recommended to repair the building to the original specification, although some minor upgrades may be incorporated to improve the flood resilience.

- Standard of Repair Level B. The risk assessment shows that the likelihood of a future flood is low to medium, i.e. it is considered sufficiently high to recommend repairs to increase the resilience and/or resistance of the property above the original specification.

- Standard of Repair Level C. The risk assessment shows that the risk of a future flood is high. It is recommended to instigate repairs that will increase the resilience and resistance of the property significantly. Such repairs involve dry-proofing and/or wet-proofing of the building.

The book reports also the roles and responsibilities in flood repair (government, regulators, local authorities, water companies, internal drainage boards, etc.).

A general recommended repair process for a flooded building is reported in Figure 32.
4.1.15 Case study 15 – Review of the flood risk management system in Germany after the major flood in 2013

The case study of Germany, proposed in the paper of Thieken et al. (Thieken et al. 2016), is particularly interesting because it makes a review on flood risk management after about 10 years from the events of 2002, described in the case study 2 (see also Kienzler et al. 2015).
The review highlights considerable improvements on many levels, in particular (1) an increased consideration of flood hazards in spatial planning and urban development, (2) comprehensive property-level mitigation and preparedness measures, (3) more effective flood warnings and improved coordination of disaster response, and (4) a more targeted maintenance of flood defense systems (Thieken 2016). In 2013, this led to more effective flood management and to a reduction of damage. Nevertheless, important aspects remain unclear and need to be clarified. This particularly holds for balanced and coordinated strategies for reducing and overcoming the impacts of flooding in large catchments, cross-border and interdisciplinary cooperation, the role of the general public in the different phases of flood risk management, as well as a transparent risk transfer system. Recurring flood events reveal that flood risk management is a continuous task. Hence, risk drivers, such as climate change, land-use changes, economic developments, or demographic change and the resultant risks must be investigated at regular intervals, and risk reduction strategies and processes must be reassessed as well as adapted and implemented in a dialogue with all stakeholders.

The flood risk management in Germany was reviewed for three domains of flood risk management:

- retention of flood water and protection measures (flood control);
- loss prevention by adapted use of flood-prone areas (including flood-adapted design and use of buildings and property-level mitigation measures);
- preparedness for response and recovery.

Concerning the first point (flood control), different kinds of measures have been proposed such as controlled retention basins (polders) that, especially in the case of extreme floods, are indispensable to cap flood peaks ( Förster et al. 2005). In 2014, a National Flood Protection Program was developed in Germany to identify potential areas for reactivation of floodplains, dike relocations, and new polder areas. The reactivation of floodplains demonstrated particularly useful for flood water levels.

Other measures, such as embankments, have a long tradition in protecting areas from being inundated (Bubeck et al. 2015). The paper of Bubeck is particularly interesting because it makes a review of flood risk management in Europe and worldwide. Flood risk management is said to be not static but constantly in a state of flux. There has been a trend towards more integrated flood risk management in many countries. However, the initial situation and the pace and direction of change is very different in the various countries and is influenced by factors such as geographical characteristics, the experience with flood disasters, as well as human behavioural aspects.

However, either retention measures nor protection measures are a universal remedy, but should be incorporated into integrated, locally adapted concepts (Thieken et al. 2016).

The paper by Thieken et al. discusses also the possibility of reducing damage potential by flood-adapted land-use planning also with strengthening of responsibility and contributions of property owners. The authors underlines that a successful flood risk management is not a singular action, but requires continual evaluation and adaptation to changing boundary...
conditions as also stated in the European Floods Directive (EC 2007b). Therefore, the authors recommend reinterpreting the flood risk management cycle in order (Figure 33):

1. to recognize events systematically as a performance test and opportunity to remove weak points;
2. to adapt risk reduction strategies to new boundary conditions;
3. to monitor flood risk and develop well-balanced risk reduction and coping strategies.

**Figure 33 Enhanced cycle of flood risk management (from Thieken et al. 2016).**

**4.1.16 Case study 16: Civita di Bagnoregio village**

Civita of Bagnoregio is a small village in Central Italy (Province of Viterbo) located in the top of a volcanic hill and affected by continues landslides that are progressively reducing the urban area. The village has been investigated in the last years to define a general plan for a restoration of the cliff-town system (Delmonaco, Margottini and Spizzichino 2009). This plan is based on an integrated approach capable to solve existing problems, minimizing the impact of interventions (sustainable mitigation).

During last years, several phenomena affected the cliff and Civita di Bagnoregio slopes. The main recorded landslides were: in February 1992 a rock fall due to an extraordinary snowfall; in summer 1993 another rock fall; in December 1996 a debris landslide, when the materials involved in the 1993 rock fall were remobilized and triggered along the clayey slopes; at last a small landslide in August 1998, involving the access area of Civita.

In the period between 1999 and 2001, deformations of the Northern portion of the cliff with phenomena of rock fall and with a huge final debris landslide occurred.

The proposed approach to mitigate landslide phenomena affecting Civita is a low impact design constituted by concrete excavate well located near the edge of the cliff. This kind of works will allow to apply, in the external portion of the cliff (instable tuff blocks), specific measures like nails, anchors and injections to strengthen the cliff itself.
The main aim of this project was to transfer the stress of the external instable portion, through deep anchors, to the stable portion of the cliff (internal massive tuff). The structural passive anchors gave a lateral restraint to the cliff preventing toppling and rock fall phenomena of instable block portions.

The grouted anchors permit stabilization of medium-small size rock blocks, affected by slide instability (falls and toppling), producing a generalized and diffused improvement of rock mass quality, plugging the lateral weathered joint and fractures. In the bottom portion of every single well was created a micro-pile foundation supporting the vertical stress induced by works.

After the first phase (well excavations) and the second one (bottom micro-pile foundations and grouted anchors) it was possible to link each well together, so producing a unique and flexible stabilizing structure (Figure 34).

![Figure 34 Detail of the developed techniques for anchoring the upper massive tuff (from Delmonaco, Margottini and Spizzichino 2009).](image)

The main advantages of this new approach are summarized as follows:

- it is possible to perform restoration works from the upper and internal portion of the cliff, avoiding dangerous scaffolding (anchored in the external and unstable zones) privileging the worker safety;
- environmental and landscape impact due to scaffolding and yard street is totally deleted;

in a single solution, structural element with drainage and monitoring function is realized during the different phases of works.

Civita di Bagnoregio experiences demonstrate that a correct and efficient landslides restoration and mitigation policy could be insert harmonically in local eco system, contributing to aesthetic and landscaping nature conservation, avoiding destruction of environmental peculiarities. At the same time, conceptual solutions adopted to stabilize rock landslide, represent an innovative approach in the cultural heritage consolidation techniques,
especially in situations where scaffolding and external operations are not allowed by the morphology and risk.

4.1.17 Case study 17: Calomini hermitage, a common but impactful case to protect the buildings against rock slope

The Calomini hermitage is located on a steep slope, below an 80- to 130-m-high hanging rock wall (D’Amato Avanzi, Marchetti and Puccinelli 2006). The monastery, completed in the tenth century, is built into the rock mass for more than half of its length. The stability and safety of the complex are threatened by stability problems in the rock slope. Structural and geotechnical investigations were carried out, showing the potential for rock blocks slides, particularly under dynamic conditions, with the fall of middle size blocks.

The stability analysis also showed that seismic conditions can lead to instability of the rock wall above the hermitage, and rocky blocks could slide under dynamic conditions and heavy rains. In particular, under severe conditions, detachment and fall of blocks are possible.

To protect the buildings and the people, the church, its courtyard, and the neighbouring area, extensive remedial works were planned and recently carried out.

They mainly consisted in the removal of loose and unstable blocks and the subsequent installation of wire mesh hung and draped on the rock wall; this is a protective measure commonly used in stabilizing rock slopes, but in this case, a certain visual impact can be noted (Figure 35).

Moreover, a kind of cage, made of wire net, encloses some areas closed to the hermitage. Even though these remedies are effective, they have a strong aesthetic impact. Perhaps a less obvious intervention, such as rock reinforcement, might have been considered. Although more expensive, it could very well have been more suitable for preserving a cultural heritage site of this sort.

![Figure 35 The Calomini hermitage: the wire mesh that draped on the rock wall is visible (D’Amato Avanzi, Marchetti and Puccinelli 2006).](image-url)
4.1.18 Case study 18: Anti-Seismic basements for the Bronzes of Riace

ENEA, the Italian National Agency for New Technologies, Energy and Sustainable Economic Development\(^5\), proposed the study of anti-seismic basements for the Bronzes of Riace.

The two statues, “Bronze A the young” and “Bronze B the old”, were previously located at the ground level of the museum and provided with laminated rubber anti seismic devices. Moving the statues from the ground level to the new exposition room on the first floor of the museum required the upgrading of the basements according to the new seismic classification of the site and the change in the maximum hazard spectra. The previous devices inserted in the old basement provided a seismic isolation coefficient value of 2.5-3 and, to avoid overturning, the statues where anchored with strengthening forces of 1800N applied to each shoulder by means of steel cables inserted in the cave legs. The need to reduce the strengthening anchoring forces, together with the new expected seismic demand due to the new seismic classification, induced to re-design the anti-seismic basements to increase the isolation coefficient, reducing the risk of exceeding the seismic capacity of the two statues.

The design results are, for each statue, a basement made of two blocks of marble type Carrara, and the surfaces of the blocks modelled as an ellipsoid of revolution, where 4 spheres made of the same material of the blocks are located.

In short, the basement is made of the following elements: BI= marble lower block, S= marble spheres, DO= Horizontal displacement limitation and re-centering device, BS= marble upper block, DV=vertical isolation device inserted in the BS upper block.

However, stiffness and principal frequency of the basement are not constant, due to the elliptical geometry of the rolling surfaces, the principal frequencies are ranging from 0.015Hz to 0.025 Hz depending on the position along the surface, with zero value at the centre, where the re-centering function is demanded to the element DO. The vertical isolation is provided by two stainless steel plates connected by four shock absorbers made of dissipative cables plus four springs inserted in piston guides confining and de-coupling the vertical and the horizontal motions. Therefore, the horizontal isolation is demanded to the basement geometry and the vertical isolation is demanded to the shock absorbers inserted in the upper basement.

New anti-seismic basements made of marble have been developed for high vulnerable statues in Italy. For the Bronzes of Riace, the very low acceleration at the base of the statues allows to reduce the strengthening forces to the values equivalent to the shield on the left arm and the lance on the right hand. Basements of the same type have been used for the two statues of the Annunciazione by Francesco Mochi, and the St. Michele Arcangelo by Matteo di Ugolino at the Opera del Duomo Museum of Orvieto, Italy (De Canio, Bonomi and Cannistrà 2012, Figure 36).

\(^5\) ENEA’s multidisciplinary competences and great expertise in managing complex research projects are put at the disposal of the Country system. Specifically, its activities are devoted to: basic, mission-oriented, and industrial research exploiting wide-ranging expertise as well as experimental facilities, specialized laboratories, advanced equipment. ENEA also: develops new technologies and advanced applications; provides public and private bodies with high-tech services, studies, measurements, tests and assessments; delivers training and information activities aimed at providing greater public knowledge and awareness on the Agency’s fields of competence, and a higher level of dissemination and transfer of research results, thus promoting their exploitation for production purposes.
4.1.19 Case study 19: Seismic isolation structure for existing buildings

ENEA proposed a structure for the seismic assessment of historic buildings, through the implementation of an isolated platform under the subfloor of the foundations, without intervening on the building above (Clemente, De Stefano and Zago 2012). Through the insertion of horizontal pipes, and the placement of seismic isolation devices, in correspondence with the horizontal plane of the pipes, a discontinuity between the foundation and the subsoil is created.

The building is then separated from the surrounding area through the implementation of a double row of vertical walls, the inner wall connected to the building and the outer wall connected to ground, this gap allowing the relative displacements of elements.

In this way the building is seismically isolated, but is not directly affected by interventions that could modify the original architectural features.
4.1.20 Case study 20: Analysis of the environmental vibrations affecting the Coclidi columns at Rome

This case study shows how the interaction between the earthquake and the vibrations caused by traffic and subway, may increase the possibilities of damages in historical buildings and assets, located in urban areas with high seismic risk (Bongiovanni et al 2014).

ENEA made accurate numerical modelling and experimental analysis on the main monuments of Rome. Within this research, carried out during 80s in collaboration with the Superintendence for Archaeological Heritage of Rome, vibrations acting on some Roman ancient buildings was evaluated: the Trajan and Aurelian Column, the Colosseum, the Temple of Minerva Medica and the of Flaminio Obelisk in Piazza del Popolo (Bongiovanni et al. 1990). Subsequently, the Round Temple at the Foro Boario, Villa Farnesina, seat of the Academy of Lincei, and the Lateran Obelisk, were analysed (Buffarini et al. 2008).

The analysis conducted revealed that on the one hand the high seismicity of the Italian territory puts a strain on the monumental historical buildings, on the other hand the resistance of such structures is worn constantly by the effect of vibrations caused by vehicular traffic and subway, which slowly but surely will make them more vulnerable to earthquakes.

In collaboration with the INGV and University of L'Aquila, ENEA has recently made a new experimental campaign on Coclidi Columns. The columns of Trajan and of Marcus Aurelius, consisting of stacked marble drums, were analysed in order to develop reliable models for the evaluation of their health status and to verify any changes in time. Seismometers able to detect vibrations of very low energy, connected to a data logger capable of storing the recordings obtained were also used. Measurements were performed on each column for about 24 consecutive hours, in order to obtain data relating to the different hours of day and night. The data were analysed obtaining the peak and effective values and the dynamic characteristics of the structure, frequencies, modes of vibration and damping. Very close resonant frequencies were found, not shown in the measurements made in the past, and torsional movements, as well as phenomena of rocking to the Aurelian column. On the basis of this information, mathematical models will be developed, which will allow assessment of the structure's ability to withstand static and dynamic actions.

4.1.21 Case study 21: Assessing Wildfire Risk in Cultural Heritage. The Case of Holy Mount Athos, Greece

A big part of CH, especially archaeological sites, in the Mediterranean area, are covered by vegetation, or located near to wooded areas. For this reason, they are exposed to fire risk. The fire can start within the site and spread out in the forest, or can begin in the woods and then damage the site. An example can be the Athos Peninsula, also called Holy Mount (Mallinis et al. 2016). In 1988, Holy Mount Athos was designated as a World Heritage Site by UNESCO due to its outstanding universal value of both natural and cultural importance (UNESCO 2013).

This area has a variform terrain, because of the great difference in altitude between the different areas. Mount Athos includes 20 monasteries, Sketes, hermitages, cells, small churches and chapels; the majority of the structures is located in the centre-north part of the peninsula, but several monasteries, cells and Sketes are located in the coastal area. The
structures are often surrounded by dense vegetation. This area was affected by two severe fires: the first one in 1990, which burnt 2200 ha of the forest and threatened to completely destroy the monasteries; the second one in 2012, burnt 5000 ha of forest and reached some of the monasteries structures. After the fires, on 2013, a field campaign began with the purpose of identifying the “fuel model” which can cause the fire. All the data collected were used to realize digital models to be used for “fire simulations”. The algorithm realised was in fact able to simulate the fire growth in the area, based on the dominant weather conditions.

The methodology of Millinis et al. (2016) was based on high-resolution RapidEye image and four Landsat-OLI images acquired over an 18-month period. This process allowed for generating Mt. Athos fuel type map by using an object-based approach and a machine-learning algorithm. The fuel type map along with topography-related variables and meteorological parameters were used for spatially explicit fire simulations. Information regarding the location and the type of various structures distributed over this World Heritage Site was collected and organized within a GIS (Figure 37). Finally, a spatial wildfire risk and exposure analysis was implemented for identifying elements of cultural heritage at wildfire risk.

![Figure 37: Overall process diagram of the recent study on fire risk and exposure assessment in Mt. Athos (from: Mallinis et al. 2016, 4).](image)

These simulations allow obtaining Burn Probability, Conditional Flame Length, Fire Size and Source Sink Ratio (Figure 38). In this way it was possible to calculate the wildfire exposure...
of the area, the likelihood and the potential intensity of the fires. The realization of these digital models can be very useful for fire prevention and mitigation, especially in the CH sites surrounded by dense vegetation, since it allows to analyse all the factors that contribute to the triggering and the spread of the fire, making it possible to have a complete picture of the risks and allowing, therefore, to intervene as quickly and effectively as possible.

Figure 38: Fire risk and exposure assessment in Mt. Athos (UTM Zone 34N, from: Mallinis et al. 2016, 14).

4.1.22 Case study 22: Arslantepe (Turkey) archaeological site. An example of protection with specially planned covering

The Arslantepe archaeological site (“the lions ‘hill’) is situated in the plain of Malatya, Eastern Anatolia. Since the beginning of the nineteenth century the site excavations are coordinated by Italian researchers\textsuperscript{56}. The director of the project is currently Prof. Marcella Frangipane from Sapienza University of Rome.

Arslantepe is an artificial hill formed by the overlapping of villages rebuilt in the same area for millennia. It has been continuously occupied since at least the fifth millennium BC.

The main constituent material of the archaeological remains of Arslantepe is the mud-brick. This material is very vulnerable to the atmospheric agents, therefore it requires constant maintenance. Plaster should be used every year, in order to protect the mud-brick structures from heavy rains and snowfalls that characterize the area of Malatya.

Furthermore, with the purpose of preventing risks due to weather conditions, the excavation coordinators have initially guarded the archaeological remains with provisional and

\textsuperscript{56} Information about the Arslantepe site can be found at web site https://web.uniroma1.it/arslantepe/ (in Italian).
rudimentary roofing, replaced every year at the conclusion of the excavation season (Frangipane and Mangano 2010).

The protection afforded by the roofing was always accompanied by annual checkup and maintenance work on the masonry where cracks or erosion are discovered. This maintenance work is performed using traditional materials (mud mixed with fine chaff) even if the structures are protected by roofing.

Once verified the effectiveness of a possible permanent covering for risk prevention, Italian researchers proceeded to design and build a new roofing in order to avoid annual substitution. The project had to consider some difficult technical aspects of the archaeological site: the vastness of the area to be protected, the numerous terraces and topographic levels on which the buildings stood, the already mentioned fragility of the structures, and the harsh winter climate in the Malatya plain.

This meant that the roofing had to be very solid, but at the same time it had to be built without foundations to avoid damaging on the underlying levels, it could not rest on the fragile walls and it had to enable all the rooms to be totally visible. Moreover, it had to be adjusted to the many differences in altitude and be aesthetically “light” in order not to disturb a proper fruition of the buildings.

After conducting various experiments and tests across the years, Italian mission designed a project for roofing that would be able to take account of all these problems.

The project comprises a very solid metal structure with vertical posts resting on a kind of narrow metal bridges passing around the walls and fixed to the ground on both sides of the wall on small reinforced concrete bases, built directly in the area in order to adhere to the irregular surface of the ground (Figure 39). This allowed to avoid sinking holes or damaging the underlying archaeological layers. The metal bridges were then linked using horizontal iron beams, suspended on the top of the walls, and therefore mostly invisible, which, together with the roofing beams, connected all the parts of the structure, making it stable. In this way, and with the help of steel tie rods, the structure does not rock, even though there are no foundations. The vertical pillars holding up the roof all run along the walls, leaving the rooms free, but they do not rest directly on the walls, rather on the metal bridges which unload the weight onto the ground in two points instead of one. The overall weight of the structure is therefore better distributed.
Figure 39 Arslantepe (Turkey). Details of the metal structure sustaining the roof. a–c, e) basement system; d – f) metal ‘bridges’ supporting the vertical posts; g) simple vertical pole at the edge of the protected area (from Frangipane and Mangano 2010, 211).

The roofing at Arslantepe was conceived as the reconstitution of several roofs related to the individual buildings, with different heights depending upon the ground height of the terraces (Figure 40).

The actual roofing has been made of wooden boards, covered on the outside by a multilayer insulating material (Figure 41), and all the metal structures in the roofing are also timber clad; this gives the visitor the perception of the colours, materials and the characteristics of the traditional roofs. The great heights of the roofs create the sense of monumentality which the buildings must have had in ancient times.

Figure 40 Arslantepe a) horizontal metal structure of the roofing system; b) view of the roof on the 4th millennium palatial area; c) the roof under the snow (from Frangipane and Mangano 2010, 212)
The last carefully studied aspect of the project was the lighting of the protected area. The roof is opaque, and this affords better protection against light and sun to the plaster- work and, above all, to the painted surfaces. The developed solution was of allowing light entering not only from the open sides all around the complex, but also from the large central courtyard and the middle section of the access corridor (Figure 42). These parts have therefore been covered with special shatterproof glass, allowing the light to enter inside the buildings, in the points where probably the daylight originally entered.

4.1.23 Case study 23: Turkey approach in seismic protection of museum collections

Seismic protection of museum collections is a relatively new topic in Turkey in comparison to the other earthquake-prone countries in the world. Disaster Preparedness Education Program (AHEP) of KOERI was initiated in 2000, but renamed as Disaster Preparedness Education Unit – AHEB - in 2004. AHEP realized a number of projects, trainings and meetings in collaboration with Yildiz Technical University, Faculty of Art and Design, Museum Studies Graduate Program in order raise awareness about the earthquake risk that museums are exposed to.
Istanbul Seismic Risk Mitigation and Emergency Preparedness (ISMEP), the World Bank funded-project was conducted by the Istanbul Special Provincial Administration and Istanbul Project Coordination Unit, between May 2005 and December 2011. Earthquake risk assessment of the collections housed at the annexed building of the Istanbul Archaeological Museums; earthquake performance assessment and preparation of structural seismic retrofitting designs of the Mecidiye Kiosk of the Topkapı Palace Museum, annexed building of the Istanbul Archeological Museums, Hagia Sophia Museum and Saint Irene Museum in Istanbul were included in the project.

A distance learning program has been developed in 2010, by Bogaziçi University, KOERI, Department of Earthquake Engineering, Bogaziçi University, Center for Disaster Management (CENDIM), Yıldız Technical University, Museum Studies Graduate Program and J. Paul Getty Museum as a last attempt (Ertürk 2012, 294).

The study conducted by Ertürk well describes the approach that some Turkish museums have adopted following the disastrous events of 1999. The data reported by Ertürk are the synthesis of two questionnaire surveys (completed in 2003 and 2009), as well as literature review and observations; which is the same procedure adopted by STORM partner for the drafting of D1.1.

The Topkapı Palace Museum, one of the most visited museums in Turkey, is a state museum. The previous museum director, Filiz Çagman, strongly believed in trainings as instrument to raise awareness in the museum staff, and thus Topkapı Palace Museum housed Emergency Planning and Earthquake Preparedness Seminar, Earthquake Risk and Emergency Planning Meeting, and Seismic Mitigation Workshop, between 2000 and 2001.

The museum directorate started to take effective and low-cost mitigation methods right afterwards. As general consideration, it was observed a relatively less difficulty in mitigating storage areas than exhibition galleries, because mitigation measures in the storage areas do not need to include aesthetic considerations. Thus, some of the storage cabinets were anchored to the wall with L-shaped brackets, large and heavy objects were moved from higher shelves to lower ones. Same type of ceramics were moved from exhibition galleries to storage areas, and they were wrapped and then placed in individual boxes.

Besides, the most important step was taken during the renovation work of the Imperial Treasury Exhibition Gallery (reopened in 2001). The museum directorate was very much aware of the earthquake vulnerability, and it was the first time in Turkey where a renovation work in a museum was held by considering earthquake risk. New showcases were put into the most secure places-niches-of the gallery. Additionally, the number of the displayed objects was reduced, and objects were fastened with Plexiglas mounts and monofilaments. At the time of the renovations, conservators, restores, and mount-makers were not engaged in the museum staff. So, the interior designer, Çağlayan Tugal, responsible for the renovation work, produced the mounts and secured the objects with mounts, and then used monofilament to tie the objects to their mounts.

In the Sultan’s Caftan Exhibition Gallery, showcases were covered with security films in order to hold showcase glasses together in case of breakage. The paintings, in the storage rooms, were hang on the compactor screen system with safety hooks both from top and
bottom corners, and locks were used in order to prevent the screens from travelling along the rails during an earthquake.

These kinds of procedures were adopted in 27 Turkish state museums.

Sadberk Hanım Museum, one of the private museums in Turkey, is located in Istanbul. In the storage areas of the Archaeological and Turkish and Islamic Art Objects, netting was used to cover the entire open face of the storage unit. Ceramics and porcelains were stored in blocks of Ethafoam in which cavities had been carved to fit the shape of the objects. Gradually, different types of mitigation methods started to be used; small glass objects were secured with museum wax applied at the base of the objects, tiles and ceramics were fastened with Plexiglass mounts, monofilaments were used to fasten small objects. Storage shelves were anchored with metal brackets to the wall and storage cabinets were secured with locks.

Among the private museums, Pera Museum and Rahmi M. Koç Museum in Istanbul are other leading institutions involved in mitigation efforts. In fact, Pera Museum hosted the first international conference on the earthquake protection of museums. The museum itself will publish the seminar proceedings which may be another useful tool for the dissemination of knowledge. Rahmi M. Koç Museum employed also mounts and monofilaments for securing objects in case of permanent exhibitions.

The Military Museum in Istanbul, which is working under the Ministry of National Defense, have already started to take mitigation efforts. Some of the fragile objects were fastened with mounts and monofilaments. Storage areas are very well-organized in case of an emergency situation.

The opening of the Storage Museum (2006) in Istanbul, under the Turkish Grand National Assembly and housing the collections from palace museums, was an important step in order to store the objects in a separate building with an adequate space and taking seismic mitigation measures in storage areas. In Storage Museum, objects were wrapped with Ethafoam and acid free tissue, and boxed. Restraints such as bungee cords were stretched across the face of the open-shelving units to prevent the contents from sliding off. Compact storage cabinets were mounted to the wall with L-shaped brackets.

Besides, the following seismic mitigation efforts were taken in Dolmabahçe Palace Museum and Beylerbeyi Palace Museum in Istanbul: framed works and consoles were secured not only at the top, but also at the bottom corners to avoid swinging or pounding against the wall. Safety hooks of chandeliers were all checked to prevent the hanging wire from escaping the hook. Small vases were secured with museum wax. All the mitigation works are being held by the full-time conservators and restorers of the palace museums.

In Turkey state museums are controlled and financed by the Ministry of Culture and Tourism. Most of them have traditional management approaches, facilities, display techniques and storage conditions.

Anatolian Civilization Museum in Ankara, State Painting and Sculpture Museum in Ankara, Antalya Museum, Ephesus Museum in Izmir, Izmir Archaeological Museum, State Painting and Sculpture Museum in Izmir, Topkapı Palace Museum in Istanbul and Diyarbakır Museum have laboratories, as well as conservators, restorers or mount-makers among their staff. Conservation/restoration work takes place either in the Central Laboratory for Restoration and Conservation located in Istanbul or in the temporary laboratories during the excavation

D1.1: Current practice for management and conservation of Cultural Heritage
season. Other museums such as Bodrum Underwater Archaeological Museum in Mugla, Bolu Museum, Malatya Archaeological Museum, Turkish and Islamic Art Museum in Istanbul have conservation laboratories; however, conservators or restorers are not permanent in the museum staff.

There is neither adequate facility nor space for post-disaster recovery in any of the state museums. However, the main problems are not only lack of staff, facilities or limited resources, but it is also overcrowded display cases and storage areas, improper shelf loading and unrestrained objects (Ertürk 2012, 291-292).

On the other hand, it is observed that museums affiliated with the General Directorate of Foundations, municipalities or universities are in a poorer state in terms of staff, facilities, display techniques and storage conditions in comparison to state museums. However, some of the museums working under the General Directorate of Foundations and municipality museums do not have funding problems. Moreover, the protection of museum collections against earthquake is not the priority, and it is not in the agenda of museum staff. Museum staff has an overloaded schedule, as they are responsible for basic museum duties such as documentation, expertise, collection development or exhibition installation (Ertürk 2012, 292).

Museums, which are working under the auspices of the Ministry of National Defense, are in a good condition in terms of staff, funding and facilities. Military museums operate more successfully in seismic mitigation work compared to state museums, municipality museums, university museums or museums working under the General Directorate of Foundations. This is due to the presence of soldiers in the museum staff with a military training that gives rise to a very well-organized approach before, during and after an earthquake. Moreover, military museums have well-organized and equipped laboratories with trained and qualified conservators or restores (Ertürk 2012, 292).

Palace museums have approaches and procedures similar to those of the military museums. Directorate of National Palaces is one of the leading institutions in taking steps towards the protection of museum collections both on storage and display, although palace museums are located in historical buildings, and a special permission is required for fastening objects or display/storage furniture.

In case of private museums, the situation is quite different than the aforementioned museums. Private museums are the changing face of the Turkish museology, because contemporary museological principles are being applied in terms of facilities, conservation work, display and storage conditions and museum activities. Private museums are self-financing, but they are supervised by the Ministry of Culture and Tourism. In most of the private museums, earthquake mitigation work is accepted as an important topic similar to the other museum duties in the staff agenda. Museum staffs are implementing some of the mitigation methods both on storage areas and exhibition galleries (Ertürk 2012, 293).
4.2 Comparative table and final results

The comparative table developed in this paragraph (Table 11) aims at comparing the most common actions and processes defined in the framework of reference (Table 2 in paragraph 2.2.2) with the same actions and processes in current practices as derived from questionnaires, literature and interviews.

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<th>DRR Phase framework</th>
<th>Current practice</th>
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<td><strong>Risk Assessment</strong></td>
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<tr>
<td><strong>Defining context and goals</strong></td>
<td>Risk assessment is well-defined in the theoretical framework. In practices, the research carried out through questionnaires, literature, interviews, highlighted that risk assessment is linked to the perception that actors involved in CH management have of the risk. So, assessment is made for those risks that are perceive in a specific area.</td>
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<td>For example, in European countries of the northern area, the assessment is made for flooding risk, perceived as main NH for assets (see case study nr. 15: Review of the flood risk management system in Germany …, and also case study 11 Historical buildings in English Heritage) (Thieken et al. 2016; English Heritage, 2010).</td>
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<td></td>
<td>In the Mediterranean area, the most perceived risks are associated to earthquake and fire, so, in this case, risk assessment is addressed to these specific hazards (see for example case studies 18, 19 and 21).</td>
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<th>Identifying the risks to the heritage object</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1. Analysing hazards and threats</strong></td>
<td>In current practice, the risk identification often is linked with the perception of the risk by the intervening actors on the base of some factors:</td>
</tr>
<tr>
<td></td>
<td>- <strong>historical factor</strong> (i.e. the occurrence of the NH during time)</td>
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<tr>
<td></td>
<td>- <strong>geographical factor</strong> (i.e. the risk associated to certain environmental conditions that make the asset exposed to frequent damages)</td>
</tr>
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<td></td>
<td>- <strong>cultural factor</strong> (this factor is linked to the attitude and background of professionals involved in safeguard of</td>
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Table 11: Comparison between DRR phase framework and current practice
### DRR Phase framework

<table>
<thead>
<tr>
<th>DRR Phase framework</th>
<th>Current practice</th>
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<tbody>
<tr>
<td>impacts on the heritage site (FEMA 2004, 2-1).</td>
<td>CH; this attitude allows for having or not a complete panorama of the potential risks.</td>
</tr>
</tbody>
</table>

### Step 2. Analysing exposure and vulnerability

The risk assessment for cultural heritage clearly involves the identification and listing of heritage assets and of their associated values. This is a common activity in archaeological sites, museums, or institutions specifically devoted to list CH (such as the Italian ICCD: *Istituto Centrale per il Catalogo e la Documentazione*, Central Institute for Cataloguing and Documentation).

ICCD has launched SIGEC WEB project whose primary objective is to ensure availability of the necessary technological infrastructure to all bodies that operate in the sphere of cultural heritage ([http://www.iccd.beniculturali.it/index.php?en/221/sigec-web-project](http://www.iccd.beniculturali.it/index.php?en/221/sigec-web-project)).

From the questionnaires, it was derived that in CH assets generally paper and/or digitalised archives exist, always containing cards with information on heritage and photos of movable and immovable heritage. Air photos and cartography are often available on the archaeological sites.

A recent European project, EU-CHIC project ([http://www.eu-chic.eu/](http://www.eu-chic.eu/)), studied twenty-three information systems from eleven European countries.

Exempla of information systems are:

- Risk Map of cultural heritage and mapping and description of cultural landscape Ministry of Culture: Technical Reports for museum interventions, extensions, upgrades or new buildings
- Acropolis Restoration Service (YSMA).
D1.1: Current practice for management and conservation of Cultural Heritage

<table>
<thead>
<tr>
<th>DRR Phase framework</th>
<th>Current practice</th>
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<tr>
<td>Current practice for management and conservation of Cultural Heritage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>In Portugal: IHRU and former IGESPAR</td>
</tr>
<tr>
<td></td>
<td>In Spain: Ficha de Patrimonio Etnológico en Castilla y Leon; Inventario de Patrimonio Industrial de la Provincia de Valladolid</td>
</tr>
<tr>
<td></td>
<td>In Germany: ADABweb – Allgemeine Denkmaldatenbank</td>
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<td></td>
<td>In Belgium: VIOE – Vlaams Instituut voor het Onroerend Erfgoed; Database of Cultural Heritage in the Brussels Region; Database of the Cultural Heritage in the Walloon Region; Monumentenwacht Vlaanderen; Cities of Bruges and Antwerp.</td>
</tr>
<tr>
<td></td>
<td>In Italy the Risk Map, an information system developed by ISCR (former ICR) was created for protecting, safeguarding and preserving CH. The outcomes of Risk Map are hazard maps, CH distribution, vulnerability datasheets.</td>
</tr>
<tr>
<td>- evaluating the coping/adaptive capacity of the heritage property. This includes the performance evaluation of existing management systems and risk preparedness plan (UNESCO-WHC et al. 2010, 25)</td>
<td>The evaluation of resilience levels in CH contexts is often based on empirical assessment; for example, structural monitoring is not performed according to specific programmed activities but usually it is carried out in case of real emergency situations.</td>
</tr>
<tr>
<td>- identifying and analysing the underlying risk factors, including poor restoration done in the past, threats in surrounding environment, existing damage and deterioration patterns, and present irreversible interventions, activities or physical planning (UNESCO-WHC et al. 2010, 25).</td>
<td>It was found that the evaluation of contexts and previous activities (such as restoration works, archaeological excavations, etc.) is generally made only on the occasion of new activities that will be performed, for example consolidation works that involve the assets directly. Often, this kind of analysis is performed on the occasion of experimental research. Some interesting case study can be found in this regards, such for instance case study nr. 9 (Cecchini 2009) and in particular the interview to the restorer who explained the methodological approach in the process of conservation of the Etruscan painted tombs, from the identification of risk (in this case flood) to the measures adopted for prevention and mitigation. Other examples are the case nr. 1 (Pompei) where the complex situation is requiring identification of risks based</td>
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### DRR Phase framework

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<tr>
<td>Current practice for management and conservation of Cultural Heritage</td>
<td>on different factors, and case study nr. 8 reporting the UK national Archives approach in risk assessment for collections also based on the previous monitoring and management (Bülow 2010).</td>
</tr>
</tbody>
</table>

### Step 3. Identifying potential impacts/losses

- **compiling sufficient and reliable data on the heritage assets at risk** (Romão, Paupério, and Pereira 2016, 697)

  Datasheets are compiled in the risk maps, currently employed as relevant instruments for evaluating CH at risk.

- **establishing cause-effect relationships and developing a scenario dynamics of potential emergencies** (EMA 2010, 24) to identify potential impacts of the hazards and threats on particular assets/components of the heritage sites;

  Real analyses of cause-effect relationship are generally not performed. The perception of NH effects is more frequently associated to the knowledge of historical events of the CH and of the environment in which it is located.

  Risk map, for example, are developed by considering the frequency of a certain ND within a defined time interval (such as earthquake map: http://www.protezionecivile.gov.it/resources/cms/images/pericolos_d0.JPG).

- **developing a risk map by overlapping hazard, heritage and vulnerability maps.**

  The preparation of vulnerability maps is not a standard practice. It has been found that actors know the significance and potentiality of these maps well. In fact, a lot of projects on regional, sometimes national, scale have been developed for creating GIS aimed at comparing natural/anthropogenic risk layers with CH territorial mapping ones.

  Risk map are available in different countries, such as the Italian “Carta del Rischio” (La Carta del Rischio 1997; Accardo et al. 2003), or other risk maps at local level, such as that proposed for wildfire (Mallinis et al. 2016, case study nr. 21).

  Other examples of risk maps are reported in se study nr. 7 (A GIS application in the city of Ferrara, Italy), the SHARE project addressed to the European Seismic Hazard Map, and the flood map develop in Austria (see Austrian case).

### Analysing the identified risks
D1.1: Current practice for management and conservation of Cultural Heritage

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<tr>
<th>DRR Phase framework</th>
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<tr>
<td>- assessing the probability or likelihood of a particular disaster scenario impacting the heritage assets;</td>
<td>In current practice, it is not usual to apply probability studies for analysing a particular disaster scenario impacting the CH objects. However, in the literature, several studies and projects exist for creating integrated predictive models for CH. Examples of probabilistic studies for disaster scenario, can be found in the risk maps as reported above and in the literature (Sabbioni, Brimblecombe and Cassar 2012; Romão, Paupério, and Pereira 2016). Case study nr. 21 is a good practice for obtaining the burn probability, conditional flame length, fire size and source sink ratio through specific algorithm (Mallinis et al 2016).</td>
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<tr>
<td>- assessing the severity of the multidimensional consequences of the disaster scenario on the heritage assets;</td>
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<tr>
<td>- assigning each identified risk (potential impacts) a rating in accordance with the agreed risk criteria (e.g. pre-defined probability and consequence acceptability levels) (EMA 2010, 31).</td>
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**Evaluating the risks**

1. Comparing the level of risk found during the analysis process with pre-defined risk criteria (established when the context was considered). If the level of risk does not meet risk criteria, the risk needs treatment, i.e., implementation of risk control measures.

In current practice, this kind of risk evaluation for CH was not found.

**Risk Control**

**Prevention & mitigation**

- reducing risks at source (Stovel 1998, 26); hazard source control and area protection

The reduction of risk at source, in current practices, has been found to be obtained by various technical solutions specifically planned and developed for each CH asset to be protected.

Case studies on risk reduction at source have been found in the literature, for example case nr. 13 that reports an integrated technical solution for protecting CH from flooding by creating barriers with low impact on landscape aesthetic (Will 2008); case nr. 22 for the archaeological site of Arslantepe in which special protection against solar irradiation and excessive rains was
Current practice for management and conservation of Cultural Heritage

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<td>developed (Frangipane and Mangano 2010); case nr. 17 in which the building is protected by installing a sort of wire net cage to avoid risk slope (D’Amato Avanzi et al. 2006); case nr. 16 concerning the application of special anchoring system to prevent landslides in the Civita di Bagnoregio Village (Demonaco et al. 2009).</td>
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</table>

- reinforcing the ability of a property to resist or contain the consequences of a crisis (Stovel 1998, 26)
- undertaking preventive conservation measures, to prevent/reduce the occurrence of persistent hazards

Structural restoration or seismic retrofitting works in CH buildings are compulsory particularly in seismic-prone areas but often these works require long times for being completed. Concerning archaeological areas, the reinforcement of structures is made on the occasion of consolidation works or restoration activities even with the use of new materials and techniques aimed at increasing the static property of ancient structures.

In terms of preventive conservation, ordinary maintenance activities such as consolidation, cleaning, ordinary operations are performed in the archaeological sites or other contexts, as derived from the questionnaires. In this field also monitoring and diagnosis can be included as necessary steps of preventive conservation. These activities are widely performed in CH assets and sites and a lot of examples in the literature can be found.

An interesting case study on reinforcing the ability of CH to resist or contain consequences of a crisis is reported in nr. 19. In case nr. 19 a seismic isolation structure is developed for isolating the building without modifying the original architectural features (Clemente, De Stefano and Zago 2012).

Examples of monitoring, diagnostic activities and preventive measures defined accordingly can be found in cases 2, 3, 4, 5, 6, and 10 (De Nuntiis et al. 2007; Flemish Region, http://www.monumentenwacht.be/en; Del Curto et al. 2010; Kaeferhaus 2014).

In these cases, regular inspection and monitoring are fundamental activities to plan preventive solution for reducing the occurrence of persistent damages such as excessive solar irradiation, highly variable relative humidity value, etc.
## DRR Phase framework

<table>
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<tr>
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<tbody>
<tr>
<td>- raising awareness and appreciation of the values of cultural heritage among community members and the officials involved (Stovel 1998, 29)</td>
<td>The development of awareness and appreciation of CH values and vulnerabilities is often undertaken via dissemination conferences and exhibitions, specialty books and other specific publications, didactic/scientific media programs specifically addressed to the concerned heritage community. Currently, institutions and associations involved in CH management and conservation disseminate their activities, projects, and news through websites and social networks, as demonstrated by a lot of information gathered by websites also for the preparation of the present deliverable. However, it is difficult to establish if these efforts are effective in raising the awareness of communities on CH values and vulnerability also because this is not a specific task of D1.1.</td>
</tr>
<tr>
<td>- developing, within the community, a good understanding of significant hazards and the related vulnerability of cultural heritage (fostering community vigilance and security) (Stovel 1998, 29)</td>
<td>Generally, funding for preventive conservation procedures is largely insufficient. States generally make low investments in CH preservation and/or management. Public funding usually derives form regional or local sources, in addition to the central government. Especially when the CH asset has a great relevance at national and international level, funding may become available from private investors. In this case the funding is sufficient to cover the entire costs or almost entirely for the intervention. It should be highlighted that, even if there may be funding for isolated interventions, currently there are not funding for constant and ongoing preservation activities. A good practice from governments was the introduction of tax credits on donations for private investors in order to stimulate the contributions from external societies to CH safeguard. For example, to support its artistic heritage, Italy introduced tax credits on donations to the arts in 2014 (Italian Law 29/07/2014 n.106): this good practice has been effective in stimulating funding from private sector (see Colosseum case: <a href="http://www.reuters.com/article/us-italy-art-colosseum-idUSKCN0ZH579">http://www.reuters.com/article/us-italy-art-colosseum-idUSKCN0ZH579</a>).</td>
</tr>
<tr>
<td>- procuring funding for preventive conservation measures</td>
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### DRR Phase framework

- **Current practice**

  This cooperation is regulated by governmental laws and guidelines. However, territorial planning and CH safeguard requirements are often in contrast and it becomes difficult to match both needs.

  In many instances, it is difficult to harmonize the strategic value of a public work such as an infrastructural construction with the strategic value of cultural and landscape heritage safeguarding. In these cases, CH is often sacrificed.

### Preparedness

- **Providing adequate warning of impending emergency**

  What was verified was that there is frequently a lack of communication between institutions, agencies, and others that are involved in climate monitoring and previsions, and CH safeguard actors.

- **Developing emergency-response plans and ensuring their availability during the emergency**

  There is a general availability of emergency plans concerned with personal safety. Additionally, governments in general supply guidelines for preparing emergency response plans specifically addressed to CH, but those are not legally binding. So, specific solutions are adopted case by case, depending on the needs of the particular situation or asset that should be protected and safeguarded. There are not many cultural institutions with solutions for emergency response in place for all hazards (e.g. fire, flooding, earthquakes, etc.).

- **Conduct simulations, training and drills using realistic emergency scenarios**

  In current practice, simulation and training are not considered standard activities. They are not praxis in risk management for CH. Pilot projects can be found involving actors operating in CH safeguarding, together with Fire Fighters, Civil Protection, etc. These projects aim at sharing the various competences and guarantying that actors have a conscious approach in case of risk. For instance, Cultural First Aid, on the side of training, is almost entirely based on emergency drills (http://www.iccrom.org/courses/first-aid/).

  Another good example can be considered the effort that the Louvre undertook last year to protect its works from being reached by the Seine floods (https://www.unisdr.org/archive/47028). Emergency drills concerned with personal safety are common practice and regulated by laws. These drills could be extended to encompass heritage assets.
D1.1: Current practice for management and conservation of Cultural Heritage

<table>
<thead>
<tr>
<th>DRR Phase framework</th>
<th>Current practice</th>
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<tbody>
<tr>
<td>Training activities, specifically addressed to CH, are sometimes spread through web sites:</td>
<td></td>
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<tr>
<td>- international training course TeRex in Tuscany, <a href="http://www.protezionecivile.gov.it/jcms/it/view_dossier.wp?contentId=DOS15077">http://www.protezionecivile.gov.it/jcms/it/view_dossier.wp?contentId=DOS15077</a></td>
<td></td>
</tr>
<tr>
<td>- training at Lucca (Italy), <a href="http://www.comune.lucca.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/15895">http://www.comune.lucca.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/15895</a></td>
<td></td>
</tr>
<tr>
<td>CH assets and sites not always dispose of material or human resources to promptly intervene during emergency.</td>
<td></td>
</tr>
<tr>
<td>The staff operating in a site or CH asset is not generally prepared for emergency management in case of ND.</td>
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<tr>
<td>Laws establish and make compulsory the presence, in workspaces, of personnel figures responsible for fire prevention, for first aid, or for evacuation, but these figures are not prepared specifically for intervening on CH in case for ND.</td>
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**Response – Cultural First Aid (ICCROM/The Smithsonian Institution 2015)**

**Step 1. Situation Analysis (see STORM Glossary)**

- **nature of the critical event and its causes**
- **heritage-specific SWOT analysis**
- **context and legal framework**
- **obtaining access**
- **actors and local capacities**
- **preparation for deployment**

From information obtained by questionnaires, it is not possible to define a complete scenario of the current practices related to procedures in the aftermath of the disaster, and before people go in the field to assess the CH damage. Some examples can be derived from chapter 4 in the single cases. For example during the recent earthquake in Central Italy, MiBACT recovery teams, assisted by Fire Fighters, Civil Protection, the Comando Carabinieri per la Tutela del Patrimonio Culturale (Carabinieri Command for the Protection of Cultural Property), and other corps, gained access to recover heritage, understand who can aid or not and what equipment is necessary ([http://www.beniculturali.it/mibac/export/MiBAC/sito-MiBAC/Contenuti/MibacUnif/Comunicati/visualizza_asset.html_919776048.html](http://www.beniculturali.it/mibac/export/MiBAC/sito-MiBAC/Contenuti/MibacUnif/Comunicati/visualizza_asset.html_919776048.html)).

**Step 2. On-site Survey (see STORM Glossary)**
<table>
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<th>DRR Phase framework</th>
<th>Current practice</th>
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<tbody>
<tr>
<td>- initial damage assessment</td>
<td>The initial damage assessment is carried out in close collaboration between actors involved in CH safeguard and corps such as Fire Fighters and Civil Protection. Praxis includes a survey of structures and assets in order to fill in specifically available forms, or to prepare a written report usually completed with photos, for preliminarily estimating the damages.</td>
</tr>
<tr>
<td>- priorities for intervention</td>
<td>Usually the priorities for intervention are established case by case on the basis of the almost prepared damage estimation report and of the necessity to reduce possible further heritage losses. Evidently, the priorities are decided also on the basis of emotional and cultural aspects that normally link each single community to specific buildings, churches, historic monuments, etc. considered as particularly relevant for the community itself.</td>
</tr>
<tr>
<td>- security and stabilization planning</td>
<td>In the case of ND involving large areas, in most situations plans for CH security and stabilization come after the recovery of primary needs of people such as for example access roads, water services, etc. After this first recovery, case-by-case, a plan is predisposed for security and stabilization of immovable and movable CH assets also in order to reduce the risks of further losses of parts. As it emerged from interviews and questionnaires, the security and stabilization planning mainly concerns the recovery of movable objects in safety places. See for example T1.1 questionnaires (A.10 - A.11 and A.12) in which suitable stores and spaces are often declared to be planned, near the archaeological site for the recovery of objects in case of ND.</td>
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</table>

**Step 3. Security & Stabilization Actions** (see STORM Glossary)

- security
- triage & in-situ stabilization (immovable heritage)
- evacuation
- salvage, triage & stabilization (movable heritage)
- full damage assessment & recovery needs
- temporary storage
- preparing for recovery

The stabilization of immovable assets is made in situ with commonly used techniques to ensure stability and security for heavily damaged buildings (scaffolds, counter-battens, braces, shoring and bracing structures, etc). This information has been derived from questionnaires and also from case studies, see for example the Greek case (4.2.1). In the case of movable heritage, the first step is usually an in situ stabilization of the objects or, if possible, the immediate transfer to safe spaces, where it is possible to carry out emergency interventions, if required, to stabilise the damage (see above). In the case of relevant CH assets, generally a lot of voluntaries mobilise for supporting the first aid (for
Current practice for management and conservation of Cultural Heritage

**DRR Phase framework** | **Current practice**
---|---
example collection of fragments and detached pieces in case of earthquake, recovery of books or other objects in case of flooding, etc.).

**Recovery**

- conservation and restoration
- returning salvaged assets (movable heritage)
- “lessons learnt” and “build back better”: efforts to reinstate and enhance preparedness and mitigation measures
- public information
- disaster memorialization

Concerning the recovery phase, from the case studies investigated and from the literature, it is possible to say that conservation and restoration activities are performed in order to allow the damaged objects to be made available again for use. The objects moved for emergency interventions and restoration are then usually returned to their original places, including the cases of collapsed wall paintings or architectural elements. In some cases, when the artefact cannot be returned to its original location due to security problems, a copy of the asset is placed there instead.

In terms of “lessons learnt”, from the analysis of current practices it could be derived that, after the first emotional moment linked to the disaster, measures for reinstating preparedness and mitigation are developed either in excessively long timeframes or they are not developed completely. Nevertheless, information is gathered and used for creating risk maps based on historical events and their frequency.

The comparison table highlights some interesting results in terms of current practices for risk reduction phases, revealing both good practices and lacks.

Risk assessment is a well-defined phase in DRR framework and in current practices good exempla have been found: information systems for documentation and listing; risk maps; development of predictive models.

Risk control, on the other hand, is well-defined but needs some improvement especially in the field of prevention and preparedness often due to the lack of funding. However, good practices were found in this regards and should be used ad models.

At last, the phase of response is generally well-assessed and defined in terms of actions and actors involved (Fire Fighters, Civil Protection and police corps).

### 4.3 Lessons learned and conclusion

What are the lessons learned from the work made for D1.1 preparation?

It is difficult to summarize all findings, due to the wide panorama of current practices in management and conservation of CH, but some general highlights could be found.

First of all, a lot of principles, guidelines, and recommendations are supplied at international and national level by associations, institutions and agencies concerning CH protection against
NHs and, in general, CH conservation. Theoretical principles for good conservation processes and managements practices are well-known but a gap also exists between theory and practice.

As expected, in absence of precise legislation setting out the actions to be taken, the protection against natural disasters is being addressed in practice with different ways referring to the nature of CH assets, their construction techniques, materials, and finally to their geographical location.

In fact, as revealed by an initial investigation made by Tuscia team, it emerged that the search of a practice for the CH safeguard is often linked to the sensibility and risk perception felt by the peripheral protection organisms of the Ministry and governments.

Basically, the design of a protection plan against natural disaster is implemented by the assigned personnel operating on the base of personal theoretical knowledge, and often using the environmental risk studies developed for other sectors such as economy, industry, landscape conservation, etc., even if it should be stressed that some examples of risk evaluation models can be found such as the Risk maps developed both at national and local levels. These maps can be considered as valid instruments for risk assessment, in fact they produce Ch distribution and vulnerability datasheets.

The perception that Tuscia team had during the research of information on current practices, (based on bibliographical studies, interviews, questionnaires, etc.) is that a real awareness of the problem of risk management is now well established.

To find the causes of this dichotomy is very complex: form one hand the staff involved in the protection of the CH has usually high professional profile, on the other this staff has limited financial resources to be invested in research for risk management. The funds allocated by the policy are often barely sufficient to perform ordinary functions.

In current practice, for example, a weather alert is issued by the central unit to the peripheral in the imminence of the event if it involves a wide geographical area. It follows that in the absence of real time data, in a CH site is impossible to promptly intervene for risk mitigation.

From the information gathered by Tuscia team it has been also deduced that in current practice, even if the alert is promptly provided, sometimes a lacking of both plan and means to deal with the impending calamity occur.

Risk management, in current practices, is addressed to those risks that are effectively perceived in sites and CH assets. In fact, generally the main considered NH and associated risks are flood, landslides and soil erosion, fire, and earthquake. NHs are clearly strongly associated to the nature and geographical location of the CH and by the typology of asset (archaeological sites, historical buildings, artifacts contained in a museum collection).

So, first lesson learned is that risk management is made in case of real risk perceived by actors involved in CH management and conservation. Risk assessment is a well-defined step supported by documentation activities, risk mapping and in some case by probability studies.

In the research for D1.1 preparation, it was also found some activities usually performed in current practices linked to risk control and conservation.
For example, concerning monitoring and diagnostics of CH asset, it can be summarized that the following steps are often or always performed in the current practices:

- visual inspection accompanied by written reports and photographic documentation, generally performed by institutional officers responsible for the CH assets;
- monitoring of climate and microclimate by different kinds of instrumental systems (data loggers, sensors, climatic stations), generally made by external subjects (universities, research centres, private societies and professionals);
- monitoring of water content and distribution in the structures and materials (gravimetric and psychometric measurements, thermography methods, wireless sensors), usually performed by external subjects (universities, research centres, private societies and professionals);
- monitoring of structures with new generation sensors, usually carried out by external subjects (universities, research centers, private societies and professionals);
- diagnostic campaigns aimed at investigating the composition of constituent materials and their state of preservation. Usually, this step is performed on the occasion of restoration activities but is not imposed by regulations and it is made by external subjects (universities, research centers, private societies and professionals);
- application of non-destructive testing for evaluating the structure stability, usually made by external subjects (universities, research centers, private societies and professionals).

Routine maintenance operations are generally performed by private contracting firms engaged according to planned time intervals or to emergency conditions on the base of directives established by the officer responsible of the CH asset. Major maintenance activities are:

- The monthly removal of deposits in gutters, downspouts, flashings, etc.;
- The half-yearly or annual elimination of abundant humus deposits and weeds by mowing and weeding operations;
- Tree pruning that is mostly done on an annual basis.

As said in par. 5.2, some steps in the risk control phase should be improved especially concerning prevention and mitigation, and preparedness. Prevention is fundamental for cultural heritage protection and safeguard but is not a compulsory activity being so “forgotten” especially in absence of funding. Neglected maintenance of old buildings, sites and materials is one of most relevant problem that often caused the extent of the damage in other disastrous events (especially if not maintenance was made after a ND has occurred).

Also the phase of preparedness should be improved by raising the awareness among communities, single citizens but above all governments, of the great values of CH and of its vulnerability to NH and CC.

Second lesson learned: in current practices conservations activities, such as monitoring, maintenance, restoration, etc., are performed in CH sites and assets.

But the effective use of these activities is linked to funding availability, to the current conservation problems, to the availability of specific projects of monitoring or restoration. In absence of specific laws, which should impose prevention and mitigation activities, and of funding, clearly such activities are not sometimes performed at all.
The same could be affirmed in the preparedness activities, even if some efforts are made in training activities and drills specifically addressed to CH assets.

The literature research associated to the questionnaires collected during the task for D1.1 elaboration, highlights some general procedures and current practices in CH protection processes, also in the absence of a specific law or recommendation for institutions, stakeholders and professionals involved in CH management and conservation. These procedures can be found in cases of good or best practices as reported in par. 5.1.

The relevance of best practice was also underlined by the World Heritage Capacity Building Strategy, adopted by the World Heritage Committee in 2011. This Strategy responds to the identified needs of a diverse and growing audience for capacity building for World Heritage conservation and management activities. Development of resource materials such as best practice case studies and communication tools are among the activities foreseen by the strategy to improve these capacities (http://whc.unesco.org/en/recognition-of-best-practices/).

An example of an innovative capacity building initiative is the recently concluded Recognition of Best Practice in World Heritage Management. This initiative, requested by the World Heritage Committee and carried out within the framework of the 40th anniversary of the World Heritage Convention in 2012, solicited applications from World Heritage properties which had demonstrated new and creative ways of managing their sites. Twenty-three submissions were received and evaluated by a 10-member international selection committee which included the representatives of the Convention’s Advisory Bodies, ICCROM, ICOMOS and IUCN. The Historic Town of Vigan in the Philippines was chosen as a best practice achieved with relatively limited resources, a good integration of the local community in many aspects of the sustainable conservation and management of the property and with an interesting multi-faceted approach to the protection of the site. Management practices recognized as being successful and sustainable can include everything from involving local people in site management, to creating innovative policies and regulating tourism. There are sites that include students from local schools in the management of the site (Slovenia), train local inhabitants as tour guides (Peru), or even put up nylon fences to protect villagers from straying tigers from the Sundarbans National Park (India). Sharing these practices helps other sites find solutions that work.

This initiative provides incentives for States Parties and site managers to reflect on their management practices and explore improvement possibilities.

**Lessons coming from good and best practices are fundamental to develop models to follow for cultural heritage management and conservation.**

In conclusion, from the investigation on case studies it can be derived that CH assets are very complex systems and that each case should be considered as unique. Current good and best practices can give to the institutions and to the stakeholders involved in risk management and conservation activities some guidelines for choosing the best procedures.

Risk management in all its phases, should be implemented in the normal activities for CH protection and safeguard and some phases, especially in risk control steps, must be improved. Furthermore, specific funding needs to be devoted to CH protection also for raising the awareness of its value and vulnerability among communities and people.
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6 Questionnaires

6.1 Introduction to questionnaires

For the editing of D 1.1 Tuscia team prepared two different questionnaires in order to obtain "first hand" information by the actors involved and current practices in the management of CH.

It was considered essential for the reconstruction of the state of art of current practices adopted for the protection of CH, use information derived directly from the voices of the actors.

This need has emerged in the bibliographic research phase since many aspects of the protection, maintenance, prevention, etc., are rarely reported in the literature, perhaps due to the fact that they often coincide with the ordinary duties of the staff working in CH (the reason may be found in the fact that the actors consider these operations as ordinary, without editorial interest.)

In the literature, works related to disclosure of guidelines and theoretical directions for optimal management and protection of CH can often be found. These works, with a strong theoretical approach, are reflected in scientific articles in which are described the so-called "best practices". In the latter case interventions on CH are proposed as expression of a multidisciplinary approach with high innovative and technological content.

It is important to remember that these examples do not represent the current practice, but particularly innovative "practice", result of an unusual synergy between all the actors involved.

In these cases, the involvement expresses a political and economic will, that goes with the need of protection declared by archaeologists, historians, conservators, etc., and the collaboration of professionals related to the natural sciences (physical, chemical, etc.) and the most advanced technology in electronics, computer science, engineering, etc.

The dissemination of the questionnaires took place in Italy following the practice provided by MiBACT, i.e. official letter to the Superintendent with a formal request to obtain and disseminate the information drawn from the questionnaire. Once received a formal request the Superintendent designate an official to complete the questionnaire.

According to the objectives of the project STORM, the questionnaire T1.1 aims at identifying the current practices, in cultural heritage and archaeological contests, linked to maintenance, conservation, preservation and safety management in case of natural hazards. Problems, gaps and needs of the different stakeholders that have attributions on the management, safeguard, protection, conservation and valorisation of cultural heritage will be also highlighted.

Respondents are sought to answer the different sections of the questionnaire according to their area of expertise; while some respondents may be able to answer all sections of this questionnaire, this is not mandatory, since sections are quite diverse in nature.

The questionnaire is developed into 3 sections:

- Section A: Prevention of risk caused by natural hazards in CH contests
- Section B: Locating, description and maintenance of the CH contests
D1.1: Current practice for management and conservation of Cultural Heritage

Section C: Professional figures contributing to the risk prevention in CH contests.

The questionnaires written in English/Italian were sent to 43 Italian superintendents, to the 5 STORM pilot sites and to the members of the project with a request to disseminate the questionnaire in their countries.

The special moment of transition faced by the peripheral units of Italian MiBACT, following the so-called “Franceschini Reform”, heavily affected the collection of information. The difficulties were increased by the re-organization of the Superintendencies with the incorporation of one into another and the consequent temporary interim regency, this also sometimes impeded the chance to get response to the requests.

In order to increase the information about the actors involved, a second synthetic questionnaire (named D1.1) was written and sent to the STORM partners with the aim at gathering some more information about current practices and actor involved in DRR phases.

The D1.1 questionnaire, entitled “Current practice for management and conservation of Cultural Heritage”, covers a wide range of issues, among them it was important for us to know the state of art and the actors involved in prevention and intervention in the countries partners of the project.

In particular, we were interested to know which are the professional figures involved in disaster risk reduction phases.